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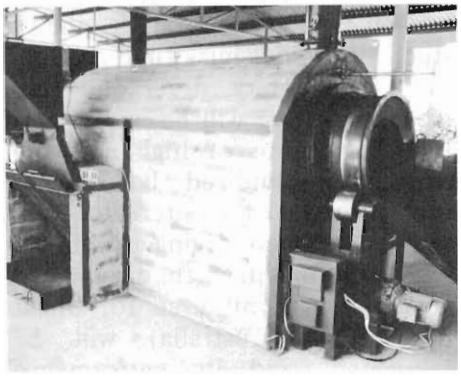
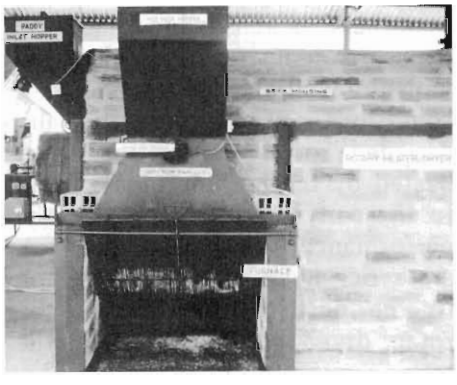
Rice Husk-Fired Rotary Dryer for Disinfestation and Rapid Drying of Paddy

The rice husk-fired dryer project at AIT was initiated in August 1984 and scheduled to last for a period of three years. The project is being funded by the U.S. Agency for International Development under its Program for Science and Technology Cooperation (PSTC).



Rotary dryer perspective



Rice husk furnace

The project has two major objectives — first, to sterilize high moisture grains with high-temperature conduction heating for a very short exposure time as a means of preserving the grain quality while undergoing temporary storage; and second, to accelerate the drying process using high-temperature conduction heating without necessarily affecting the grain quality adversely.

With these aims in mind, both the engineering performance and the microbiological efficacy obtained with a small-scale thermal disinfestation dryer using rice husk as a fuel are presently being studied. Later, the mechanical, operational and economic feasibility of the experimental units will be tested and carefully evaluated.

In the tests which are being

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Workshop on the Design and Construction of a Solar Dryer

This workshop was conducted from 2-10 December 1985 at the Asian Institute of Technology (AIT) under the sponsorship of the Mennonite Central Committee, Bangkok, in collaboration with the

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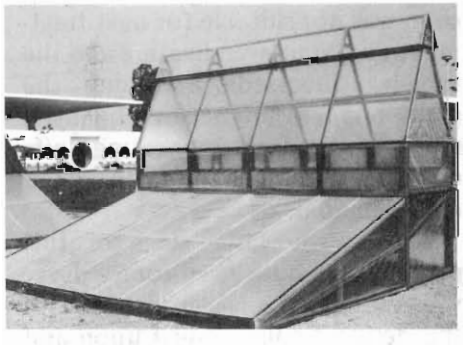

AIT portable solar dryer

tool

wind and sun compendium

Development of wind and solar energy for water pumping

cwd

CRRERIS

Incorporates news from the Commonwealth Regional Renewable Energy Resources Information Service (CRRERIS) and Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

INNERTAP

Rice Husk-Fired Rotary Dryer for Disinfestation and Rapid Drying of Paddy

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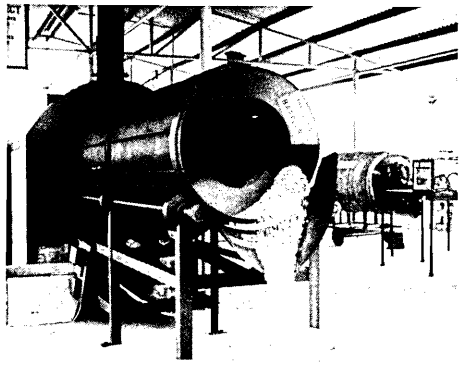
carried out, emphasis has been given to the following major parameters affecting the rice quality as a result of heat treatment and rapid drying: maximum temperature of exposure; duration of grain exposure; initial moisture content of grain; and, moisture removal or drying rate. The overall experimentation is divided into three phases, with each phase lasting for a period of one year.

Phase I consists of experiments on the quality effects of High Temperature Short Time (HTST) exposure of high moisture rice using a laboratory oven. The primary objective of this study was to demonstrate the microbiological efficacy of the heating process in high moisture rice and to establish heating regimes that do not result in detectable changes in grain quality.

The results of this study indicated that heat treatment can suppress the fungal activity in rice grains while at the same time improving the milling quality. However, it was found that a laboratory oven was not suitable for heat treatment due to uneven heating and the time-lag involved in raising the grain temperature. Consequently, rice husk-fired rotary heating units of different designs were considered and evaluated.

During the later stage of this phase, a rice husk-fired rotary dryer was fabricated in accordance with the design finally agreed upon and initial tests were made. The results of these initial tests indicated that the rotary dryer prototype heated by the burning of rice husk is suitable for heating, drying and cooling wet grains, and has the additional advantage of improving the milling quality. The rice husk furnace and the rotary dryer prototype are shown in Figs. 1, 2 and 3.



Rotary dryer – In operation (complete units)

Phase II aims at testing the hypothesis established in Phase I on exposure temperature, and initial moisture content for a variety of conditions using the specially designed rotary conduction dryer heated by the burning of rice husk. In the early part of this phase, the performance of the inclined fire grate rice husk furnace in relation to the heat requirements of the rotary dryer was evaluated from the tests.

Operationally, the rice husk furnace can supply a maximum hot air temperature of 700°C that gives a heating surface temperature of about 300°C, and is attainable at 30 kg/h husk feed rate. This level of heating temperature is more than sufficient to suppress fungal growth in high moisture paddy and to accelerate the drying process. The dryer capacity varies from hundreds of kilograms to half a ton per hour.

The rotary dryer is a continuous mixing type heat exchanger in which the wet grains are frequently mixed by its rotary movement and helical baffles. The wet paddy either tumbles or rolls down through the heat exchanger surface, and gets heated and then cooled while grains are conveyed to the other end, until it is finally discharged into a grain container. The heat transfer in this type of dryer is predominantly in conduction mode.

Suitable arrangements have been made to control the feed rate, residence time, and temperature of the grain. Detailed experiments on heat treatment with accelerated drying are presently being undertaken in the rice husk-fired rotary dryer to establish guidelines for arresting the fungal invasion in high moisture rice in terms of initial grain moisture content, temperature, and exposure time.

It is expected at the end of this phase that the milling quality of grain which has been subjected to various storage periods will be determined and predicted by an appropriate combination of the major heating and drying parameters.

In phase III, a performance evaluation and economic feasibility study of the rice husk-fired conduction type rotary dryer and fluidized bed dryer will be carried out. HTST exposure of high moisture rice in a fluidized bed merits evaluation as an alternate heat sterilization and drying technique. An experimental fluidized bed disinfestation unit used for wheat in CSIRO (Australia) will be fabricated, and its performance with wet rice will be tested and evaluated. Thus it will be possible to critically evaluate the economic feasibility of the two systems.

It is estimated that the cost of conduction heating will be considerably less than the cost of fluidized bed heating due to the use of rice husk as fuel and the fact that a fan is not required. The results from this phase are expected to provide baseline information on the design and development of an appropriate drying unit using rice husk as a fuel.

For further details contact: Dr. V.K. Jindal, Associate Professor and Principal Investigator or Mr. L.G. Obaldo, Research Associate, USAID Dryer Project, AFE Division, Asian Institute of Technology, G.P.O. Box 2754, Bangkok 10501 Thailand.

State of the Art Report on Gasification of Biomass – India

In tropical countries like India, which have abundant rain and sunshine, biomass can significantly supplement the fossil fuel supplies of the country. The main areas in which biomass can play an important role as an alternate source of energy are in thermal applications (boilers, furnaces, kilns etc.) shaft power applications (internal combustion engines, spark ignition as well as compression ignition engines), and in the production of chemicals and fuels. In all these applications the first step towards the utilisation of biomass is to convert it into gaseous and/or liquid form and the thermochemical gasification of biomass should therefore be seen as an important aspect of biomass utilisation.

The government of India has declared that the development of biomass energy is a priority area for research and development, and will attempt to popularise it through field demonstrations. The Department of Non-Conventional Energy Sources is the central agency which has to plan, implement and monitor all these activities, and an action plan on national basis will be formulated to promote the project. As part of the action plan a preparation of state-of-the-art report on biomass gasification will be prepared which will review the current national and international status of biomass technology and consequently help to formulate a strategic plan for proposed activities. The present document is an interim report on the topic.

Preliminary descriptions of the processes involved in gasification of biomass are presented in chapter 2 of the report, where a brief description of the types of gasification equipment used for the purpose is also included. The economic viability of the concept has been illustrated with reference to shaft

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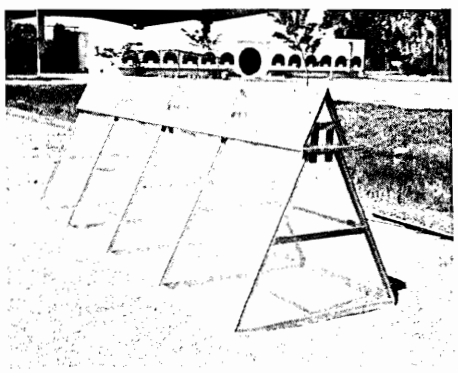
WORKSHOP ON THE DESIGN AND CONSTRUCTION OF A SOLAR DRYER

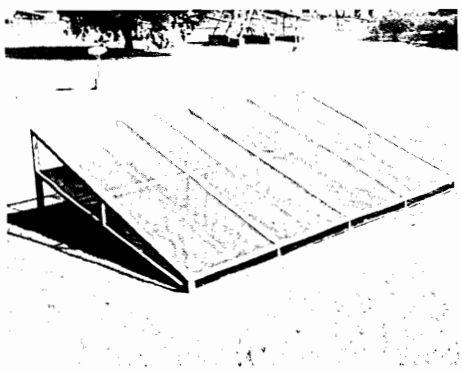
From P. 1

National Center for Research and Utilization of Solar Energy of Vietnam at Ho Chi Minh City. Dr. Nguyen Duc Canh, Mr. Nguyen Thanh Phuong, and Mr. Le Trung Hai visited AIT for the workshop.

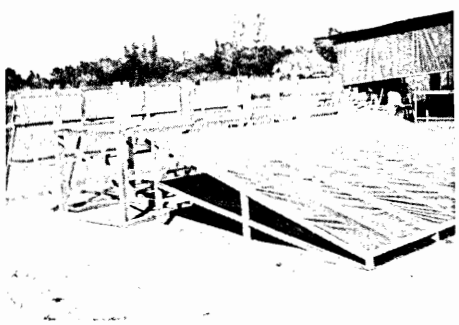
A new AIT solar dryer was designed and fabricated by the participants under the supervision of Mr. Sommai Kornsakoo of the Energy Technology Division, AIT. In this new model black plastic is used as an absorbing surface and covered by clear low-density polyethylene (LDPE) sheet which is now available in Thailand. The LDPE sheet costs half the price of the PVC sheet previously used and does not deteriorate in sunlight. The supporting structure is made of wood. The dryer is built in three separate parts (collector, bed and roof) that can be moved from one site to another instead of being fixed in position as the other AIT dryers are. The dryer is suitable for many agricultural products such as rice, soybean, beans, and corn. The participants plan to introduce this dryer for drying agricultural products in Vietnam.



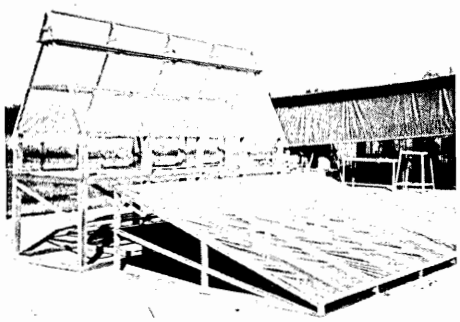
Roof of the dryer



Solar collector



Three separate parts of the dryer – solar collector, bed and roof.



The roof on top of the bed.

STATE OF THE ART REPORT ON GASIFICATION OF BIOMASS – INDIA

From P. 3

power application, giving examples of the parameters which need to be taken into consideration, and the bearing which they have on this particular application.

Chapter 3 presents an assessment of the scope and limitations of gasification technology. Details are given on the influence of biomass properties on the gasification process and on the design of gasifier equipment. The limitations imposed on the utilisation of biomass-based producer gas by the design of the utilising equipment (i.e. engines, burners, etc.) are also described.

Chapter 4 gives an analysis of the scope and limitations of biomass-based producer gas for dual operation in existing diesel engines. The main considerations are the power capacity and thermal efficiency under dual-fuelling. The engine life, maintenance, load following capability, and additional attention which may be required are also discussed.

Chapter 5 presents an overview of biomass gasification and related activities in India. The major emphasis is on R&D work at various R&D institutions. An account of the Central and State Level Energy Development Agencies, which shoulder the responsibility of promoting R&D as well as providing field demonstrations and popularising the process is also presented. Manufacturing and commercial activities, both those which are currently taking place and those in the offing, have also been listed. An extensive bibliography, which includes most of the published work until January 1985, with extended abstracts is given. In addition, over 400 gasifier equipment manufacturers have been contacted out of whom 50 have replied with full details of their products, and these details are also presented. The report also has an author index which contains full postal addresses. Over 1400 persons and institutions have been contacted for collection of information covering various aspects of the subject, i.e. research, technology, prototype building, field trials and data, and in general, the success and failure stories.

The Interim Report *State of Art Report on Gasification of Biomass* (1985, 566p.) was prepared by Prof. P.P. Parikh, Department of Mechanical Engineering, Indian Institute of Technology, Bombay, Bombay 400076, India.

Biomass Gasifiers for 3.7 kW Engines

India has about six million pump sets using diesel engines of 3.7 kW capacity. It was recognized that running these pump sets with producer gas from a wood gasifier (in a dual fuel mode) could constitute a significant conservation measure for oil resources, and also make the user somewhat less dependent on a centralized supply of diesel. The Indian Institute of Science, Bangalore, undertook a project in 1981 to develop a gasifier for the 3.7 kW diesel engine pump set.

In about a year a design using

RERIC SUBJECT COVERAGE

ENERGY CONSERVATION

is currently receiving considerable attention because of its importance for the efficient use of energy resources. RERIC has therefore decided to include materials on ENERGY CONSERVATION TECHNOLOGY, preferably related to renewable energy, in RERIC News and the Renewable Energy Review Journal.

Workers actively involved in R&D on renewable energy are invited to contribute news items or journal articles on energy conservation related to Renewable Energy Resources to RERIC for worldwide dissemination.

For further details contact:

Renewable Energy Resources Information Center (RERIC).
P.O. Box 2754, Bangkok 10501,
Thailand.

extrapolated values for parameters given in a US Solar Energy Research Institute (SERI) report was developed, and tests showed an average replacement of diesel of about 80% at full power. The gas produced by the gasifier and the cooler scrubber system was occasionally characterized by excessive levels of tar. The system required frequent operator attention and often had to be dismantled for maintenance. For ease of dismantling, some of the major junctions on the reactor shell were not welded, but were made leakproof using fire clay and plaster of Paris, which led to the development of cracks, eventually lowering performance. The operation became reliable only when this practice was abandoned completely and fully welded joints and water seals were used.

In the second phase of the project, initiated in 1983, the objective was to develop a prototype that would run reliably and yield good-quality gas while demanding very little attention. Several earlier designs that have various provisions for proper drying and charring of wood chips inside the reactor were considered. This concept has been adapted in the present design as a combination of a unique water seal and high-point gas offtake to obtain reliable operation.

During several runs when the gas quality was bad, it was necessary to dismantle the system and examine various parts. This required almost half a day in the early prototypes, but the time was reduced to thirty minutes in the final version. In a field environment it would be a great help if the system could be dismantled and reassembled in about an hour to reduce down-time.

Functionally the reactor consists of a fuel container, an air-intake arrangement, a throat (hearth), a reduction zone, a grate and a gas-offtake system. The gas passes through a cyclone, a cooler, and a fabric filter before going into the engine. In the earlier prototypes, there were no cyclones and only the coolers and filters were used. The cyclone was introduced for the first time in the fourth prototype (PIV), and is described below.

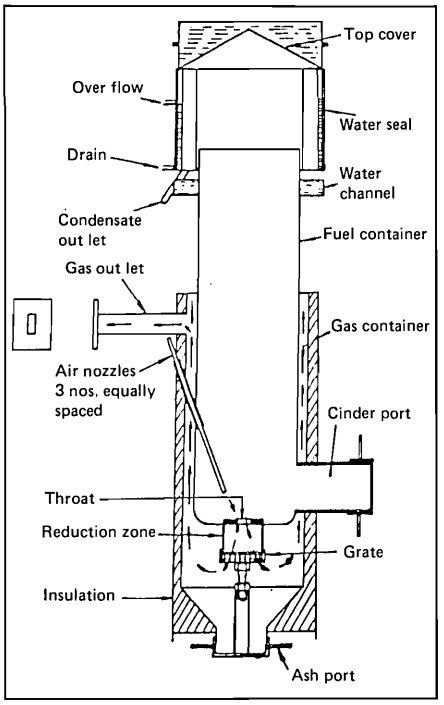


Fig. 1 Prototype IV (PIV)

The Fuel Chamber

All reactors have a fuel chamber that stores wood chips which are deposited there by gravity (as in the present case), or by gravity aided by vibration. The fuel container should be able to condense the moisture liberated from the wood chips and drain it out of the reactor.

The size of the container depends on the number of hours the gasifier is expected to run continuously and on the demand for wood chips, which is about 3.5 kg/h for a 3.7 kW engine. Since it was found that water in most wells in Karnataka could be pumped in two to three hours (at a pumping rate of .01 m^3 per second), it was decided to provide for a substantially lower volume. Prototype IV has a volume of 0.04 m^3 with a diameter of 0.2 m and a height of about 1.0 m. The problem of removing the moisture from the wood chips was successfully overcome by incorporating a water seal at the top of the container, and replenishing the water every hour or so.

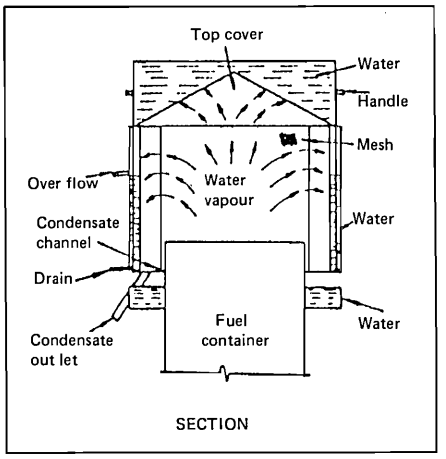


Fig. 2 The water seal.

Loading of Wood Chips

Loading is done through the top cap in Prototypes I, II and IV, and through the side cap in Prototype III. To prevent wood chips from getting into the water channel, the top cap in Prototype IV is replaced by a hopper while loading. The entire loading operation in this last prototype does not take more than two minutes.

The Cyclone

The cyclone has been designed in accordance with standard practices. Its inlet velocity at the nominal flow is 15 m/s and it has been estimated that the dust collection efficiency exceeds 95% at nominal flow. The cyclone inlet temperature is about 400 to 450°C and the exit temperature is 250°C. The cyclone collects on average about 6 g/h of dust.

Further details on the prototypes developed, and the experience in operating them in various engine runs, are available in *Experience with Gasifiers for 3.7 kW Engines* by S. Dasappa, Vikram Reddy, H.S. Mukunda and U. Shrinivasa, AMBIO, Vol. 14 (4-5), pp. 275-279.

Regional Meeting on Solar Drying

This meeting took place from 21-22 January, 1986, and was originized by the Food and Agricultural Organization (FAO) Regional Office (RAPA). The meeting which was called to update knowledge and information on solar drying in the countries of the Asia and Pacific Region, was attended by five participants from countries outside Thailand (Indonesia, the Philippines, China, Malaysia, and India) and about ten from within Thailand.

The following topics were discussed:

- state of the art of solar drying in the region;
- field experiences in the use of solar driers;
- suitable designs of solar drier for different applications; and
- the development and promotion of solar drying.

For further information on the meeting contact:

Dr. Sermphol Buengsung
Consultant on Agricultural Engineering
Regional Office for Asia and the Pacific
FAO, Maliwan Mansion, Phra Atit Road,
Bangkok 10200

Wind Energy Farm in Tamil Nadu – India

A wind energy farm project is ready for commissioning in Mullaikadu, about 15 km from Tuticorin in the Tirunelveli district of Tamil Nadu. The pilot project has been set up on a 40-acre site close to the sea. The farm has 10 windmill towers, each 24 m high. The windmill towers, rotor blades, generators and computer controllers have come from Denmark. Only the control room equipment, the transformers and the cables linking the windmills to the control room have been indigenously manufactured.

The towers have been erected in two rows, 200 m apart — six in one and the rest in another. Each tower is separated by a distance of 105 m to avoid "wind shadow." Though they should be in a straight line, a dispute with a land owner

TRAINING COURSE

Photovoltaics and Solar Powered Pumping Systems: The Technology and Economics

The training course is organized by Global Renewable Energy Services Ltd., the parent companies of which are Intermediate Technology Power Limited and Sir William Halcrow and Partners, the consultants for the UNDP/World Bank Solar Pumping Project. It was held on four occasions in 1984 — twice for engineers from the Laboratoire de l'Energie Solaire, Mali, once for engineers from the Egyptian Electricity Authority, and once for a commercial organisation from India.

The principal objectives of the two-week course are —

- To reinforce the knowledge of the participants in the principles of solar energy and photovoltaic conversion with specific reference to solar pumps.
- To review the main applications of photovoltaics.
- To establish an understanding of alternative solar pump types.
- To review solar pump test procedures and establish an understanding of instrumentation and calibration methods for solar pump testing.
- To obtain and analyse test results for (a) PV arrays, (b) high head submersible solar pumps (c) medium head surface mounted solar pumps.
- To establish an understanding of the methods of economic analysis.
- To allow participants to become conversant with undertaking economic case studies on solar pumping systems.
- To review solar pump purchasing procedures, including tender documents and pump selection procedures.
- To learn the essentials of planning and implementing a field trial programme.

The general purpose of the course is to improve the participants skill in understanding and using photovoltaics for water pumping, and to place them in a good position for planning and evaluating the use of solar pumps in developing countries. Further details can be obtained from: The Director of Courses, Global Renewable Energy Services Ltd., Burderop Park, Swindon, SN4 OQD, U.K.

has meant that one of the towers had to be erected slightly away from the straight line.

To obtain a maximum generating efficiency of 90 to 94% the towers were erected in a north-northeast direction, taking into account the wind direction. Wind velocity peaks in the area during the June-August period, and mills can be operated all through the year except in the last quarter.

The Assistant Divisional Engineer in Tuticorin and the Executive Engineer of Tower Line Construction in Tirunelveli said that the capacity of the ten windmills was 0.55 MW (550 kW). Each windmill has two generators, one with 11 kW capacity and another with 55 kW capacity. At low wind speeds, from 4 m/s to 6 m/s, the turbine ran at low rpm, activating the 11 kW generator. When the wind speed exceeded 6 m/s, the bigger generator would automatically start operating.

The tower was erected in three stages. The first stage, up to a height of 6 m, was assembled on the ground and subsequently erected. The second stage of 9 m was assembled and then lifted by a crane. The third part was prefabricated in Denmark and was installed using a bigger crane requisitioned from the Southern Petrochemical Industries Corporation. On the top was the nacelle, a turbine with three fibreglass reinforced plastic (FRP) blades, the yaw section, etc.

There is also a computer controller between the spans of the bottom tower to monitor the functioning of the wind generator and to detect faults. The yaw system helped keep the turbine directed to the wind, and the controller monitored the direction by means of a wind direction sensor mounted on the nacelle. Thus the blades were turned towards the wind direction automatically.

The entire job of erection of the windmills has been done by engineers of the Tamil Nadu Electri- 25 and a trial run was made in the presence of a Danish expert on December 22 when one of the wind generators produced about 40 units of power. The entire project is now ready for commissioning.

Out of the project cost of Rs. 1.25 crores (≈US$1.06M) the central government gave Rs. 75 lakhs (≈US$0.64M) as aid. The rest was shared by the Electricity Board and the Tamil Nadu Government.

The TNEB is looking for suitable sites to establish similar wind energy farms, and a few suitable locations have been identified in Tirunelveli district itself. The Government of India is supporting the establishment of wind energy farms in Tamil Nadu, Gujarat, Orissa and Bihar. A wind farm set up in Mandvi in Kutch district of Gujarat is being commissioned by the Prime Minister on January 17.

(Source: *The Hindu*, 9 January 1986. Information sent by Dr. A. Jagadeesh, Society of Science for the People, Andhra Pradesh, India).

French Program Looks to Small Grids

France is pursuing a modest wind energy program aimed primarily at islands, overseas territories and smaller diesel grids, according to a program summary provided by the Agence Française pour la Maîtrise de l'Energie (AFME). Funding for the program is about Ffr18M (≈US$2.5M) in the current fiscal year, an amount similar to the preceding two years.

Several research projects are being carried out for smaller (less than 20 kW) and medium (50-200 kW) sizes of wind turbines. AFME works with both the federal aerospace research agency, ONERA, and with private industrial partners in the research program. Private firms involved in the effort include:

- *Pro-Engin*, with 30 employees, which manufactures ship superstructures and military equipment. The company is building Savonius vertical-axis "microgenerators" for battery-charging applications.
- *Le Jeloux*, with 30 employees, a yacht manufacturer, which is developing wood epoxy blades similar to those produced by American blademaker Gougeon Brothers, and which is also working on a 12 m (39.4 ft), three-bladed, upwind turbine.
- *Ratier Figeac*, a 500-employee maker of aircraft propellers and equipment, which has an 18 m (59 ft) 100 kW unit in production and is developing a prototype 200 kW machine with a 22 m (72.2 ft) rotor.

The program's primary demonstration projects are located at:

- *Trébeurden* in Brittany, the site of the Centre National d'Essais Eoliens (CNEE), where applied research on dynamic behavior is being conducted and a Ratier prototype machine is installed.
- *Lastours*, in the south, where a windfarm of 10 kW turbines has been interconnected with the utility grid, and a prototype Ratier 100 kW machine is installed.
- *Ouessant*, where another 100 kW system is scheduled for installation in April 1986 by Electricité de France, the state utility board.

Future projects are planned with 100 kW units at Camazes and at Marie-Galante, which is in the French West Indies, and with 200 kW turbines at Lastours and on the Mediterranean island of Corsica.

For further information, contact AFME, Route des Lucioles, 06565 Valbonne Cedex, France.

(Source: *Wind Energy Weekly*, Vol. 4 (184), November 1985).

Israel Sees Wind Energy Potential of 1000 MW

Israel is pursuing a wide range of wind energy activities aimed at realizing the 1000 MW potential identified several years ago in a survey of the country's wind resources. Current programs include determining windfarm sites, developing numeric and physical models for predicting wind flow, preliminary siting surveys (using maps, photographs and kite anemometers), and detailed surveys with meteorological towers.

Wind speeds at the candidate windfarm sites which have been identified range from 6-8 m/s (13.4-17.9 mph), and the sites span the country from the Golan Heights in the north to the Negev desert in the south. The most significant in terms of megawatts of estimated capacity are: Negev — 200 MW; Shegev (Galilee region) — 100 MW; East Mountains (Golan Heights) — 80 MW; and North Galilee — 60 MW.

According to an article in the Autumn 1985 issue of *Israel Energy News*, the Israeli government forecasts that with a 30% capacity factor, the windfarms could produce some 2.5B kWh of electricity annually, an amount equal to about 20% of the country's annual power demand. Israel considers that private investors can be encouraged to build wind projects and sell the power which is generated to the Israel Electric Corporation (IEC), the state utility.

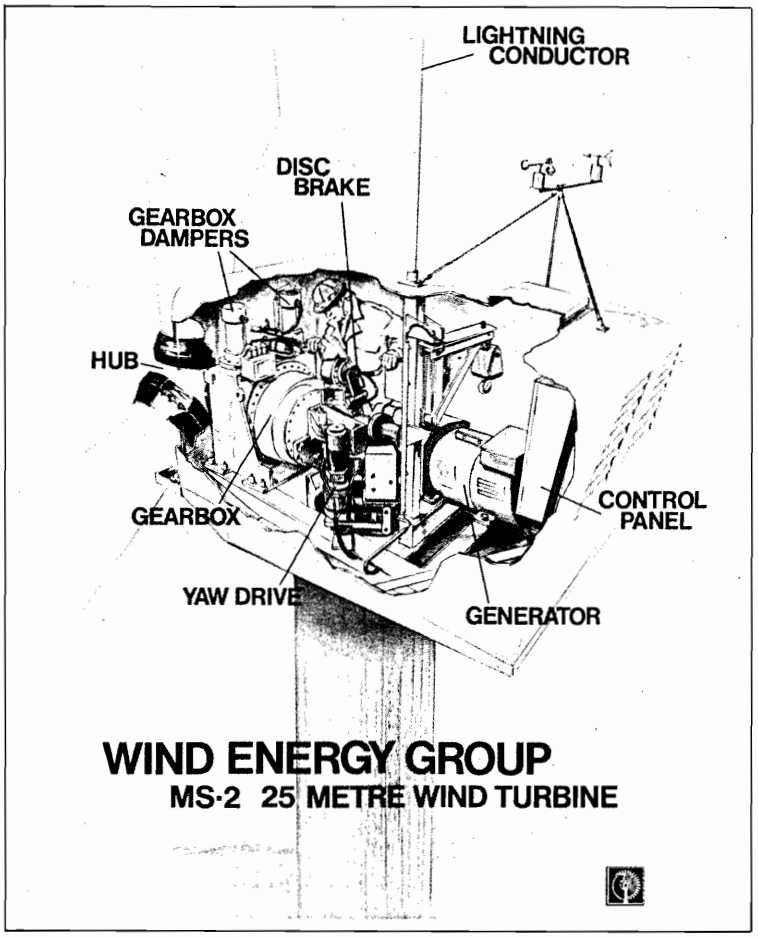
Two turbines are currently operating in Israel. The first, a 45 kW machine, was built in 1981 at the Iscar Blades factory in Ma'alot, and supplies electricity directly to the plant, which makes precision cutting tools. The second, a 55 kW Vestas unit, was funded by a local water supply cooperative in the Golan Heights and also a 30% grant from the federal energy ministry, and went into operation this year.

The Energy Ministry continues to seek investors for wind projects and to work with local companies and organizations that could build and maintain windfarms. Among groups with wind energy plans, according to materials provided by the ministry, are:

- o IEC's R&D branch, for a 200 kW turbine in a demonstration project at Shegev in the Galilee region, and a 20 MW windfarm in the same area.
- o Mei-Golan, the cooperative which installed the 55 kW unit in the Golan Heights, for a 20 MW windfarm.
- o Upper Galilee Water Authority, for a 20 MW windfarm in the Galilee mountains.
- o Misgav Regional Municipality,

UK Wind Energy MS-2 Prototy

In parallel with continued operation of its MS-1 prototype on Orkney, the Wind Energy Group (WEG) has now commissioned the MS-2 commercial derivative. This MS-2 wind turbine has a three-bladed wood-epoxy rotor with a diameter of 25 m mounted on a rigid hub, and a planetary gearbox suitable for induction or synchronous application (see figures).



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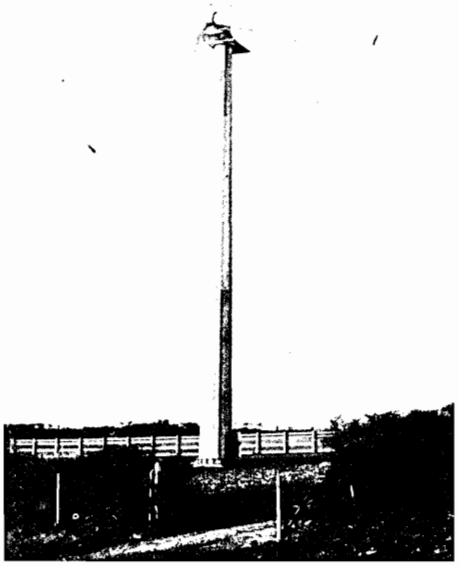


WEG 25 m 200/250 kW MS2 Wind Turbine Generator at Ilfracombe

The innovative features of the machine include:

- o all electric, fail-safe, variable pitch rotor control
- o gear train compliance for synchronous generator operation
- o installation and exchange of all major components using only a small winch and off-loading crane.

The MS-2 has been specifically engineered for low-cost installation and operation both in windfarms and with small diesel-powered grids. The design features of reduced weight, increased reliability, and ease of maintenance and erection have been combined to create an economical machine. Safety standards in operation and maintenance access have been combined with engineering excellence to produce a 'utility standard' wind turbine.

The MS-2 prototype has been designed, built, factory-tested and installed at Devon (U.K.) for field testing. The field-test results show that the LS-1 aerofoil section of blades and unbroken blade line make the rotor highly efficient; the test also shows that the power regulation by pitch control is suitable and effective.

During the latter part of 1985, the rotor and transmission were removed as planned for strip-down and examination. Minor modifications are being made to improve the smoothness of running.

For further details contact: General Manager, Wind Energy Group, Taywood House, 234 Ruislip Road, Southhall, Middlesex UB1 2QX, U.K.

for a 20 MW windfarm in the Shegev area of the Galilee region.

- o Maale Gilboa Regional Municipality, for a 60 kW demonstration turbine and 10 MW windfarm in the Gilboa mountains.

For further information, contact the Israel Ministry of Energy and Infrastructure, P.O. Box 1442, Jerusalem 91013, Israel.

(Source: *Wind Energy Weekly*, Vol. 4 (185), November 1985).

Assistance for Micro-Hydro Development

The Intermediate Technology Development Group (ITDG), through its micro hydro programme, aims to improve the productivity of communities and small enterprises in rural areas of developing countries by offering advice in the choice of appropriate technologies and providing technical assistance. ITDG can also help find potential sources of finance to support projects, whether through government agencies, co-operative banks, or development agencies. In some cases, ITDG will help to support projects with financial assistance from its own funds.

One of the first aims is to identify competent and motivated collaborating institutions interested in the development of rural communities in hilly areas. These organizations may be government authorities, private voluntary agencies, or individual entrepreneurs. The local need for energy, in terms of productive end use, is identified, and then technical assistance in the design and construction of a small number of micro hydro schemes is provided, to demonstrate the economic feasibility and examine the practical feasibility of such schemes when appropriate techniques and simple equipment are adopted.

During this period of establishing pilot projects, local personnel are trained in the application of unfamiliar techniques or the manufacture and maintenance of the necessary equipment. This training is augmented by visits from technical experts. Services to evaluate the social and economic impact of projects and to advise on complex social problems of the ownership, management and maintenance of integrated micro hydro schemes are also provided.

Considerable effort and attention is now being directed towards repeated use and dissemination of those technologies that have been shown, by successful demonstration

Cont. P. 10

ASSITANCE FOR MICRO HYDRO DEVELOPMENT

From P. 9

projects, to have potential for widespread application. Much of the expertise that has been gained by ITDG in micro hydro development has come from the rehabilitation of micro hydro plants on tea estates in Sri Lanka.

The initial assignment given to the consulting body of ITDG — Intermediate Technology Consultants (ITC) — in 1983 by the Dutch-funded Integrated Rural Development Project (IRDP) was to identify 10 tea estates where rehabilitation of disused micro hydro plants could provide financial return over six years. The criterion was that the work should give a simple payback in less than three years.

Under a specific agreement with the Sri Lankan Tea Estates, IRDP pays the renovation costs, then sells the electricity to the factory at the normal rate for six years, then at a 25 per cent reduction for another four years, with the plant reverting to the tea estate after that. The consequent savings on electricity bills are to be spent on welfare projects for the workers. This arrangement allows IRDP to augment their grant funds for further welfare projects and provides the tea estates, at no cost, with renovated hydro plants which eventually revert back to their ownership.

Within the context of this assignment, the consultant (ITC) was responsible for:

- o the overall design and specification of the plant;
- o the selection of local contractors, by tender;
- o monitoring the work and supervising commissioning; and
- o training a counterpart from the staff of the Tea Corporation in all aspects of the undertakings.

Some of the other Third World schemes which have been undertaken are in Colombia, Nepal, China and Peru.

Colombia. A village community has built its own micro hydro plant to drive a sawmill. The market value of logs felled locally has been doubled and, in addition, it has been possible to supply electricity for cooking and lighting to each house. ITDG helped to install the turbine and is now assisting local funding institutions in the search for other suitable locations for micro hydro projects in the country.

Nepal. The United Mission to Nepal set up a company under local management for the manufacture of cross-flow turbines. Some 135 have already been introduced and are providing mechanical drive power for rice mills, grain mills and oil expellers. With ITDG assistance, these installations are being extended to supply domestic electricity to neighbouring communities.

China. Electronic load control (ELC), which is now acknowledged as the most reliable method of controlling micro hydro plants, has been demonstrated and field-tested in China, a country with some 87 000 small and micro hydro plants already in operation. At the invitation of the Hangzhou Regional Centre for Small Hydro Power (set up under a collaborative agreement between the Chinese government and the United Nations) the ELC is now to be assembled in Shanghai, and will be installed in existing micro hydro plants in China, Nepal and Pakistan.

Peru. Eighteen months of investigations have shown that the prospects for community micro hydro projects in Peru are very promising. Three sites have been selected for initial demonstration projects.

For more information, contact: Intermediate Technology Development Group Ltd., Myson House, Railway Terrace, Rugby CV21 3HT, U.K.

(Source: *Water Power & Dam Construction*, Supplement, November 1985).

Tiny Turbo-Generator for Low Water Heads

The Nanjing Farm Machinery Research Institute in China has developed a new tiny turbo-generator that can make small mountain brooks or irrigation ditches generate electricity. Dubbed the "family generator," it can operate on streams with a flow of 0.025-0.030 m^3/s. It can also operate on a stream with a head of 2.5-3.5 m.

The unit is made up of three parts — the dynamo, turbine and load regulator. The dynamo, which generates the electrical power by rotating an armature through a magnetic field, is cylindrical in shape and is encased in a waterproof cover 15 cm wide. The turbine, which is turned by the water from the stream and transmits rotary mechanical power to run the dynamo, is smaller in size, resembling a 30 cm loud-speaker. The turbine and the dynamo are connected by an axle, and pipes are fitted into both ends of the water turbine. The load regulator, about the size of a table radio, is wired to the generator and the electrical appliances at home. It works automatically, ensuring that too much power is not drawn and that a constant level is maintained.

According to Mr. Zhao Shukai, chief engineer of the institute, the generator is suitable for use in flat and hilly regions as well as on small islands. It can work either by a mountain stream, a pond, an irrigation ditch or at the waste water outlet of a factory.

(Source: *The Hindu*, 28 August 1985).

Wave Power Heat Generating System to be Constructed – Japan

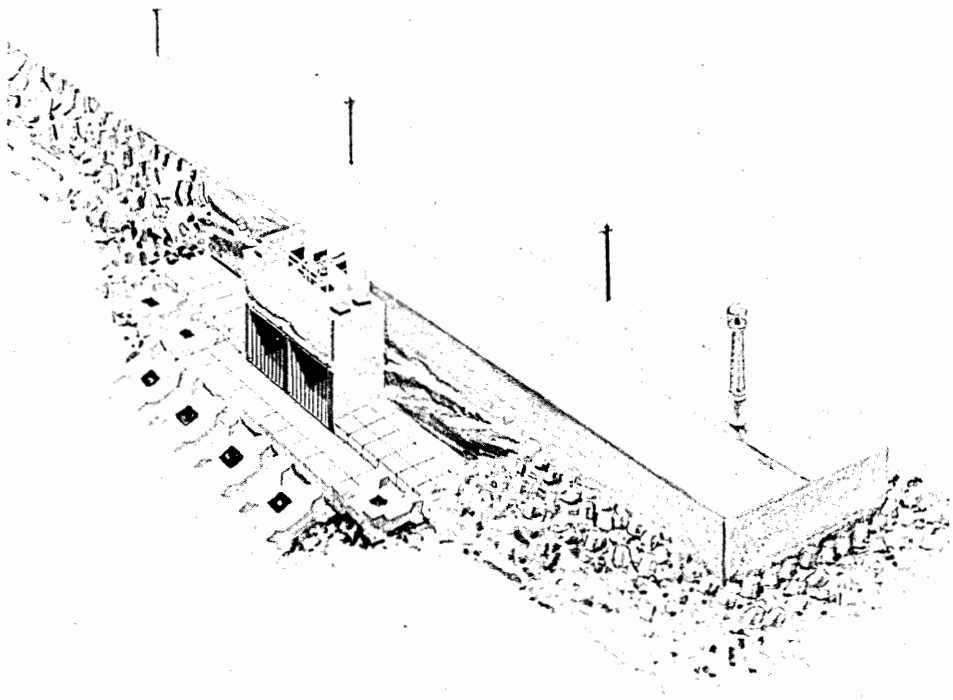
Taisei Corporation begins development this year of a pilot plant to convert the energy of waves hitting break-waters into heat to be used for fish farms, melting snow and as local heating energy. The development is to be carried out over a three-year period. The first year will concentrate on design aspects, the second on construction, and the third year will be concerned largely with follow-up experiments.

The pilot plant is to be constructed on a site in the northern part of the main Japanese island facing the Japan Sea, at a total construction cost of ¥400M (US$-2.24M). It will be supported by subsidies from the Ministry of International Trade and Industry of Japan. The plant will be placed in front of an existing break-water, and will be composed of a wave-air converting box (a resonant type wave power converter) made of concrete, and heat generating devices (a turbine plus an eddy-type direct heat converter). The dimensions of one unit of the concrete box are 13.3 m (width) × 14.5 m (height) × 7 m (depth).

Waves enter the box from the lower open part, and the water surface moves up and down in the box and creates air currents in the air chamber in the box. The air current is turned into heat energy as hot water by the turbine and heat generating device. The heat energy is absorbed by the cooling water flowing through the heat generator, and the hot water is brought out and stored in the tank.

Taisei expects heat energy conversion of 30% from the wave energy. In the case of waves 2 m

Cont. P. 12



An artist's sketch of the wave power heat generating system pilot plant.

Renewable Energy Studies in Australia

Several candidates in the Master's Degree program in Development Technologies at the University of Melbourne have carried out the research/development component of their studies in the field of renewable energy or in energy conservation. In particular, the following topics were chosen for this component of the course:

Energy losses and thermal efficiencies of traditional Burmese-type cooking stoves (U Aung Myaing); Solar rice drying in Thailand (Somnuk Theerakulpisut); The manufacturing of direct-reduced iron and its use with possible applications in Thailand; (Chatchai Somsiri); The effects of methods of air supply on the operating behavior of a rice-husk pyrolysis reactor (Bordin Dejsupa); Improvement of the thermal efficiency of traditional Burmese cooking stoves (Daw Sandy Myint); Carbon-producing volatile burner (Hans Ots); Thermal effects influencing the pyrolitic decomposition of rice husks (U Kyaw Minn); Solar ponds (Surachai Limyingcharoen); Solar refrigeration for developing countries (Marites Carbrera); Solar desalination with natural gas boosting (Sam Khatib); Design optimisation and economic evaluation of a solar hot water system for the rural wool dyeing process in India (Yogesh Parikh); Natural convection solar heat pipe storage systems (Graeme Smith); Energy considerations in building technology in Tanzania (Stephen Basimwaki); Design and testing of a solar crop dryer (Milton Henry).

(Information contributed by Dr. D.S. Mansell, Appropriate Technology Coordinator, Appropriate Technology Section, Faculty of Engineering, University of Melbourne, Melbourne, Australia).

New Renewable Energy Equipment in China

The Nanchang City Industrial Technology Development Centre has designed five new pieces of equipment for utilizing renewable energy resources.

Solar Concentrator for Water Heating

This water heater can be used for producing drinking water for communities in remote or hilly terrains, or on islands where energy sources are not easily available.

It is equipped with a CPC vacuum concentrator, and does not have any tracking mechanism or temperature control device since these would require the use of an electrical source. It is very convenient to use, portable, and reliable.

On a clear day during summer and autumn, when there is an average solar radiation of about 500 kcal/m^2 per h, this equipment can produce about 65-92 kg of boiled water each day, and the daily average heating efficiency is 30%. In winter and spring, with a lower insolation of 400 kcal/m^2 per h, the daily output is 20 kg of boiled water, and the daily average heating efficiency is 15%.

Double Cylinder Solar-Powered Pump

This water pump (NSP-1) is solar powered and vapour-operated. It can be used mainly by rural communities to provide water for irrigation and domestic purposes. The system consists of a flat-plate collector, a vapour/water separator, a working pump, a circulating pump and a condenser. This pump is the first of its kind to be developed in China. Test results show that the pump system is simple to operate, easy to start, and stable while running. It is also convenient since it does not require an external power source, it has a high suction lift, and can accept a high condenser temperature. The pump can be used for pumping well water and river water, or it can be used where the water level is very low.

On a clear day, during May to October, the pump can be operated for five to six hours, with an average output of 70-90 W. The discharge head is up to 30 m, the suction head is 7 to 8 m, and the pump has an average daily efficiency of 0.6%.

Wind Generator

This wind turbine (SZD-1) has been designed so that the blades can be adjusted automatically, and to ensure that installation can be carried out quickly and simply. Its starting wind speed is 2.5 m/s and the operating wind speed is 6.5 m/s. At the design speed, the output of the machine is 100 W, and the system includes electricity storage facilities.

The turbine will directly drive an electrical generator, and electricity can be used directly or can be stored for use when wind is not available. The machine can be used to meet household needs in places where energy is not easily available. It can be used to provide electricity for lighting, radio, television or other domestic equipment.

Solar/Steam Drier for Timber

This drier, known as the Zhiang Zi Zhang drier, incorporates a solar air heater of 120 m^2, and is capable of drying 14 m^3 of timber. During overcast days, the system can be operated using an auxiliary heat source — namely excess steam from the factory's boiler. The steam from the boiler is used to heat air via a steam-air heat exchanger. Both the cost of building the drier and its operational costs are cheaper than using steam by itself. The system is simple and safe to operate, and provides a good quality product.

Solar Box Cooker Using a Flat-Reflector Concentrator

This solar box cooker uses the greenhouse effect to trap radiation, has a flat-reflector for concentrating solar radiation, and an efficient absorbing surface for heat collection. Its main features are —

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WAVE POWER HEAT GENERATING SYSTEM TO BE CONSTRUCED — JAPAN

From P. 11

high with 6.5-second intervals, the system can convert 130 kW of wave energy into 40 kW of heat energy. When 10 units are used, Taisei claims that it will be possible to raise the water temperature from 7°C to 15°C in 15 to 40 fish tanks measuring 2 m (width) × 1 m (height) × 3 m (depth).

The pilot plant is to be constructed on the Japan Sea side of the country because the waves are high in winter, so that the generated hot water may be used for heating in fish farms, horticulture, schools, offices and homes. At the same time, this heat generating system serves as a wave power absorbing system for use in front of break-waters.

Break-water projects cost ¥330B (approximately US$1.85B) a year in Japan, and Taisei hopes the wave power heat generating system will be used in break-water projects as a wave power absorbing system as well as a local energy generating system.

(Source: News Release for Taisei Corporation, 6 November 1985, by Tele-Press Associates, 4-2 Kasumigaseki 1-Chome, Chiyoda-ku, Tokyo, Japan).

CRRERIS

Recent Developments in the Renewable Energy Index*

Introduction

Libraries are the usual places we go to when we want to find reference books. There are also alternatives to libraries such as information brokers, specialised information centres, or on-line computer databases. However, libraries offer many advantages because they are already organised to deal with information requests and the supply of documents, and they offer an established "dealer" network for databases — operating between the "naive" user and the system.

The needs of information users in developing countries which lack sophisticated library systems offer a different set of challenges. The *Renewable Energy Index* illustrates a response to these needs on a regional basis, and is managed by the Central Information Service of the Commonwealth Scientific and Industrial Research Organization (CSIRO). It is a product of the Commonwealth Regional Renewable Energy Information Service (CRRERIS) which is an initiative of the Commonwealth Heads of Government Regional Meeting, and is supported by the Australian Development Assistance Bureau.

The Renewable Energy Index

The *Renewable Energy Index* covers energy management, solar, sea, wind, wave, tidal and biomass energy sources. Geographically it covers the nineteen Commonwealth countries of Asia and the Pacific which are members of CRRERIS. The structure of the Index has been described in the works listed in the reference section.

The Index is unique as a regional operation because of its *vertical* integration. Every operation from collecting documents through to supplying copies to users is covered. The left-hand side of Fig. 1 shows the steps from gathering documents to entering coding information. It is also unusual with regard to the extent to which it pursues "grey" literature produced in the region such as internal government reports, project specifications, consultants reports, and student theses. This literature is usually not available in general-purpose libraries, but is often the material of greatest interest to users of specialised information services. The CRRERIS Liaison Centre in each member country is asked to collect documents concerned with energy management and renewable energy, and in addition CRRERIS organises regular user workshops in each member country to find potential authors and gather suggestions for obtaining additional reports. These active "search and locate" forays are not typical of libraries.

The user can approach the Index either through printed or online modes.

The Printed Index

In the "current awareness"

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- it is simple to construct, light and convenient to use;
- it is suitable for a variety of cooking methods and food;
- during summer, spring, or autumn, a maximum temperature of 184°C can be achieved;
- the temperature in the cooker can be raised quickly and maintained at a constant level.

(Source: *Xin Neng Yuan*, No. 6, p. 49, 1985 [translated and adapted]. Published by the Chongqing Branch of the Institute of Scientific and Technical Information of China, P.O. Box 2104, Chongqing, Sichuan, People's Republic of China).

High Efficiency Plastic Solar Water Heater

In July 1984, Zhangzhou City's Plastic Material Research Centre obtained technical approval for the design of a high-efficiency plastic solar collector (CPS-1). The plastic material has an absorption coefficient $\geqslant 0.9$ and an emissivity of $\leqslant 0.3$. The operating temperature range is 20-120°C and the heat transfer characteristics range is 0.4-0.8 kcal/cm^2 h°C. The anti-static electricity characterstic is less than 10 Ohm mV, and it has an estimated life span of 10 years.

The efficiency of the CPS-1 heater is comparable to others constructed from copper-based material. The total surface area is 1.5 m^2, and on a clear day 100-120 kg/m^2 of hot water at 40-60°C can be obtained. The total weight of the collector, excluding the glass, is about 25 kg. The cost is 80 yaun/m^2 (approximately US$25.00 /m^2).

(Source: *Xin Neng Yuan*, No. 5, p. 14, 1985 [translated and adapted]. Published by the Chongquing Branch of the Institute of Scientific and Technical Information of China).

RECENT DEVELOPMENTS IN THE RENEWABLE ENERGY INDEX

From P. 13

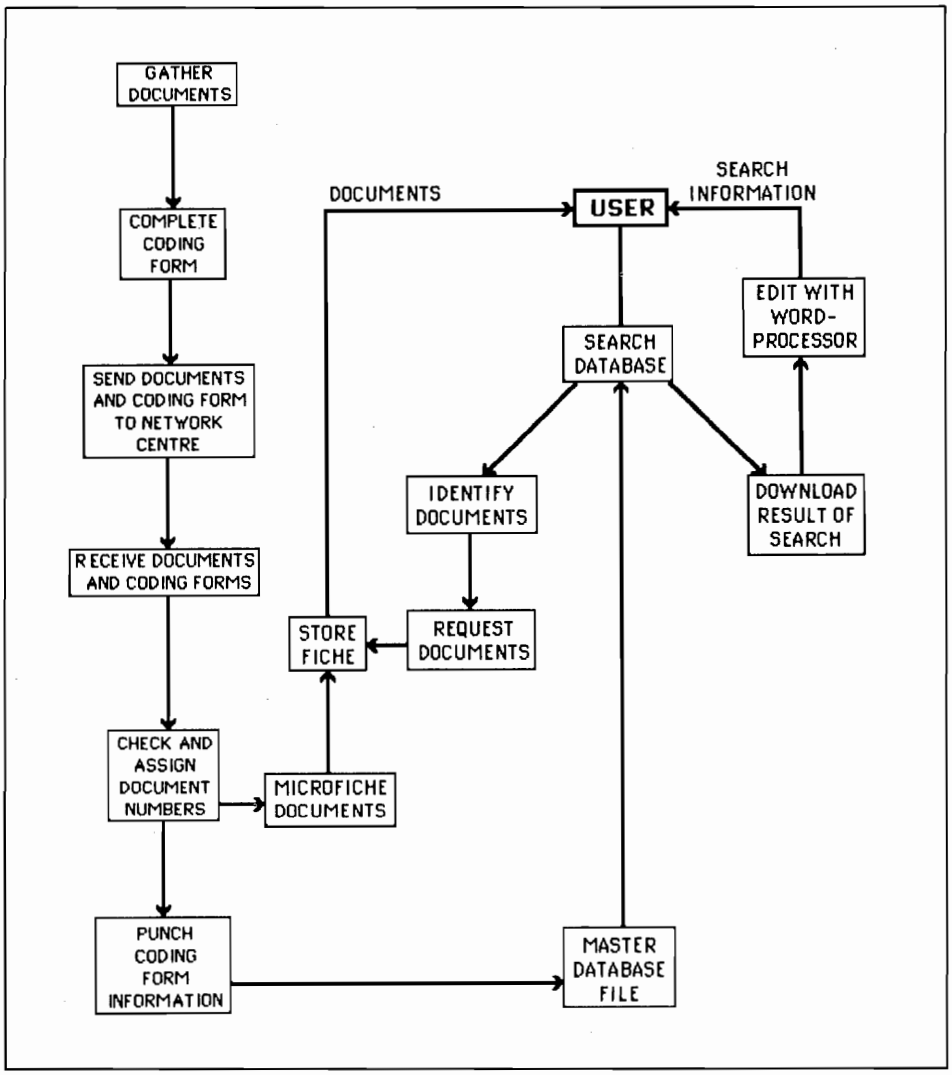

Fig. 1 Operation of the Renewable Energy Index

mode, the researcher uses the printed index. Every three months a volume with all the new material in the database is printed. Where suitable documents are identified, the user can request microfiche copies from the CRRERIS Network Centre in Melbourne. This service is called the "document back-up" service.

The On-line Index

In the on-line system, which became publicly available in January 1986, far greater power and flexibility is possible. Instead of searching many separate printed volumes, the user can search the entire collection of documents at once. The database is available under the AUSTRALIS system of CSIRO.

The database can be used in two ways. In the simple mode, it is searched for suitable documents, their reference numbers are noted, and microfiche copies are ordered by phone, telex or mail (see centre cycle in Fig. 1). In the future CRRERIS plans to have an automatic on-line order system. Because CRRERIS supplies the documents listed in the database, there is no need to search for libraries which hold the items and then order inter-library loans.

The other mode of operation is designed for the information specialist, who is usually preparing a bibliographic search for a client (see the right-hand cycle of Fig. 1). With suitable software (e.g. Crosstalk 16)[4] the result of the search is "downloaded" into a file on the floppy disk of the user's microcomputer (see Fig. 2 for an example). The result is usually full of unwanted messages from the database operating system. After logging off the database, this file is opened using a word processor and edited into a suitable format for presentation to the client (Fig. 3). Typically, a search title and date are added, various database messages are deleted and page breaks are positioned for convenience. It is important to note that these "downloaded" operations involve little extra work, but greatly improve the appearance and value of our search to many users. These easy-to-use and attractive output formats are a feature of a number of commercial database services. However, they are not 'user-controlled' as in the example above.

In 1986 the AUSTRALIS team will concentrate on marketing its on-line services to librarians. As experienced information managers with established clients, librarians have been selected as having the highest market priority. We seek to supplement the present system, not compete with it. In the CRRERIS countries, the organization will promote the service to libraries which have the necessary database searching facilities. If these are not available the database searches will be undertaken at the Network Centre and results posted to users.

Conclusion

The *Renewable Energy Index* database operation incorporates many features that researchers only dreamed about five years ago. It has already merged the functions of report identification and document supply, to make regional

material available to a wide range of users. Access by users outside the region is now possible through on-line searching.

CRRERIS looks forward to the day of *integrated* automation when the present disaggregation of functions is rationalised. When this is achieved, online searching will not only tell us where the item is held, but will enable us to order a copy with a few key strokes on the terminal. The document will be transmitted digitally from storage on laser disk to be viewed on the screen or printed on paper. The user can immediately check the relevance of the item to their needs. References and footnotes in papers can be followed up immediately in a realtime cycle of search-locate-requestreceive and search again.

References

1. Carter, A. and Stockton, J. (1985) *Are You Getting the Most Out of Our Energy Information Service? — CRRERIS*, paper presented to the Commonwealth Science Council Workshop on Solar and Wind Power for Remote Areas and Rural Communities, Melbourne, 9-17 December 1985.
2. Cotterill, D. (1984a), Marketing Information Systems — Case Study of the Commonwealth Regional Renewable Energy Resources Information System (CRRERIS), in: *Delivering Information to Users: Products, Packages and Promotions*, Proceedings of the Eighth General Assembly and Congress of the International Federation for Documentation Commission for Asia and Oceania, Melbourne, 23-28 November 1984, pp. 266-273.
3. Cotterill, D. (1984b), CRRERIS — A Technical Information Service Marketing Case Study, in: *Delivering Information to Users: Products, Packages and Promotions*, Proceedings of the Eighth General Assembly and Congress of the International Federation for Documentation Commission for Asia and Oceania, Melbourne, 23-28 November 1984, pp. 274-286.
4. *CROSSTALK 16 Data Communication Software System*, Microstuf, Inc., Copyright 1983, 1984.


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Renewable Energy Index (REI), approx. 8,100 records, updated quarterly

 AQUARIUS - SEARCH MODE - BEGIN YOUR QUERY AFTER THE STATEMENT NUMBER
 00001PADDY AND DRY$

 PADDY                                33 OCCURRENCES       21 DOCUMENTS
 DRY$                                  2 OCCURRENCES        2 DOCUMENTS
 RESULT                               17  OCCURRENCES      17 DOCUMENTS

 00002..BROWSE

 AQUARIUS - BROWSE MODE - ENTER PRINT SPECIFICATIONS - DR:
 ALL - TOTAL DOCUMENT, A - ALL PARAGRAPHS, B - ALL FIELDS, OR C OR
 EXPLAINALL

 I0405 * WORDLIST-CREATION IS IN PROGRESS.
                                                   PAGE =     1 OF     16
AE850024     DOCUMENT=       1 OF      17
      DN       = AE850024
      CO       = AE
      YR       = 85
      NO       = 0024
      DATE     = 1984
      DOCTYPE  = J
      LANG1    =
      LANG2    =
AU         Shukla=BD; Khan=AU
AULOC      Agricultural Engineering Department,  IRRI,  Los Banos,
           Laguna, Phillipines
TI         Parboiling of paddy with heated sand
SOURCE     Agricultural Mechanization in Asia, Africa and Latin America
           15(4):55-60; 13 refs 1984
DE         Paddy drying
CL         FDOA
IN850023     DOCUMENT=       2 OF      17
      DN       = IN850023
      CO       = IN

                                                   PAGE =     2 OF     16
      YR       = 85
      NO       = 0023
      DATE     = 1975
      DOCTYPE  = P
      LANG1    =
      LANG2    =
AU         Muthuveerappan=VR; Ambalavanan=G; Veeramani=S; Panchatcharam=A
AULOC      Annamalai University, Annamalainagar, India
TI         Design of solar paddy dryer
SOURCE     4 pp; 9 refs 1975
DE         Paddy drying;  Solar dryers;  Design criteria;
           Air flow efficiency
CL         SDOA
```

Fig. 2 The result of a typical database search.

```
SEARCH FOR MR RAGHUBAR SINGH
          MANAGING DIRECTOR
          VISAMA RICE MILLS
          PO BOX 139, NAUSORI
          FIJI

Topic of Search: PADDY DRIERS

The search was made on the  Renewable Energy Index (REI), approx.
8,100 records, updated quarterly


      DOCUMENT NUMBER    = AE850024
AUTHOR    Shukla, BD; Khan, AU
          Agricultural Engineering Department,  IRRI,  Los Banos,
          Laguna, Phillipines
TITLE     Parboiling of paddy with heated sand
SOURCE    Agricultural Mechanization in Asia, Africa and Latin America
          15(4):55-60; 13 refs 1984
KEYWORDS  Paddy drying


      DOCUMENT NUMBER   = IN850023
AUTHOR    Muthuveerappan, VR; Ambalavanan, G; Veeramani, S;
          Panchatcharam, A
          Annamalai University, Annamalainagar, India
TITLE     Design of solar paddy dryer
          4 pp; 9 refs 1975
KEYWORDS  Paddy drying;  Solar dryers;  Design criteria;
          Air flow efficiency


      DOCUMENT NUMBER    = IN850020
AUTHOR    Singhal, OP; Gupta, CP
          Department of Agricultural Engineering, Indian Institute of
          Technology, Kharagpur, WB India
TITLE     Sun-drying studies of raw and parboiled paddy
          2 pp; 8 refs
KEYWORDS  Paddy drying;  Sun drying;  Performance data
```

Fig. 3 After "downloading" the file shown in Figure 2 was edited to make it more readable.

Contributed by Jim Stockton, Liaison Manager, CRRERIS, P.O. Box 89, East Melbourne, Victoria 3002, Australia, *with acknowledgements to Penny Bray-brook, Karen Harris, Andrew Carter, Sue Harvey, Grahame Jackson and Ted Hamilton.*

INNERTAP

The Third INNERTAP Regional Steering Committee Meeting

Third Regional Steering Committee Meeting of the Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP) was held in Kathmandu, Nepal, from 16-19 December, 1985. The committee reviewed regional networking activities, national networking activities, and related activities by the participating international institutions. INNERTAP's work program for 1986-1988 was also formulated.

Dr. Ibarra E. Cruz, the INNERTAP Coordinator, reported on the status of the implementation of INNERTAP projects/activities for 1985. It was suggested that in order to make INNERTAP a more user-oriented service, the network should intensify its initiative to identify users and their specific information needs and use the information collected as a basis for its information analysis and consolidation work. Institutions in each participating country which are actively involved in a particular new and renewable sources of energy (NRSE) technology should be identified so that INNERTAP could arrange to work closely with them in developing information services in their specialized field(s). In addition, INNERTAP should consider the information needs of the rural areas, which are the major users of NRSE resources and technologies.

Following the Regional Secretariat report, the committee discussed, among others, the following points that are related to the implementation of the INNERTAP program:

- the present level of usage of INNERTAP services, and how this may be improved;
- a reliable mechanism to be divided to ensure access to information from reports/proceedings generated by meetings/seminars sponsored by international institutions;
- Plans to be formulated for marketing INNERTAP products and services;
- the scope of information being handled by INNERTAP which may have to be adjusted to meet the needs of perspective users and to accommodate new areas such as energy conservation and rural energy systems.

The Liaison Officers of INNERTAP Member Countries — Indonesia, the Republic of Korea, the People's Republic of China, the Philippines and Thailand reported on their activities and proposed national activities for 1986-1988.

Representing the Commonwealth Regional Renewable Energy Resources Information Service (CRRERIS), Mr. Andrew Carter, the CRRERIS Manager, reported on a recently prepared marketing plan for CRRERIS products and services. This was efficiently done by an Australian consulting firm and has significantly affected his work methodology. Mr. Arthur Vespry, Director of AIT/RERIC, reported that RERIC has been sending its regular publications, RERIC News, Renewable Energy Review Journal, Abstracts of AIT Reports & Publications on Renewable Energy Resources, and Holdings List, etc., to INNERTAP and to its National Focal Points (NFPs) as part of the group subscription paid by UNESCO. He agreed that should a new funding source be found, INNERTAP would be given priority. AIT/RERIC's experience in providing information services was also discussed.

Dr. Shigeaki Koide, Coordinator of the Regional Network on Biomass, Solar and Wind Energy of ESCAP, reported on its information activities and stated that its newsletter is being sent to INNERTAP and also to its National Focal Points upon request.

For additional information on INNERTAP's activities and on the third INNERTAP Regional Steering Committee Meeting please contact:

Dr. Ibarra E. Cruz
INNERTAP Coordinator
PNOC – Energy Research & Development Center
Don Mariano Marcos, Avenue
Diliman, Quezon City
Philippines.

South Pacific Institute for Renewable Energy - SPIRE

The South Pacific Institute for Renewable Energy (SPIRE) is an Economic Interest Group comprising the Territory of French Polynesia, the Atomic Energy Commission, and the French Agency for Energy Management. It has three main orientations:

- o Its Research and Development Laboratory innovates in such fields as solar energy, wind energy and biomass energy and systematically tests all new equipment marketed in the area. This activity is carried out within the regional framework in conjunction with the South Pacific Commission (SPC), the South Pacific Bureau for Economic Cooperation (SPEC), the United Nations Pacific Energy Development Programme (PEDP), and the University of the South Pacific (USP).
- o Its Engineering Group designs renewable energy systems such as solar and wind pumping units, photovoltaic generators, solar water heating stations and carries out studies on energy conservation.
- o Its Training Center provides training required for operators, installers, technicians and engineers using renewable energy.

SPIRE consists of a team of experts located in Tahiti and has a branch office in France within the Atomic Energy Commission. This allows SPIRE to operate in the Pacific Ocean environment, in close contact with the specific problems of tropical and island conditions while retaining the assets of the industrialized world's technical expertise.

As an Instrument in the Development of French Polynesia, SPIRE is willing to offer its experience and know-how to the sister countries and territories in the South Pacific area.

Correspondence should be addressed to: SPIRE, P.O. Box 11530 Mahina, Tahiti, French Polynesia.

An Integrated Rural Energy Center

Khandia, a typical Indian village, is situated at 45 km north-east of Vadodara, Gujarat. The nearest 'Pucca' road is 4 kms away from the village. The inhabitants have to depend mainly on agriculture for their livelihood. Rain-fed agriculture, uneconomic land holding and scanty rainfall have forced the inhabitants to go out in search of secondary occupation to supplement their meagre income. Absence or ineffective utilization of infrastructural facilities such as irrigation, drinking water, health care, education and transportation are the outcome of inadequate energy resources. Women have to walk miles to collect the firewood they need for cooking.

The same is true for a large number of remote, isolated villages spread throughout the country. Either the non-availability or the high cost of commercial sources of energy like coal and oil, together with the dwindling of non-commercial sources like firewood and cowdung, and the increasing demand for energy, has hampered the economic development of these villages. Electrification, the possible alternative to supply power to such remote villages, has not been an economic proposition because of the high investment which would be required in the transmission and distribution network. The losses incurred through the high cost of transmission and distribution and the low demand would result in under-utilisation of the costly power supplied to these villages.

Local Support

The Gujarat Energy Development Agency has therefore, decided to experiment with a novel concept — the Integrated Rural Energy Centre. This centre has decentralised, self-reliant power generation systems based on renewable energy sources which are locally available to meet the total energy requirements of the village. The main objectives of such a centre are "to energise", rather than "to electrify" the village, to make energy available in all requisite forms without compromising on the quality of energy, to use locally available renewable energy sources and to distribute the benefits of increased energy availability equitably.

The involvement of the inhabitants is the key to the success of such a novel experiment, and the Khandia Rural Development Cooperative Society was set up to involve the local people in the decision-making process and the formulation of the Integrated Rural Energy Centre.

The design of the centre involves assessing the availability of renewable energy sources like sunshine, wind, biomass and water on the one hand, and energy requirements for cooking, irrigation, lighting, drinking water, health, education/extension, entertainment and industry on the other. Based on this "matching" of energy requirements and energy availability in Khandia itself, details of systems working on such renewable sources were worked out. A 25 kW biomass

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Canadian Wind Energy Association (CanWEA)

The objectives of the Canadian Wind Energy Association (Can WEA) are formally given as follows:

- To assist the wind energy community, comprising members of industry, research, potential and actual system users and the interested public, with the dissemination of technical and trade information, standards and experience.
- To produce and publish a newsletter at least four times a year and to organize and hold an annual meeting and symposium.
- To represent the interests of the wind energy community before municipal, provincial and federal governments in Canada, and to thereby encourage the adoption of equitable legislative and economic conditions for the industry.
- To promote discussion and to disseminate information on wind energy products, projects and studies, through publications and meetings for the benefit both of industry members and the general public.
- To compile and maintain a registry of wind energy studies, projects and systems, particularly within Canada.
- To foster links with similar organizations outside of Canada.

The newsletter of CanWEA is published quarterly by World Wind Communications Co. (44A Clarey Ave., Ottawa, Ont. K1S 2R7, Canada) under the title *CanWEA Bulletin*. For further details on the organisation's activities, please contact: Alex Printzios, President, Adecon Energy Systems Inc., 32 Rivalda Rd., Weston, Ont., M9N 2M3, Canada.

Note to Organizations...

If you wish to promote your current activities/projects on renewable energy resources in this section, send your information to:
The Editor,
RERIC News,
GPO Box 2754,
Bangkok 10501, Thailand

AN INTEGRATED RURAL ENERGY CENTER

From P. 17

gasifier-based power generation system for domestic and street lighting, as well as for community water supply, was set up. Four 4.5 kW biomass gasifier engine pump-sets for irrigation have also been installed. The fuel required to run these gasifier engine systems is to be supplied by the energy plantations (eucalyptus, subabul, manila, tamarind and neem trees). An 85 m^3 biogas plant with distribution pipelines and gas burners to all the houses has been constructed to meet the energy requirements for cooking. The plant uses the cowdung supplied by members of the Energy Co-operative Society, for which they are paid. A solar hot water system, three solar desalination systems and a photovoltaic-powered refrigerator for the Primary Health Centre has also been provided. Photovoltaic-powered television and radio sets are used to provide education and entertainment at the Community Centre.

(Source: *Urja*, January 1986).

Announcement of ICTP Prizes

The International Centre for Theoretical Physics (ICTP) announces the 1988 prize, in honour of Professor Sigvard EKLUND, in the fields of Solar Energy, Physics and Development and other fields of Physics. The 1986 prize is for contributions in the fields of Solid State Physics, Atomic and Molecular Physics and, the 1987 one is for contributions in the fields of High Energy Physics, Nuclear Physics and Plasma Physics.

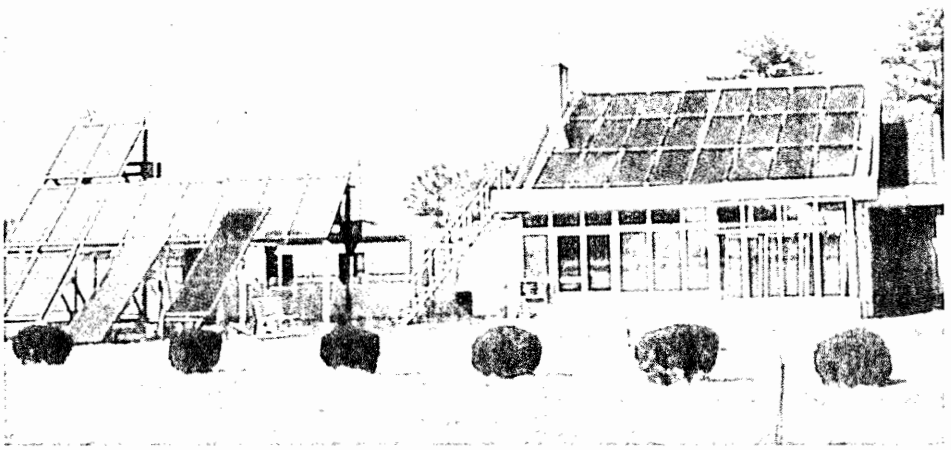
Candidates for the prizes must be nationals of developing countries, working and living in developing countries. Leave of absense due to sabbaticals or studies abroad does not disqualify candidates. Each prize will consists of the sum of US$1000, payable in US dollars or in local currency. The winner of each prize will be selected by an International Committee, from among the most outstanding scientists in the abovementioned fields. The final decision on these awards will be announced in December of each year.

In order to be considered for any of these prizes, a candidate must submit a review of his work and attach a brief curriculum, a list of publications and any relevant published work. The age of the candidate must not exceed 40 years at the time the submission is made. Submissions for each prize must reach the ICTP before 30 June of the relevant year.

Submissions should be sent to:

The ICTP Prize Committee
International Centre for Theoretical Physics
P.O. Box 586
I – 34100 Trieste
Italy

Korea Energy Research Institute (KERI)



Solar collector testing facilities

The Korea Energy Research Institute (KERI) developed from the Korea Institute of Energy Conservation which was established in 1977. The original organisation was expanded and restructured in 1980 and took on its new designation at that time. During the same year, the Korea Solar Energy Research Institute became a subsidiary of KERI, and today KERI is the Energy Laboratory of the Korea Institute of Energy and Resources.

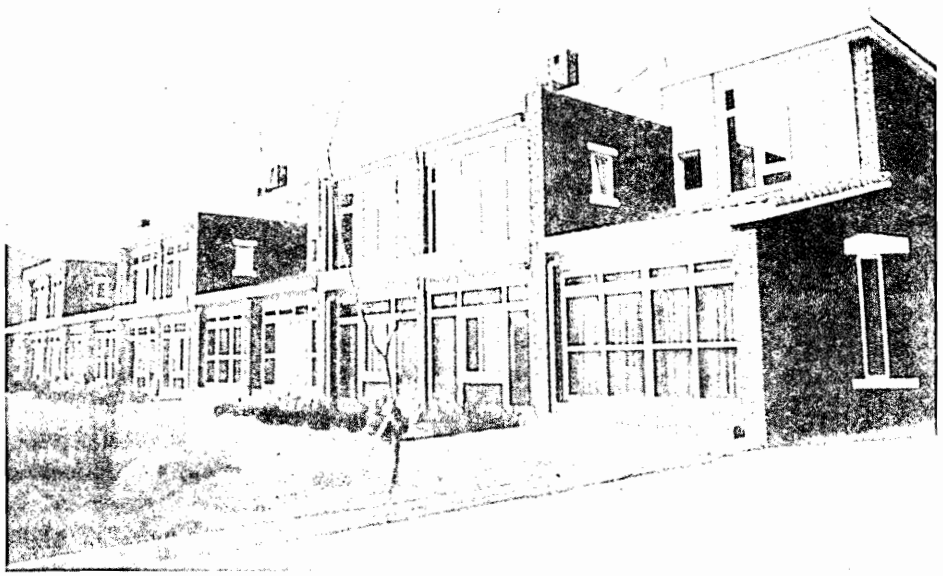
The Laboratory is actively involved in energy technology research and in conservation measures — including the development of alternative sources of energy. The current active areas of research on new and renewable energy technology are:

- o operation of photovoltaic power system and related technology development
- o R&D on passive solar systems
- o R&D on wind power systems
- o comparative analysis of programs and laws related to the new and renewable energy
- o R&D on solar hot water systems
- o solar radiation measurement and performance test of solar energy-related equipment
- o R&D on biomass systems

Some of the recent achievements are:

- o the establishment of a 4kW photovoltaic power plant in Achado Island
- o a demonstration solar house for research and experimental purposes
- o the development of performance-testing techniques for solar products
- o a technical survey of small-scale hydropower resource sites in Korea
- o the establishment of a standard design for passive solar buildings
- o the development of small methane generators for rural areas.

Correspondence should be addressed to: Energy Laboratory, Korea Institute of Energy Resources, 71-2 Jang-Dong, Jung-gu Daejeon 300-32, Korea.



Experimental solar multi-family house

You can now SAVE on postage and have immediate delivery of BOSTID publications from RERIC

The Board on Science and Technology for International Development (BOSTID), U.S. National Research Council, has agreed to have the Asian Institute of Technology's Library and Regional Documentation Center (AIT-LRDC) act as the BOSTID distributor in Thailand. To obtain copies of the following listed BOSTID publications, please contact:

RERIC, AIT-LRDC
P.O. Box 2754
Bangkok 10501,
Thailand

BOSTID publications

US$5.00 Butterfly Farming (34p.)
Winged Bean (50p.)
Calliandra (52p.)
Vector Biology (53p.)
Crocodiles (59p.)
Mangium (62p.)
Sowing Forest from the Air (64p.)
Opportunities for Control of Dracunculiasis (65p.)

US$5.50 Amaranth (80p.)
Agroforestry/Sahel (86p.)
Firewood Crops, Volume II (92p.)
Environmental Change/Sahel (96p.)

US$6.00 Leucaena (100p.)
Producer Gas (101p.)
Jojoba (102p.)
Alcohol Fuels (109p.)
CHEMRAWN (118p.)
Casuarinas (118p.)
Diffusion Biomass Technologies (120p.)
Water Buffalo (124p.)
Little Known Asian Animals (131p.)

US$6.50 More Water for Arid Lands (155p.)
Food, Fuel & Fertilizer from Organic Wastes (172p.)
Making Aquatic Weeds Useful (175p.)
Underexploited Tropical Plants (188p.)

US$7.00 Post-harvest Food Losses (202p.)
Energy Survey Methodologies (220p.)
Firewood Crops, Volume I (237p.)
Priorities in Biotechnology Research (261p.)

The following amount should be added to the listed price for air-mailing charges:

Asian countires (excluding Thailand) US$5.00 per copy

All other countries US$10.00 per copy

Energy Terminology

Energy Balances and Energy Accounting is taken from a larger work, *Energy Terminology: A Multilingual Glossary*, and published by the World Energy Conference through Pergamon Press Ltd, Oxford. This volume on energy balances and energy accounting gives the terminology in four languages — English, French, German and Spanish, and was completed by a working committee of experts from about 15 countries. Other versions of this multilingual glossary are available in Arabic, Chinese, Finnish, Icelandic, Indonesian, Japanese, Norwegian, Portuguese, Russian, or are currently being translated.

For the terms selected, the committee has only presented definitions which have already been agreed upon in the literature or which are in common use in the various countries or sectors.

The sections of *Energy Terminology: A Multi-Lingual Glossary* which have already been published are as follows:

Section 1 General Terms
Section 2 Electricity Industry
Section 3 Water Power
Section 4 Mining and Processing of Solid Fuels
Section 5 Extraction and Refining of Liquid Fuels
Section 6 Gas Industry
Section 7 Nuclear Power Technology
Section 8 Impact of Energy Industries on the Environment
Section 9 Energy Conservation
Section 10 Solar Energy
Section 11 Energy from Biomass
Section 12 Wind Energy
Section 13 Ocean Energy
Section 14 Geothermal Energy
Section 15 Nuclear Fusion
Section 16 Energy Balances and Energy Accounting.

Energy Forecasting Methodology, *Uses of Energy*, and *Instrumentation and Control in Energy Installations* are in preparation. Enquiries should be addressed to Pergamon Press Ltd., Headington Hill Hall, Oxford OX3 OBW, England.

PUBLICATIONS RECEIVED

Biomass Energy

— The Purification of Biogas, Helmut Muche and Harold Zimmerwann, 1985, 34 p.
Available from:
German Appropriate Technology Exchange, GATE
Postbox 5180
D-6236 Eschborn 1
Federal Republic of Germany

— Forestry Biomass for Energy, Proceedings of Technical Consultation of el/n.3, European Cooperative Network on Rural Energy (CNRE), FAO, 1984, 77p.

— International Bio-energy Directory and Handbook 1984, P.F. Bente (Ed.), The Bio-Energy Council, Washington D.C. (USA), 1984, 610p.

— FPRDI Journal, A publication projecting the research and industries development efforts of the Forest Products Research and Development Institute (FPRDI).
Available from:
FPRDI
National Science and Technology Authority
College, Laguna
Philippines

* Improved Biomass Cooking Stove for Household use, Forest Products Research Division, Ministry of Agriculture and Cooperatives, Bangkok, 1984, 323p.
* Industrial Biogas, A Feasibility Study of Waste Utilization from Agro-Industry in Thailand, Division of Energy Research and Development, National Energy Administration, Bangkok, 1984, 137p.
* Biomass Gasification in Thailand, Chulalongkorn University, Bangkok, 1984, 280p.
* Charcoal Production Improvement for Rural Development in Thailand, Forest Products Research Division, Ministry of Agriculture and Cooperatives, Bangkok, 1984, 163p.
* The Village Woodlot: Its Implementation in Thailand, National Forest Land Management Division, Ministry of Agriculture and Cooperatives, Bangkok, 1984, 192p.

Solar Energy

* Solar Thermal Processes in Thailand, A Study on Solar-Assisted Curing of Tobacco Leaves, King Mongkut's Institute of Technology, Thonburi, Bangkok, 1984, 130p.
* Solar Thermal Processes in Thailand, A Study on Forced Convection Hut Drying, King Mongkut's Institute of Technology, Thonburi, Bangkok, 1984, 110p.
* Solar Thermal Processes in Thailand, A Study on Natural Convection Cabinet Drying, King Mongkut's Institute of Technology, Thonburi, Bangkok, 1984, 108p.
* Solar Thermal Processes in Thailand, Studies on Solar Distillation and Solar Refrigeration, King Mongkut's Institute of Technology, Thonburi, Bangkok, 1984, 155p.

Wind Energy

— Capturing Energy from the Wind, J.L. Schefter, National Aeronautic and Space Administration, Washington, D.C., 1982, iii+84p.

Hydropower

* Development of Kam Pong, Mae Ton Luang, Huai Pui, and Bo Kaeo Micro-Hydropower Projects, Development and Promotion Division, National Energy Administration, Bangkok, 1984, 202p.

— Chinese Experiences in Mini-hydropower generation, Small hydropower series No. 3, Ministry of Water Conservation, China, UNIDO, 1985, 122p.

Energy Conservation

— Energy Conservation with Tractors and Agricultural Machines,

Cont. P. 22

Directory of UK Renewable Energy Suppliers and Services 1985

This 1985 issue of the Directory is the 3rd edition, and is produced and published by the Energy Equipment Testing Service, Department of Mechanical Engineering and Energy Studies, University College, Cardiff, U.K. Fifty-two Companies in the United Kingdom whose activities are related to renewable energy are listed under the following classified sections:

— architectural energy saving fitments
— biogas and biomass
— photovoltaics
— heat pumps and accessories
— solar heating equipment
— swimming pool heating supplies
— small-scale hydro, wave & tidal power equipment
— wind power equipment
— geothermal energy equipment
— energy recovery and general supplies.

DIARY OF FORTHCOMING EVENTS

- February 12-19, 1986, Japan

Study Meeting on the Applications of Alternative Energy Sources

This Study Meeting will be conducted by the Asian Productivity Organization in Japan from 12-19 February 1986. The purpose of the meeting is to provide an opportunity for exchanging ideas, information and experiences on the applications of solar energy and natural gas (including co-generation systems). In addition to technical presentations based largely on Japanese, American and Israeli experiences, there will be a number of field trips to places of interest for the participants.

For further details, contact: Hiroshi Yokota, Secretary-General, 1-1, Shibuya 3-chome, Shibuya-ku, Tokyo 150, Japan.

- February 27-28, 1986, Hyderabad, India

IEEE Conference on Energy Options for Power Generation

The conference is sponsored by the Hyderabad Section of the Institute of Electrical and Electronics Engineers, Inc. (IEEE), and is cosponsored by the A.P. State Electricity Board, Hyderabad, BHEL R&D, Hyderabad, Central Electronics Ltd., Sahibabad, the Department of Non Conventional Energy Sources, Delhi, Jyoti Limited, Vadodara Gujarat, and the Tata Energy Research Institute, Delhi.

The conference is expected to provide a forum for exchange of information and discussion among engineers, policy analysts and organizations working in the field to find a better solution for future power generation and related public policy decisions on energy.

The energy options for power generation to be disccussed in the conference are:

- o renewable energy sources – biomass, solar, wind and low-head hydropower
- o conservation, cogeneration, waste heat recovery, improved systems in energy generation and utilisation.

The conference comprises keynote addresses, state of art lectures, and paper presentations and discussions.

For further details, please contact: Mr. C. Satish, Secretary, IEEE Hyderabad Section, 10-5-3/2/6, Masab Tank, Hyderabad – 500 028, India.

- March 3-7, 1986, Bangkok, Thailand

Regional Training Workshop on Energy from Biomass.

This workshop is being organized by the King Mongkut's Institute of Technology Thonburi and sponsored by Unesco. The objectives of the workshop are:

1. To provide the latest information on the status, application of research, development and applications of biomass energy.
2. To create an environment conducive to new technological development in the field of biomass energy within the region.

From P. 21

Proceedings of Technical Consultation of el/n.la, European Cooperative Network on Rural Energy (CNRE), FAO, 1984, 76p.

Renewable Energy

- Renewable Sources of Energy – An annotated bibliography, Consortium on Rural Technology (Delhi, India), 1985, vii+ 392p.
- Renewable Energy Sources: International Progress, Nejat Veziroglu, T. (Ed.), Elsevier Science Publishers B.V. (Amsterdam, Netherlands), 1984, xxii+ 458p. (Part A) and xxii+500p. (Part B).
- * A Feasibility Study of Water Lifting Technology in Thailand, Energy Research and Development Division, National Energy Administration, Bangkok, 1984, 140p.
- * Solar and Wind Energy Resource Assessment for Thailand, Meteorological Department, Ministry of Communications, Bangkok, 1984, 176p.
- Solar and Wind Power for Remote Areas and Rural Communities, CSC Technical Publication Series No. 185, Charters, W.W.S., 1985, v+29p.
  Available from:
  Commonwealth Science Council
  Commonwealth Secretariat
  Marlborough House, Pall Mall
  London SW1Y 5HX

Energy

- * Sectoral Energy Planning Models, Supporting Studies of Thailand's Energy Master Plan, Energy Policy and Planning Division, National Energy Administration, Bangkok 1984, 232 p.
- * Rural Village Surveys in Thailand, Energy Economics Division, National Energy Administration, Bangkok 1984, 212p.
- * The Establishment of Regional Energy Centers for Rural Development in Thailand, National Energy Administration, Bangkok 1984, 145p.

*Available from the publisher; National Energy Administration (NEA), Pibultham Villa, Kasatsuk Bridge, Yodse, Bangkok 10500, Thailand.

NOTE TO ORGANISERS . . .

To announce meetings in this calendar, please notify: The Editor, *RERIC News*, G.P.O. Box 2754, Bangkok 10501, Thailand.

3. To exchange information among scientists and engineers and for young researchers to interact with experienced researchers.
4. To establish a base for cooperation after the conference.

The workshop will be directed toward conversion technology, environmental impacts and economic analysis of biomass production and use. These include lectures by invited speakers, practical instruction, and presentation from participants. A field trip to biogas plants and rice husk gasifiers will be included.

The workshop will bring together engineers and scientists from the Asia and Pacific, and experts on biomass energy. Participants should have background experience or currently be working on biomass energy either on thermoconversion or biological conversion. The training would be of interest to environmental engineers as well as to others interested in waste treatment and utilization.

Using funds contributed by Unesco, the organizers are in a position to support the travel of a few selected participants from developing countries.

For further inforamtion, please contact: Dr. Morakot Tanticharoen, School of Energy and Materials, King Mongkut's Institute of Technology, Thonburi, 91 Suksawasd 48 Road, Bangkok 10140 (Telex: 72383 KMITT TH) or Dr. U.S. Kuruppu, Program Specialist, Unesco Regional Office, Jalan Thamrin 14, Tromolpost 273/JKT, Jakarta, Indonesia (Telex: 44178 UNDEUPPROIA).

- **March 17-19, 1986, Washington, D.C., U.S.A.**

ET '86: 13th Energy Technology Conference & Exposition

This event is sponsored by American Gas Association, Electric Power Research Institute, Gas Research Institute and National Coal Association.

For more details contact: Energy Technology Conference, Inc., 966 Hungerford Drive, 24, Rockville, MD 20850, U.S.A.

- **April 21 — May 16, 1986, Miramare — Trieste, Italy.**

Course on Physical Climatology for Solar and Wind Energy

This course is being organised by the International Centre for Theoretical Physics, Trieste, Italy, and sponsored by the Italian Dipartimento per la cooperazione allo Suilupps.

The course will be conducted in English, and is open to research workers from all countries of the world that are members of the United Nations, IAEA or UNESCO.

The objectives of the Course will be to compile, riview, present and discuss the methods of computation and measurement for the assessment of the availability of solar and wind energy in different regions of the world, with a particular emphasis on Third World countries. It is intended for an audience of scientists and engineers with various backgrounds in energy analysis, meteorology, architectural engineering, physics of solar radiation, as well as for those who intend to convert their future research and teaching activities towards aspects of physical climatology related to solar and wind energy.

The following topics will be covered by a distinguished faculty:

- o solar energy calculation methods
- o atmospheric and earth longwave radiation
- o wind energy assessment
- o solar maps with satellites

The activity will be based on plenary lectures and seminars by visiting experts and participants about specific research projects and realizations. An important part of the Course will be based on practical work with a Microclimatology Laboratory.

For more details write to: International Centre for Theoretical Physics, Course on Physical Climatology for Solar and Wind Energy, P.O. Box 586, I-34100 Trieste, Italy.

- **May 5 — July 5, 1986, Enschede, The Netherlands**

International Course on Rural Energy Planning

This is an annual course for district and regional level energy planners, emphasizing energy technology, planning methods, and implementation and administration, directed especially to the problems and needs of developing countries.

For information, contact: Course Administrtor, International Course on Rural Energy Planning, Technology and Development Group, Twente University of Technology (THT), P.O. Box 217, 7500 AE ENSCHEDE, The Netherlands.

- **May 13-16, 1986, Gatlinburg, USA.**

Biotechnology for Fuels and Chemicals

This conference will focus on the application of biological systems and processes to energy production.

For more information, contact: Martin Marietta Energy Systems, Inc., Box Y, Oak Ridge, TN 37831, U.S.A.

- **May 15, 1986, Piccadilly, UK.**

Solar Energy for Developing Countries: Power for Villages.

Papers are invited from specialists working in the developing world for the improvement of living conditions. Subject areas are: water pumping, domestic lighting, refrigeration and grain grinding. Technical organiser: Mr. B. McNelis, I.T. Power Ltd., Mortimer, Reading.

For further information: Miss J. Morton, UK-ISES, 19 Albemarle Street, London WIX 3HA, U.K.

- **June 11-14, Herning, Denmark**

DANWEA 86

This international conference and exhibition on Wind Energy Conversion System is organized by the Danish Windmill Manufacturers Association in cooperation with the Herning Exhibition Center. The conference will be in English. The exhibition will be open to the DANWEA participants during the first three days and to the general public thereafter. Moreover trips will be arranged to Danish wind energy farms.

For further details write to the following address asking for enquiries to be forwarded: The Editor, Windpower Monthly Magazine, Forlarget Vistoft Aps, Vrinners Hoved, DK-8420 Knebel, Denmark.

- **July 10-11, 1986, University of Birmingham, UK.**

Solar Design and Buildings.

Two-day workshop following on from the ISES Board Meeting. The workshop will have an international flavour. Technical organiser: Dr. L.F. Jesch, Solar Energy Laboratory, University of Birmingham. For further information:

Miss J. Morton, U.K-ISES,
19 Albemarle Street,
London WIX 3HA,
U.K.

From P. 23

- August 19-22, 1986, Beijing, China

Conference on Photovoltaic Science and Engineering

This is the second international conference on this subject, and is being organized by the Chinese Institute of Electronics and related international organizations. The conference will provide a forum for photovoltaic specialists from all over the world to present information on and discuss the most recent advances in research and development and manufacture on photovoltaic materials, devices, components and systems. It will also provide the opportunity to discuss general aspects of solar energy, such as field experience, applications, future trends and economics.

The preliminary topics for presentation at the conference are:

- o Solar cell technology: theory and modelling, advanced materials and concepts for solar cells, compound solar cells;
- o Space solar cells: module and array technology, space radiation;
- o Terrestrial system technology: Installation, operation and maintenance of terrestrial systems, low-cost feedstock;
- o Polycrystalline silicon materials and cells;
- o Amorphous silicon solar cells;
- o Economic and market analysis: national programs;
- o Measurement and calibration techniques of solar cells and modules.

The official language of the conference will be English, and the papers will be presented in oral and poster sessions. All the accepted papers will be published in the conference proceedings; the authors will be provided with further details only after the acceptance of their papers.

An exhibition of photovoltaic hardware will be held during the conference, which will include devices, systems and related instruments. For those delegates who may wish to extend their visit, post-conference tours can be arranged.

Further information may be obtained from:

Zou Xun (Conference Chairman)
Tianjin Institute of Power Sources
P.O. Box 277
Tianjin
China

- October 13-16, 1986, Sirmione/ Brescia, Italy

Energy & Agriculture, 2nd International Conference

This conference is being organized by the Energy and Agriculture Research Centre, Manerbio (Brescia), and the Chamber of Commerce of Brescia. A poster session on the technical applications of energy in agriculture will be arranged in conjunction with the conference and five prizes will be awarded by the Scientific Committee for particularly distinguished proposals or applications.

The specific topics to be covered in the conference will be as follows:

- o Appropriate technology for the use of renewable energies in agriculture: state of the art and critical review: plenary session.
- o Energy-intensive agricultures: case studies, barriers hampering the diffusion of renewable energies.
- o Labour-intensive agricultures: case studies, barriers hampering the diffusion of renewable energies.
- o Models and data banks: plenary session

The sessions concerned with energy-intensive agricultures will deal with the presentation and disscussion of examples – suitable for wider diffusion – which can be applied to the agricultural productive branches as well as to dwellings in different countries, on the base of the acquired technical and economic results. The field of applications will be:

- – cattle breeding;
- – after-crop operations;
- – protected cultures;
- – irrigation and mechanization;
- – small scale agro-alimentary units;
- – agricultural housings and villages.

The subject will deal with designs and approaches for a rationalization of energy consumption and/or applications of the following non-conventional energy sources:

- – solar energy or energy from vegetal and animal wastes for production of heat and/or electricity;
- – mini and micro hydropower and wind energy;
- – geothermal energy and energy from industrial wastes.

The sessions concerned with labour-intensive agricultures will deal with the presentation and discussion of the barriers (of technical, operative, economic, social and institutional nature) which hinder, on one hand, the diffusion and exploitation of renewable energies and, on the other hand, the transfer of these technologies from one country to another.

The final session will deal with the presentation and discussion of models and computerized systems for the acquisition and management of energy consumption which can be applied to different agricultural realities, as well as with the organisation and management of data banks for a correct energetic planning in the agricultural system.

All the accepted papers will be included in the conference proceedings and have to be presented in no more than 8 pages (format A.4), plus eventual tables, pictures or diagrams. A 300 word abstract in English (6 copies), in A.4 format, should be submitted before 15 April 1986 to the General Secretariat.

For further details contact:
General Secretariat,
2nd International Conference
Energy & Agriculture,
c/o Camera di Commercio di Brescia,
via Einaudi, 23 – 25122 BRESCIA,
Italy
Telex 300260 CAM BS I.

- November 30 — December 5 1986, San Francisco, U.S.A.

Hydropower Fluid Machinery

The fourth international symposium on Hydropower Fluid Machinery is sponsored by the Fluid Engineering and Power Division of ASME and the Hydraulics Division of ASCE.

The four-day event will cover the planning, selection, application, design, technical and commercial evaluation, operation, system control, environmental impact, maintenance, repair, refurnishment and installation of hydroturbine machinery and hydroelectric projects.

Unlike previous symposia, this symposium is being expanded to include all aspects of hydropower, although there will be sessions dedicated specifically to the technical aspects of small and/or standardized hydropower units, classical and/or "custom-designed" units, pumped-storage units, and the rehabilitation of existing units.

For further details, please contact:
Susan K. Wagner
PE, Allis-Chalmers Fluid Products Company
P.O. Box 712
York Pa 17405
U.S.A.

RERIC news

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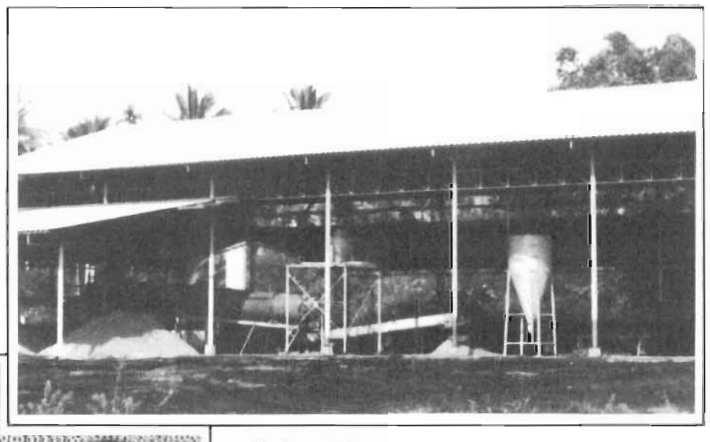
VOL. 9, NO. 2, APRIL 1986

SOLID FUEL FROM AGRICULTURAL WASTES

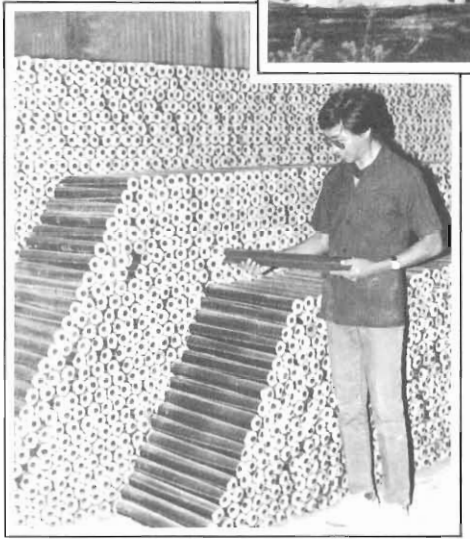
THE Energy Technology Department of Thailand Institute of Scientific and Technological Research (TISTR) has designed and developed a briquetting machine for various agricultural wastes — rice husk, sawdust, bagasse, coconut coir, coffee hull, peanut shell, and straw.



Industrial production of sawdust briquets

Production of Briquets

Raw material is fed directly into the briquetting machine. The feed is compressed primarily by a friction force between the extrusion screw and the cylinder to form a briquet. As the briquet moves along the extrusion cylinder, it is heated up by three electric heaters. The briquet is 5.6 cm in diameter, 50 cm in length and approximately 1.3 kg in weight. The extrusion speed is 30-50 seconds per briquet. Under suitable temperature, moisture and pressure, the briquetting process is possible without any need of binding agents.



Briquets – industrial production

Drying System

Drying is not necessary for rice husks but it is required for briquetting raw materials with a moisture content of more than 10%. A special rotary dryer with a double shell, 1000 cm in length and 98 cm in diameter, has been designed entirely by TISTR to serve this purpose.

Machine Performance

The machine can be operated continuously for 24 hours without changing any extrusion screws. It can be easily installed, and an area of only 2.5 m^2 is required. The specifications of the machine are as follows:

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wind and sun compendium

Development of wind and solar energy for water pumping

tool

cwd

CRRERIS

Incorporates news from the Commonwealth Regional Renewable Energy Resources Information Service (CRRERIS) and Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

INNERTAP

Using Dung as Fuel in Developing Countries

The calorific value of dried dung is usually lower than crop residues. This is because it contains more inorganic material. Fresh dung is often contaminated with a certain amount of earth or grit which the animal has inadvertently eaten while grazing; it can also become mixed with some dirt when the dung is collected.

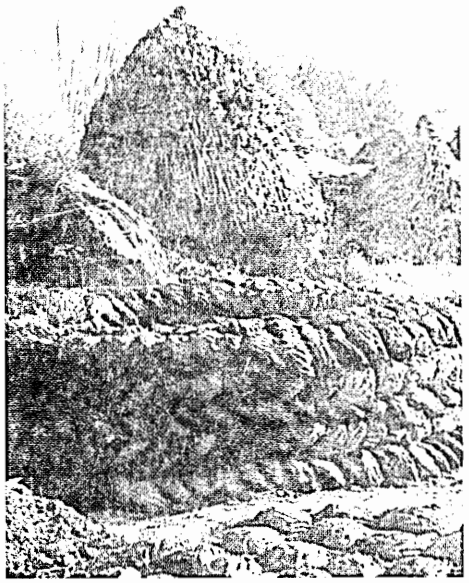
One set of detailed measurements from Thailand put the gross calorific value of fresh dung at 11.8 MJ/kg for buffaloes, 12.8 MJ/kg for cows, and 14.9 MJ/kg for pigs, all on an oven dry basis (Arnold and deLucia, 1982). Other estimates in the literature range from 10-17 MJ/kg, though it is not always clear if these refer to air-dry or oven-dry dung. Figures also change somewhat depending on whether dung is mixed with straw or other crop residues when dung cakes are being made.

Methods of preparing and storing dung vary between countries. In one Maasai village in Northern Tanzania where dung has only recently started to be used, pieces of dried dung are simply collected from cattle corrals and brought to the family hut. Women say it burns very quickly, and regard it as an inferior fuel (Leach, 1985). Similar practices are reported in Southern Botswana (Shepherd, 1985).

Where dung has been in use for many years, people have generally developed special techniques for preparing and storing it. In northern India the standard procedure is to make cakes by mixing fresh dung with straw, dried leaves, waste paper, or some other burnable material. This helps to hold the cake together and greatly improves their burning properties. The flattened cake is then dried in the sun, stuck to a rock or on a wall, or neatly laid out along the roadside. Drying takes 5-8 days, depending how thick they are, and what the weather is like. In one village near Delhi, the average weight of dry dung cakes was found to vary from 330-460 grams, depending on the season (Kumar et al, 1985).

Packing dung onto sticks in Bangladesh. (Mark Edwards/Earthscan)

Once dry, dung cakes become a very convenient fuel. They lose their smell and are easy to store, even inside the house. Unlike woodpiles, they do not attract insects or snakes. And when they need to be used, the cakes can be broken up into a handy size for burning (Gopalakrishnan, 1984). If it is raining, however, it is impossible to make dung cakes at all. Because it will not dry, dung that is produced during the rainy season cannot be used as a fuel, even if other fuels are very scarce.



Northern India: Dung silos keep cow dung cakes dry during the rainy season. (Geoff Barnard/Earthscan).

To get round this problem, people make more dung cakes that they need during the dry season and store them up for later use. The common practice in north India is to pile dung cakes carefully into large conical heaps, or silos. These are smeared with a thin layer of fresh dung, which when dry forms a hard and waterproof coat. In some places it is traditional to decorate the outer surface with intricate designs.

These silos keep the dung cakes dry during the rainy season. When they are needed a hole is cut in one side of the silo near the base. The cakes can then be removed, as required. Though the silos will eventually disintegrate, they can last up to four years. Old dung silos can be recognised as they are often overgrown with grass. Sometimes they are also used for growing pumpkins on.

A similar storage approach is used in eastern Turkey. Here, dung and straw is dug out from stables each spring after the animals have left for the summer grazing grounds. The procedure has been described as follows: "Some water is added if necessary so as to be able to work the mixture better. It is then mixed up and spread on the ground to dry. This process

may take several weeks. Once dry the mixture is cut with a special knife, into oblong blocks and then stacked in hollow beehive-shaped cones about ten or twelve feet high" (Fitzherbert, 1985).

Dung silos are rarely seen in the south of India, where dung burning is much less common. Where it is used it is mainly for lighting fires. Some people make homemade firelighters by mixing cowdung with coal dust and making them into balls. When dry, these burn vigorously and are useful for helping to start a reluctant wood fire.

In Bangladesh, instead of making large dung cakes, small palm-sized patties are more common. People also have an interesting technique for combining dung with crop residues. They pack dung around a jute stick or some other crop stem, to make a 'dung-stick'. When dried, these can be fed into the traditional Bangladeshi chula just like a piece of wood.

In the southern African villages of Malefilaone and Jozannas Nek studied by Best, dung is prepared in two ways. Some is collected from the fields by young girls and dried in cakes. The rest is dug twice a year from the kraals near the house where milking cows, oxen and other livestock are kept overnight. This dung is cut into large blocks, each weighing about 3 kg. These are stacked along the walls of the kraal and take as long as 3-4 weeks to dry (Best, 1979).

The silos are opened and the dung cakes passed out from inside. (Mark Edwards/ Earthscan)

Source: Extracted from "Agricultural Residues as Fuel in the Third World" by Geoffrey Barnard & Lars Kristoferson, published by Earthscan, 3 Endsleigh Street, London WC1H ODD, UK.

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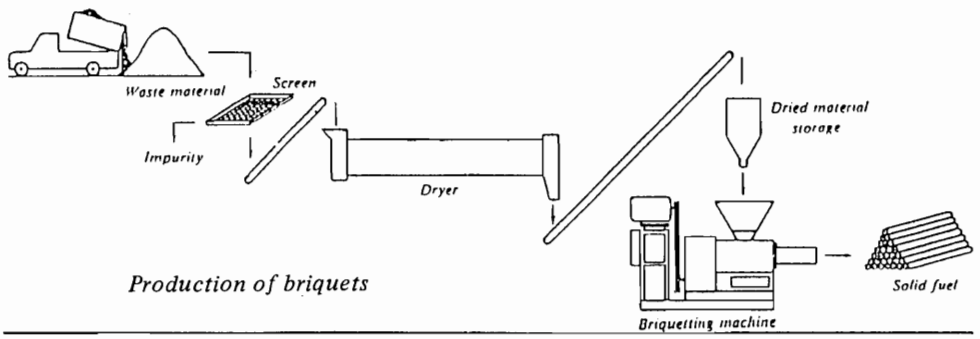
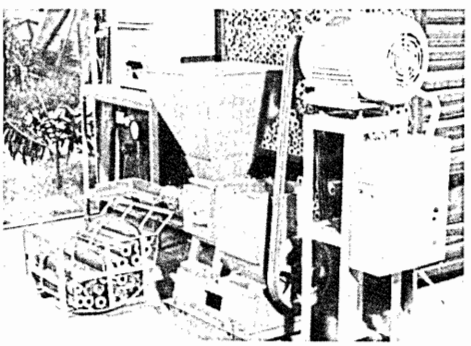
Solid Fuel from Agricultural Wastes

From P. 1



Production of briquets

- o Power supply: 380 VAC, 3 phase
- o Driving motor: 15 hp
- o Electric heater: 3 × 1 kW, 220 VAC
- o Capacity: 2.5-3.0 ton/day
- o Production rate: 30-50 sec per briquet
- o Overall length: 1,800 mm
- o Overall height: 1,600 mm
- o Overall width: 650 mm
- o Net weight: 600 kg



Briquetting machine

Fuel briquets

The briquets are suitable for use in both household and industry. By having a higher density than firewood, its combustion lasts longer and transportation expenses are reduced. It can be easily carbonized to obtain good quality charcoal at a yield of 35-40%.

For further information please contact:

Energy Technology Department
Thailand Institute of Scienfific and Technological Research (TISTR)
196 Phahonyothin Road,
Bang Khen
Bangkok 10900, Thailand
Tel. 5796517, 5798593

Biomass Energy Programs — Case Study The Philippines

Biomass Users Network

Representatives of seventeen developing countries, meeting at the workshop entitled Bioenergy Approaches to National Development in Manila in March 1983, realized that properly managed biomass programs catalyzed rural development and contributed to resource conservation. However, developing countries had no formal means to share research results and practical experience. They decided that the diversity of national programs, biomass professionals, and the technologies themselves called for the creation of a formal mechanism to facilitate the exchange of information, including such non-technical concerns as program formulation, financing, biomass resource management, and government policy.

Representatives of Costa Rica, Indonesia, Jamaica, the Philippines, and Sudan were elected to the organizing committee that laid the groundwork for the Biomass Users Network (BUN). The Canadian Industrial Development Agency (through the International Institute for Environment and Development), the Rockefeller Brothers Fund, the Swedish International Development Authority (through the Beijer Institute), the U.S. Agency for International Development, the U.S. Agricultural Resources Development Foundation, and the World Resources Institute provided assistance in various forms. The network's formal inauguration took place at a meeting of more than twenty developing countries in Bangkok in October 1985, and the results of this meeting were presented in RERIC News, Vol. 8, No. 4, October 1985.

BUN plans to produce a number of reports on case studies of biomass energy projects conducted in member countries. The case studies will show how a program was developed, where integration made a difference, how it was tailored to specific conditions, how management and social concerns were handled, and what concrete results were obtained could be immediately useful to other countries.

Case Study: The Philippines

The Philippine government recognized in the mid-1970's the need to develop its biomass energy resources. An integrated and diverse development program increased commercial bioenergy production from 2.23M barrels of oil equivalent (mboe) in 1973 to 14.6 mboe in 1983, making biomass only second to oil as an energy source in the country. A government survey in 1979 estimated noncommercial bioenergy use at more than 50 mboe. While the Philippine biomass program has fallen far short of its original goals, it has achieved notable success in its dendrothermal, gasifier, and alcohol efforts.

The government began in 1977, with surveys of household energy use and industrial biomass fuel use, to gain a general understanding of the energy scene. It followed these two surveys with six targeted surveys designed to help choose appropriate technologies and marketing strategies. The government also began funding biomass research in 1977, and in 1979 created the Center for Nonconventional Energy (CNED) to guide research and development of biomass and other alternative energy sources. CNED's R&D responsibilities were transferred to the state-owned Philippine National Oil Company in 1981. The focus of the Philippine program was not research, however, but commercial production of bioenergy. The major components of the biomass program are wood-fired (dendrothermal) electricity, gasifiers for stationary and vehicle engines, alcohol fuel from sugar, and cocodiesel fuel (a blend of coconut oil and diesel fuel).

Dendrothermal

In 1977, the Philippine government gave the National Electrification Administration (NEA), which oversees the country's one hundred rural electric cooperatives, the responsibility for increasing the use of wood-fired electric generators. NEA developed a model based on building a 3 MW base-load plant for each cooperative. A typical cooperative has a total load of 6 to 8 MW. Wood for the plant would be supplied by 1000 ha tree plantations.

The government selected parcels of marginal and unused federal land to make available for the plantations. The 1000 ha plots are divided into 100 ha modules that are rented on a 25-year renewable lease to farmers' associations, of ten to fifteen farmers, for a nominal fee of US$2.70 per year. The program is aimed particularly at the "kaingineros" — slash-and-burn farmers who were contributing to forest destruction and soil erosion. These farmers are trained to plant and care for the plantations of fast-growing ipil-ipil (*Leucaena leucocephala*) trees, which they sell to the cooperative at a predetermined price.

NEA provides loans to the cooperatives to build the power plants and to reloan to the farmers to cover the cost of starting the plantation. The plantation needs four years to produce the first crop. At that time, the farmers will harvest one quarter of the trees and replant that area. Each subsequent year, the farmers will harvest and replant one quarter of the plantation. Each 100 ha plot is expected to produce 10 dry tons of wood a day for the power plant. Program managers estimate that the final cost of electricity from the dendrothermal plants

will be US$0.056/kWh, much less than the US$0.085/kWh that a World Bank team estimated as the marginal cost of electricity in Luzon province in 1981.

The first trees were planted in 1980, and the first plants went on line in 1984 with a total generating capacity of 12.7 MW producing 1.66 mboe a year. Only about one fourth of the 1980 plantations survived because of poor site selection and belated planting caused by bureaucratic delays. The system was improved, and the 1984 survival rate was 80%. Of the 17 800 ha planted since 1980, 8000 ha have survived.

The original plan called for 114 MW of capacity in 1985, but technical problems and government budget constraints limited progress. A revised target of 200 MW capacity by 1990 has been set, but continued budget limitations could put this goal out of reach. One surprise development was international interest. The Philippines is currently negotiating a joint venture to help develop dendrothermal capacity in Indonesia.

Gasifiers

The state-owned Farm System Development Corporation (FSDC) had promoted the use of diesel pumps for irrigation for years. When the price of diesel fuel rose steadily through the 1970's, FSDC began experimenting with pumps powered by a blend of woodgas and diesel fuel. Other Philippine agencies were meanwhile testing jeepneys and other vehicles powered by the blend.

In August 1981, the government established the Gasifier and Equipment Manufacturing Corporation (GEMCOR) as a subsidiary of FSDC to build and sell gasifiers for agricultural use. By linking GEMCOR to FSDC, Philippine officials gave the new entity the benefit of the experience and infrastructure of an agency that was already familiar with the introduction of new technology to the farm. And to ensure that gasifier development was coordinated with other energy and agriculture. The GEMCOR board of directors includes the ministers of Human Settlements and Public Works and Highways, and the administrators of the National Food Authority, National Electrification Administration, and National Irrigation Administration.

The original goal was to build 72 000 gasifiers between 1983 and 1989. The first 2000 unit plant opened in Carmona in 1981 and expanded to 4000 units in 1982. As with the dendrothermal development, government budget cutbacks in 1983 drastically slowed progress, forcing GEMCOR to lay off about 40% of its employees. At the same time, however, GEMCOR received numerous inquiries from industry about using gasifiers with kilns, driers, and other equipment. In response, GEMCOR developed, and is

Cont. P. 7

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Biogas Purification

Hydrogen sulphide is a natural component of biogas. Its concentration depends on the sulphur content of the raw material being digested and lies in the range 1500 ppm — 5000 ppm or 0.15-0.5 vol. % or 2.1-7 g H_2S/m^3. Hydrogen sulphide is responsible for corrosion of various parts of the plant equipment.

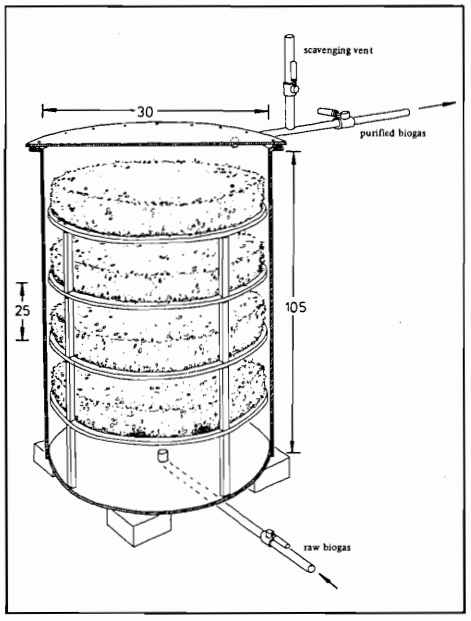
The use of biogas in an internal combustion engine causes uncontrollable corrosion problems. Engine components are very susceptible to corrosion by H_2S and its reaction product SO_2.

The experience of various manufacturers and users, as well as the (older) literature indicate that with the sulphur concentrations mentioned, the service life of the engines can be reduced by up to 15% of their normal value. Not only are the resulting repair and maintenance costs increased but also the costs for service materials, such as spark plugs and lubricating oils.

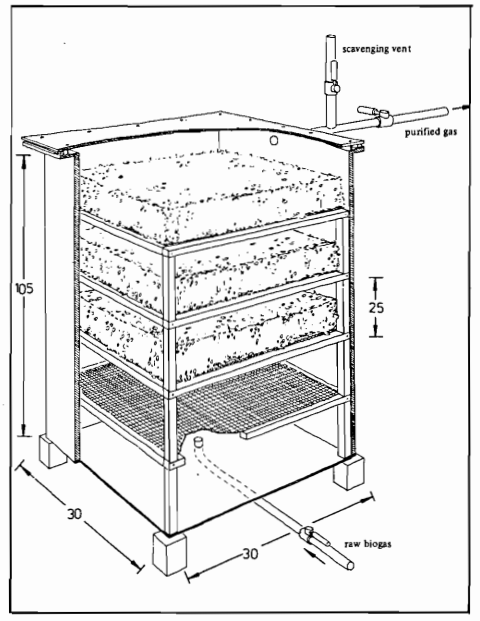
Even with special oils the oil change interval drops up to one-fifth of that under normal conditions. The oil becomes acidic from sulphur dioxide and thus loses its lubricating properties. Acidic exhaust gases corrode the exhaust systems very severely.

Desulphurizing biogas with acceptable investment and operating costs is only possible employing the dry desulphurization method. Iron-containing materials of specified compositions are utilized as absorbing agents for H_2S. Alongside the traditional, commercially available absorbents, certain substitutes can be used. Various tropical and subtropical soils contain sufficient iron in a suitable form. They must be prepared, in order to obtain the proper purifying characteristics. The material must be loose, porous, moist and granular.

The raw soil has to be ground and mixed with a filler and water to obtain a homogeneous texture. The finished absorbent is placed on gas-permeable trays in a purification chamber. The raw biogas is fed in at the bottom and the desulphurized or partially desulphurized gas is extracted from the upper part of the chamber.



Cylindrical purification chamber (1.25 m^3/h)



Rectangular purification chamber (1.25 m^3/h)

Eventually the absorbing agent is saturated with sulphur and can be regenerated either inside the chamber or outside through natural ventilation with air (oxygen). The absorbent material can, therefore, be re-used several times.

Using two or more purification chambers connected in series ensures a continual production of purified gas and allows a good capacity utilization.

The spent absorbent can be disposed of safely by burying it. Various factors must be considered when dimensioning the purification chambers. A certain maximum flow speed should not be exceeded. The gas volume to be purified per unit time determines the cross section of the purification chamber. The chamber volume and, hence, the amount of absorbent determine the operating time for the purification process up to regeneration or exchange of the absorbent.

Further details on methods for removing hydrogen sulphide from biogas, purifying absorbent, absorbent preparation, desulplurization apparatus, the calculation method for dimensioning desulphurization units, and operation procedures for gas desulphurization are presented in a publication entitled *The Purification of Biogas* by Helmut Muche and Harald Zimmermann. This book is published by the German Appropriate Technology Exchange (GATE), a division of the Deutsche Gesellschaft für technische Zusammenarbeit (GTZ) GmbH, and is available from: Friedr. Vieweg & Sohn, Verlagsgesellschaft mbH, Westdeutscher, Verlag GmbH, Postfach 5829, 6200 Wiesbaden 1, West Germany.

Agricultural Residues as Fuel in the Third World

For millions of families in the Third World the "firewood crisis" is already over. Supplies of wood have run out, and villagers have been forced to burn dung, straw, and other agricultural residues, as these are the only available alternative fuels. This report is the first detailed attempt to document the use of agricultural residues as a domestic fuel in the Third World — and to analyse the possible negative impact on the soil due to reduced recycling of nutrients and organic matter.

Using examples from throughout the developing world, the authors piece together a picture of the vital and complex role that agricultural residues play at the village level. Data on residue production under different farming systems are compared, and the properties and uses of different types of residues are described. The report highlights the essential role that organic recycling plays in maintaining soil fertility, and examines the risks involved if agricultural residues are burnt instead of being returned to the soil.

For some farmers, the authors argue, agricultural residues represent an important untapped energy resource. But for others, especially those on poor soils and without access to chemical fertilizers, burning dung and crop residues could have serious long-term effects — reducing crop yields and increasing the risk of catastrophic soil erosion.

Agricultural Residues as Fuel in the Third World was written by Geoffrey Barnard, of the Earthscan Energy Information Programme, and Lars Kristoferson, of the Beijer Institute of the Royal Swedish Academy of Sciences. It is the fourth report in the Earthscan Technical Report Series, in which previous titles have covered biomass gasification, improved cooking stoves, and community forestry. The study report is available in the UK, price £10.00/ US$ 20.00, from Earthscan, 3 Endsleigh Street, London WC1H ODD. In the USA, it can be obtained from Earthscan, 1717 Massachusetts Avenue NW, Washington, DC 20036.

Brazil Develops Aviation Fuel from Vegetable Oil

Having achieved very good results in developing fuels from renewable resources, especially with its ethanol program, Brazil continues in search of substitutes for petroleum-derived fuels. Now, an available kerosene replacement made from vegetable oil is beginning to attract attention.

The product, called "Prosene," can be derived from any vegetable oil and is of the same viscosity, vapor pressure and caloric value as kerosene. Prosene was developed by the government's Aerospace Technology Center (CTA) and the privately-owned Produtura de Sistemas Energeticos (Proerg).

Although work is continuing to come up with a continuous, balanced homogenization process and to lower the freezing point of the product (from its present −46° to −50°C), several test flights using Prosene have met with good success. CTA and Proerg have signed an agreement calling for the construction of a 1000L/day pilot plant.

Proerg has also achieved excellent results with a vegetable oil/ethanol mixture to replace diesel fuel; and CTA is already in the advanced stages of developing a 220-240 HP Otto-cycle ethanol engine and an ethanol-powered engine for conventional propeller aircraft.

(Source: *Chemical Engineering*, October 1985).

Biomass Energy Programs — Case Study: The Philippines

From P. 5

marketing, a gasifier for industrial process heating. GEMCOR has also laid the foundation for future growth by entering cooperative projects with the food, irrigation, electrification, and natural resources agencies. Because the government was the anticipated buyer of most of the early systems, sales have been disappointing. Approximately 1000 units had been sold by the end of 1983.

In 1983, the government established the Philippine Dendro Gasifier Corporation to manufacture gasifiers for use in vehicles, with a production target of more than 400 000 units by the end of 1989. This effort will have to overcome substantial user resistance. The gasifiers result in a 25% power loss in spark-ignition engines, have a 20-minute warm-up period, and require weekly maintenance. Of the 186 experimental units installed from 1981 to 1983, only about 10% are still in operation. Nevertheless, the government decided to go ahead with the program.

Alcogas

The Philippine National Oil Company began experimenting with alcogas in 1976, and program managers closely followed Brazil's alcohol development program. The Philippines formally launched its alcogas program in 1979 with the creation of the Philippine National Alcohol Commission (PNAC), chaired by the Minister of Energy and the Chairman of the Philippine Sugar Commission, and including the Ministers of Agriculture, Industry, Finance, and Natural Resources as well as several private-sector representatives. The private sector was expected to provide most of the investment and direction of the program, with the government contributing consumer incentives.

The program was launched in September 1980 in Negros Occidental province. A blend of 15% alcohol and 85% gasoline was sub-

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From P. 7

stituted for pure gasoline at all filling stations, with the government giving financial assistance to the dealers. An ineffective promotional effort left motorists confused and created resistance to alcogas. The government has to resume the sale of pure gasoline and subsidize the cost of alcogas to make it cheaper. Alcogas was later introduced in other provinces, the alcohol content raised to 20%, and the discount increased.

The incredibly ambitious goal of producing 400 000 kL of alcohol in 1984 was scaled back to a goal of 18 600 kL. Actual production was 5045 kL.

Cocodiesel Fuel

The Philippine effort to use a blend of 5% coconut oil with 95% diesel fuel reveals the pitfalls of an unintegrated program. The Philippine Coconut Authority has sole authority for the program and never developed a concrete implementation strategy. Cocodiesel fuel was introduced abruptly in September 1982 when the price of coconut reached a five-year low of US$0.21 per pound.

After two months, complaints of fuel-filter clogging began. A task force discovered a gelatinous microorganic growth in the storage tanks, and the government decided to stop making the blend. Further research revealed that substituting a semi-refined coconut oil called cochin eliminated the gelatinous growth. Meanwhile, however, the price of coconut oil rose rapidly, reaching US$0.49 per pound in 1984. At this price, the blend is no longer economical, and the program remains suspended.

For case studies of biomass energy programs in other member countries of BUN and for informations on BUN's activities please contact:

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Biomass Users Network
P.O. Box 960 4050
Alajuela
Costa Rica

Regional Wood Energy Development Programme in Asia

The First Technical Meeting for the official constitution of the Regional Wood Energy Cooperative Programme in Asia was held in Bangkok from 5 to 8 November, 1985. The meeting was attended by representatives from seven countries (India, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Malaysia), and eighteen observers from the host country and from International Organisations — ESCAP, the Asian Institute of Technology (AIT), the Regional Energy Development Programme of ESCAP, and the FAO.

The Project Status Report was presented to the meeting by the Senior Technical Advisor (STA), who gave an overview of the considerations and decisions leading to the constitution of the programme and of the project activities undertaken since March 1985. The STA reported that contacts have been made with all governments in the participating countries, that focal points have been established, and that training activities and studies have been initiated. An overview of some urgent issues as expressed by the governments' representatives to the STA during his visits was also reported.

Since October 1985 a rural sociologist/communication specialist has joined the project team, and a wood energy conversion specialist was expected to join towards the end of 1985. An associate professional officer (genetic resources) was expected to join early in 1986. The project was conceived for a duration of four years, but funding was secured for an initial period of two years. A decision on the remaining two years will be taken on review of the project status at the end of the first two years.

Six countries, (Bangladesh, Nepal, Pakistan, Philippines, Sri Lanka and Thailand) have officially endorsed the project document. Indonesia has agreed in principle to participate in all the project activities, and official endorsement of the Government of India is expected shortly. The STA recalled that the main objective is to support the establishment of continuing cooperation between the participating countries, which should continue on a self-reliant basis at the end of the project.

Country status reports were presented to the meeting by the country representatives. In the discussion of the reports it became apparent that in most countries wood energy strategies are not clearly defined and policies have not been formulated. This also applies to the implementation of detailed fuelwood supply and demand analyses. However, in recent years, the awareness of the problems and potential of wood energy has been growing in the region, particularly with regard to the potential role of wood energy in national development. This is in contrast to the earlier nearly exclusive focus on the fuelwood crisis at subsistence level indicated in the last FAO/ESCAP Regional Consultations in December, 1983. The growing awareness is also evidenced in the constitution of National Wood Energy coordinating committees in three countries (Nepal, Sri Lanka, and the Philippines) and plans to constitute such committees in other countries. These committees will coordinate all the national efforts for the development, improvement and utilization of wood energy resources.

The meeting agreed on the need to concentrate the following activities of the project:

- The training and exchange of personnel. In this category, emphasis was laid on the introduction or adaptation of wood energy aspects in forestry oriented curricula, the training of trainers, and the strengthening of

capabilities in the formulation of wood energy strategies.

- o Information and extension. Emphasis was given to the exchange of information on R&D programmes and results, the dissemination of information relevant to farmers and field staff, and to the development of appropriate communication and extension techniques and materials.
- o Research, development, and demonstration. Emphasis was given to access to improved genetic material and on conversion technologies. It was recognized that within the limited time and resources of the project it would not be possible to provide substantial assistance in research because these activities would take longer. The countries were, however, requested to identify and propose research activities within the framework of project objectives. Activities of an experimental/demonstrative nature are most suitable for such support. Such activities, when proposed, will be screened by project officials, and will be assisted if they also appropriate and complement national efforts. Such assistance may involve cooperation with other relevant international assistance programmes.
- o Technical assistance. Emphasis was given to the formulation of wood energy policies and strategies, monitoring and evaluation of wood energy programmes, and the design or adaptation of suitable training programmes.

Further details on the programme are available in *Report of the Technical Meeting of Regional Wood Energy Development Programme in Asia*, Bangkok, Thailand, 5-8 November 1985 (GCP/RAS/111/NET). Food and Agriculture Organisation of the United Nations, 1985, 91p.

Institutional Peat Stove Program in Burundi

A successful dissemination program on institutional stoves has been introduced in Burundi. The stove program is connected with the Projet Tourbe II, a multilateral cooperation project between USAID, ONATOUR, and the Irish Government. This is a project for the exploitation of peat as an alternative fuel.

Around 800 tons of peat per month have been sold in Burundi during the past few years. This is equivalent to about 600 tons of wood. As Burundi is a relatively small country (27 000 km^2), this peat project has become an important component in saving wood and forest reserves.

In the past, most of the peat was sold to army camps, since they did not require specially designed stoves and fuel efficiency was not a major factor. The first attempt to enter the private household market with peat failed due to improper stove design and the fact that at that time (1982) charcoal was still cheaper than peat.

Since the beginning of 1985, peat has been actively marketed as an alternative fuel to restaurants, school canteens, hospitals, prisons, and small industries. Although these establishments were generally buying wood for fuel purposes, they were able to switch to peat easily when it proved to their advantage to do so.

Since few places had proper stoves in which to burn peat, the project offered the client a free stove when he agreed to buy one ton of peat. A ton of peat costs about US$70/8000 FBu in Bujumbura and about US$50/5500 FBu in the interior near the peat bogs. The peat is delivered at no extra charge as an ONATOUR service. The client signs an agreement in which the stove may be taken back if he does not continue using peat.

Within a very short time, the stove team had a two-month waiting list for people ordering stoves. The team consists of three masons who are building four stoves for two clients per week. The stoves are especially designed for burning peat, but can be used for wood and other fuels as well. The two types of stoves being promoted are the Burundian Community Stove (B.C.St.), designed for large pots of about 50 cm in diameter, and the two-pot stove for casseroles, which are up to 27 cm in diameter.

The stoves are built with bricks in a kind of sandwich construction. A strong and heavy casted concrete top plate (5 to 7 cm in thickness) keeps the stoves together. The bricks between the top plate and the ground foundation are layed with adobe (clay or red earth). Only the ground bricks for the foundation are layed with concrete to protect the stove from groundwater. The joints between the bricks are sealed with mortar, which gives a strong outer shell to the stove. To build one stove, 25-35 kg of cement and 350 bricks need to be used. Materials and labour cost about US$70/8000 FBu which is about the same price as one ton of peat.

The stove contains a lot of hollow spaces for insulation. The side and back walls are double walls, filled with ash for insulation, which enables the firebox to heat up quickly. This is necessary as peat burns smokeless only in a hot fire chamber. The percentage of heat utilised (PHU) in the B.C.St. is about 29% as the pot is mainly sunken. The flue gas temperature in the chimney is about 200°C to keep the water simmering in a pot without a lid.

The stoves would seem to have a long life expectancy, since after nearly one year of use, they are showing no signs of corrosion. Some restaurants in the suburbs of Bujumbura report that they are

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Charcoal Making in Developing Countries

Charcoal is one of the major fuels of the developing world, since several hundred million people depend on it for their daily cooking needs. It is also the fuel of a myriad of small industries and commercial enterprises.

It is important to realise, however, that charcoal making puts a heavy burden on wood resources. Five tonnes of wood are needed to produce one tonne of charcoal. Attempts have been made for over a century to introduce more efficient methods of charcoal making, but most of them have been failures. Some development experts now say that charcoal making should be discouraged, and the Gambia has imposed a ban on charcoal making.

Charcoal Making in the Developing World by Gerald Foley is essential reading for anyone concerned with the problems of woodfuel and deforestation in the developing world. It is the most comprehensive publication available on the techniques of charcoal making, the physics and chemistry behind them, how they fit within their local context, and the history of attempts to introduce new and improved manufacturing methods.

The analysis goes beyond the fixation with technical efficiency which has characterised most past programmes, and makes clear why so many failures have occurred. It shows that when charcoal making is clearly seen in its broader social and economic context, the way is opened to a more creative approach than simply promoting technical improvements.

The author of this publication is head of the Earthscan Energy Information Programme, and the book itself is copiously illustrated and written in a clear and lucid style. It is the fifth report in the Earthscan Technical report series, in which there are also previous reports covering biomass gasification, improved cooking stoves, community forestry, and the use of agricultural residues as fuel.

This report is available in the UK, price £10/US$20, from Earthscan, 3 Endsleigh Street, London WC1H ODD. In the US it can be obtained from Earthscan, 1717 Massachusetts Avenue NW, Washington, DC 20036.

Institutional Peat Stove Program in Burundi

From P. 9

spending only half to three-quarters of what they were spending on the wood fuel which they need to burn on a three-stone fire. In most places, the fire is kept on for three hours to keep big pots (40 L) of beans boiling. A European biogas project is using peat stoves to make food for 20 persons daily, and are using about 15 kg of peat per day.

Additionally, the project has organized a bakery team to build bread stoves. Two masons and one helper are building two "medium-scale bakeries" per month. This is a modern designed bread stove with outer dimensions of 2 m × 2 m × 1.5 m, and a bread chamber of 1.2 × 1.2m. The bread stove can be used continuously because it has external heating for the bread chamber. The consumption of peat per eight breadmaking hours is about 50-75 kg (heat value 12000 KJ/kg). The bakery is provided by the project if ten tons of peat are bought, and clients are reportedly very enthusiastic about the bread stoves.

For more information contact:

Chris Adam
Hagelbergerstr. 4
D-1000 BERLIN 61
W. Germany

New Solar Heat

A new breakthrough in solar heating technology, introduced by Chichester-based Energy Saving Consultants Limited has enabled boiling water to be produced for heating systems, even under cloudy and overcast conditions.

Based on the Philips VTR high-vacuum tube (launched after a ten-year development programme) the 'Solar 2000' system has been shown to be at least three times more efficient than standard 'flat-panel' collectors, with a pay-back period on installations as short as four years.

Solar 2000 is suitable for domestic and industrial applications, and consists of a series of high performance glass collector tubes — measuring 176 cm in length — arranged in a modular collecting structure, which transfers heat to the water system with negligible energy loss.

Each tube contains a black cobalt-coated absorber plate — running its entire length — acutely sensitive to even low solar levels. A heat pipe partially filled with dimethylpropane fluid, between the absorber and hot water system, transfers the collected heat to a condenser through a highly-effecient gravity-assisted evaporation/condensation process within the pipe.

The low thermal mass of the absorber plate and heat pipe means that energy is removed without undue delay on the heat transfer process. An integral 'one-way valve' feature prevents heat being lost under cool conditions and prevents overheating when demand is low.

An important development of the system is the routing of water, which is kept separate from the tube collector. The absorber and heat system are fully divided circuits. The collector heat pipe is joined directly to the hot water pipe by a clamping-block giving a completely dry connection. The

g Breakthrough

tube therefore forms no part of the water circuit, thereby avoiding the possibility of contamination — often a problem with conventional flat-solar panels.

Each Solar 2000 module consists of ten or twenty separate collector tubes. Due to its higher efficiency, the surface area of the modules is much smaller than that of flat-plate collectors, enabling convenient mounting on roof areas. For domestic heating requirements, between one and two modules may be installed, and up to half the total fuel costs can be saved when providing heat for central heating and domestic hot water.

Solar 2000 modules also provide heat for swimming pools — the pay-back period being as short as three years. In some cases excess heat can also be diverted into the domestic system creating even bigger savings. For industrial, group, or district heating an infinite number of modules can be inter-linked, providing free use of solar power.

For further information contact Energy Saving Consultants Ltd., Stirling House, Stirling Road, Chichester West Sussex PO19 2EN, UK.

Source: Energy Digest, Vol. 14, No. 4, p. 41, 1985.

New Variable Geometry Darrieus Wind Machine

Two consultants at the Centre for Energy and Environmental Research at Puerto Rico, G.T. Ptylinski and D. Serrano, have proposed, a new variable geometry Darrieus wind machine. One of the features of the new machine is that the lower attachment of the baldes to the rotor can move freely up and down the axle, allowing the blades to change shape during rotation.

G.J.M. Darrieus, a French inventor, patented in the United States in 1931 a wind machine characterized by a vertical axis of rotation and curved blades attached to the rotor at two ends. The Darrieus machine was reintroduced in the mid-1960's by researchers of the National Research Council (NRC) of Canada. Since then the theoretical aspects of Darrieus turbine operation have been studied in detail by NRC and Sandia Laboratories in the United States. Their research has shown that the machine has aerodynamic characteristics which in some respects differ from those of other wind machines; that it has a greater energy output per unit of mass than many other wind machines; and, that it is easily adaptable not only for electrical power generation, but also for a wide range of mechanical applications.

For example, Darrieus wind machines ranging from a few kilowatts to 250 kW are used, instead of diesel engines, to pump water and generate electric power in remote locations of Canada, the United States, Australia, New Zealand, Argentina and other countries. Research is being done to improve the aerodynamic performance of the turbine and to develop machines in the megawatt range.

Experimental data for a 17 m diameter Darrieus rotor and a theoretical model for performance prediction were used to develop a computer simulation program for studying parameters that affect the machine's performance. New structural and dynamic parameters were incorporated into the program and varied to simulate the machine's operation under a wide range of aerodynamic conditions.

The computer simulation study shows that the governor behavior of a Darrieus turbine cannot be attained by a standard turbine operating within normally occurring rotation velocity limits. As a result of the study, a second generation variable geometry Darrieus wind turbine using a telescopic blade is proposed as a potential im-

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US$ 10 M Photovoltaic Manufacturing Plant in China

Chronar Corp., (Dept. ASE, P.O. Box 177, Princeton, NJ), announced on 10 January 1986 the signing of a definitive agreement to build a US$10M photovoltaic panel production facility in Harbin, The People's Republic of China, using Chronar's amorphous silicon manufacturing technology.

The factory is expected to manufacture enough panels each year to produce 1MW of electricity. The agreement requires final government approvals and registration (which is expected to be completed in the near future) before it becames effective.

Chronar presently operates similar plants in Port Jervis, New York and Bridgend, Wales. They are developing other production facilities, including 1 MW capacity plants in Alabama (in a joint venture with The Southern Company and AFG Industries, Inc.), and in France, in a joint venture with Charbonneages de France and Les Grands Moulins de Paris.

Chronar will own 28% of the Chinese joint venture, and the remaining 72% will be owned by several Chinese entities, principally the Harbin Electronic Instruments Company and the Harbin Steam Turbine Corp. The contract was signed in Harbin, China, by Chronar president Dr. Zoltan Kiss and officials of the Chinese partners. Chronar's amorphous silicon thin film technology was selected by the Chinese after they conducted an extensive study of competing Japanese and American PV firms.

Source: Alternative Sources of Energy, March 1986, p. 79.

New Variable Geometry Darrieus Wind Machine
From P. 11

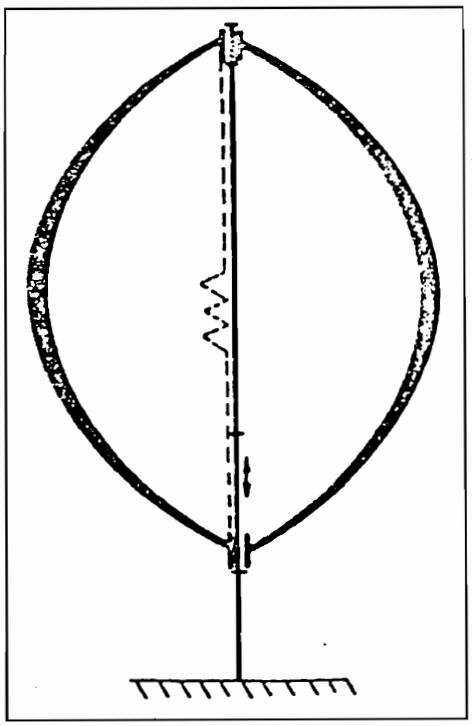


Fig. 1: New variable geometry Darrieus wind turbine with structural spring.

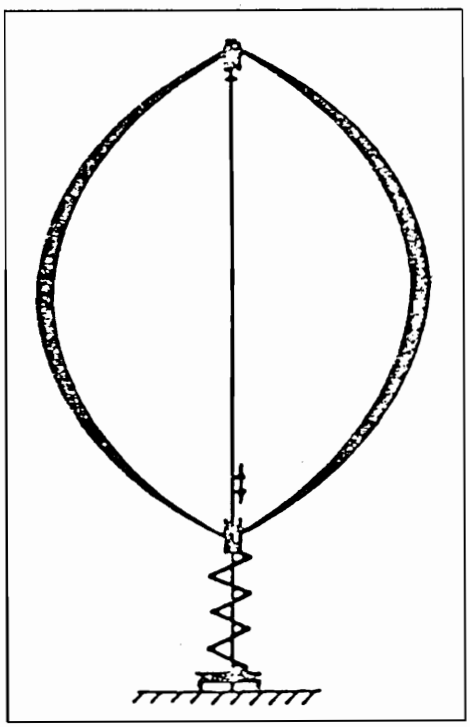


Fig. 2: New variable geometry Darrieus wind turbine with external spring.

provement on the studied concept.

Fig. 1 shows a conceptual drawing of the new variable geometry Darrieus wind turbine. In this turbine the lower attachment of the blades to the rotor axle is free to move up and down. This motion occurs because of variations in the turbine angular velocity caused by different wind conditions and the subsequent variation of the turbine moment of inertia. Centrifugal force bends the blades into geometrical shapes imposed by the aerodynamic conditions of the turbine operation.

Two concepts were investigated: in the first concept, the blades themselves act as a structural spring as shown in Fig. 1; in the second concept, an external spring is added as shown in Fig. 2.

In a standard Darrieus turbine, the tip to speed ratio (TSR) varies along the rotor blade from a peak near the blade midpoint to near zero where the blade joins the torque axle. Consequently this ratio cannot be optimal along the entire length of the blade. The turbine geometry results from the shape imposed on blades by being permanently attached at both ends during a wide range of aerodynamic conditions, and by being shaped to minimize bending stress.

In a standard turbine, the blade is curved like a free-spinning rope or troposkein that would allow centrifugal forces to act throughout the length of the blade. In practice, however, the blades do not assume a troposkein shape. During rotation factors imposed on the machine such as energy output per unit of mass, tip to speed ratio, aspect ratio and solidity determine the shape of the blade during rotation.

In a variable geometry turbine, however, the blades assume a shape imposed by the turbine operation conditions and by the centrifugal forces acting on the blades. In a standard turbine and in a variable geometry turbine the blades are fixed in pitch. In both, the blades have the same cross section from one end to the other. Therefore, they can be extruded and mass-produced.

(Source: *Sunworld*, Vol. 9(3), 1985)

Wind Power for Ice Production

IT Power, an associate of the Intermediate Technology Development Group (ITDG) has completed a feasibility study on the optimum design for a wind-powered ice-making machine. The machine is to be installed on the Egyptian Red Sea coast at Abu Ghoson as part of a United Nations Development Programme (UNDP) demonstration project on renewable energy. Combining a wind turbine, a diesel generator for back-up, an ice maker and an ice store with battery storage, the system will be made entirely from proven, commercially-available components to produce three tonnes of ice per day.

This design has great potential for small-scale fishing activities in the Third World since ice is vital in order to store and transport fresh fish for market. Even in the tropics, relatively little energy is required to produce commercially useful quantities of ice. Ice-making is a process well suited to the variable nature of sun and wind

Europe's Largest Windmill Park

With the commissioning of 13 Bonus 100 kW wind turbines at Oddesund Syd, Denmark, the largest windmill park in Europe has become a reality. It is the first time that a 100 kW wind turbine has been used in a windmill park. Prior to the commissioning of this project, twenty 55 kW wind turbines had been installed, and are operating in a neighboring project at Oddesund Nord. Behind both projects stand a number of investors who make up Dansk Vindmøllepark A/S.

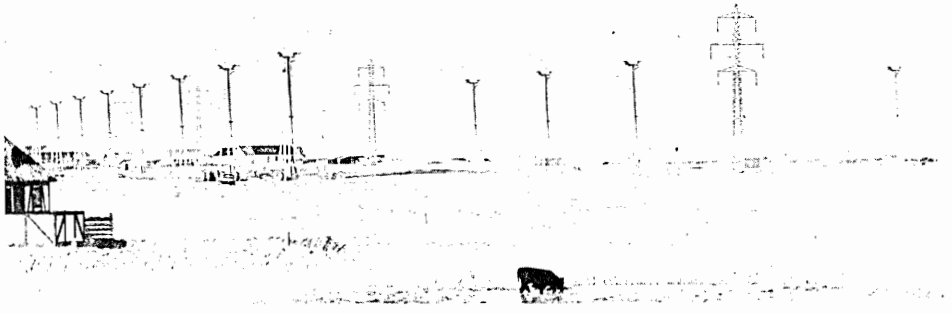
The installed capacity from the thirteen new 100 kW wind turbines qualifies the Oddesund Syd project's claim to be called Europe's largest windmill park. The new 100 kW wind turbine is the first of its kind to receive system approval (from The Test Station for

energy resources as the product is easily stored. It can be over-produced during plentiful supplies of energy, and stored for occasions when production is lower than demand.

With mean wind speeds at Abu Ghoson of 5 m/s (10 knots), it is estimated that the wind-powered design can produce ice to a unit cost of £15/tonne. Each tonne of ice will permit one tonne of fresh fish to be transported to market, adding 2p-3p to the price of a kilo of fish.

Although the energy cost is substantially higher than for refrigeration from grid electricity, it is still much cheaper than the cost from the small-scale energy systems in use in the remote areas of developing countries. The few systems that exist in rural areas usually rely on diesel generation. The fuel is often difficult to obtain and the cost of producing a tonne of ice can be as high as £70. This rules it out as a possibility for small-scale fishermen.

(Source: *Appropriate Technology*, December, 1985).



Smaller Windmills, Risoe, Denmark).

The considerable increase in power output from this new model means that the 13 units located at Oddesund Syd will produce enough electricity to supply 650 households. One of the reasons for this higher output is due to larger blades. The increased swept area enables more of the wind's energy to be captured. In addition, the construction design is more compatible with the environment because the three-legged tower blends in better with the surrounding landscape.

At the end of 1985, Bonus had sixteen of these new wind turbines installed in Denmark and forty of them were placed at one of the major sites in California, which is one of the company's largest export markets. Bonus produces approximately 400 windmills annually. Owing to this new and larger wind turbine it is calculated that this figure will increase significantly in the future.

For further information contact: Bonus Wind Turbines, Fabriksvej 4, DK-7330 Brande, Denmark.

Canadian Wind Energy Research Goals

Canada's program for wind energy research over the next two years provides for a modest but steady effort in several areas.

Outlined by Monique Carpentier, Wind Engineer for the Department of Energy, Mines and Resources (EMR) the program is comprised of the following subdivisions:

(1) Generic research (approximate funding US$110,000).

(2) Technology development (approximate funding US$145,000). This portion of the program aims at improving wind machine cost, performance, reliability and operating lifetime. Specific goals identified in these areas were summarized as follows:

Installed Cost — Windfarm Systems: Current, $500-$1,000/square meter; near/long term goal, $300-$400/square meter.

Installed Cost — Remote Systems: Current, $1,000-$3,000/square meter; near/long term goal, $600-$1,200/square meter.

Availability: Current, 85%; near term goal, 90%; long term goal, 95%.

Mean Time Between Failures: Current, months; near term goal, about a year; long term goal, years.

Maintenance Costs: Current, high; near term goal, better; long term goal, 0.5-1 cent/kWh.

(3) Wind/diesel systems (approximate funding US$215,000). This is considered the top research priority, since Canada has a number of remote communities with high power production costs (ranging from 8-75 cents/kWh and higher). Many of these communities also have good wind speeds.

(4) Technology Testing (approximate funding US$70,000).

(5) Windfarms/Arrays (approximate funding US$110,000) are listed as the second most important research category. Because of its abundant hydropower, Canada's main utility grid generally has low power costs and retail rates. However, there are a number of isolated grids (Magdalen Islands, Prince Edward Island, Newfoundland, etc.) with considerably higher generating costs and enough demand to make windfarms a possible option.

Although many research questions are being answered through the monitoring of major windfarms in the U.S., issues are felt to remain in such areas as array controls and utility grid/windfarm interaction.

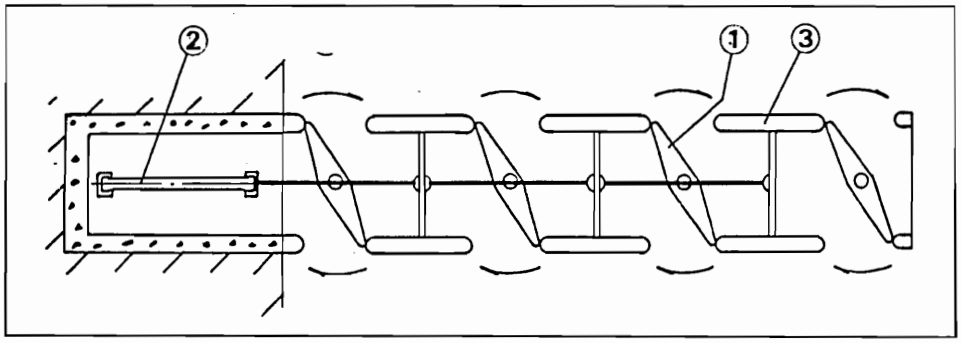
(6) Technology Transfer (approximate funding US$35,000).

The first phase of Canada's Remote Community Demonstration Program (RCDP), under which several small wind turbines have been tested at remote sites, is now completed, and reports are available from EMR.

The second phase will involve the installation and monitoring of a single Howden 60-kW turbine at Fort Severn, a small community located on Hudson Bay in northern Ontario.

(Source: *Wind Energy Weekly*, Vol. 4(187), 1985)

New Ultra-low Head Hydroelectric Generator



1) Gate 2) Power take-off cylinder 3) Barrage walls

The Salford Transverse Oscillator (STO) is a new type of hydroelectric power device, designed to produce power economically from rivers, canals or tidal flows. It can operate economically with heads as low as 2 to 3 m, considerably lower than existing turbine systems, but because of its simple low-cost design, can still be economical at these heads. The STO is modular in construction, and can be produced with power outputs in the range of 100 kW to 10 MW.

The STO has been developed by AUR Hydropower Limited in conjunction with Salford University Department of Civil Engineering, and James Howden & Co., UK, now have a worldwide license agreement to construct and market the STO. Commissioning trials are due on a US$1M prototype to be installed off the west coast of Scotland. The 270 kW prototype will have a working head of 3 m.

The STO consists of a series of cells, formed by twin vertical walls, arranged as a barrage across the flow (the figure shows a view from the top of a section taken at the axis of a power take-off cylinder). At intervals the barrage is broken by openings, in which vertical "gates" mounted on bearings are so placed as to be able to direct the flow of water alternatively to right and left.

In the "cells" formed between the gates are vertical "paddles" hung on "carriages" running on rails. By swinging the gates back and forth the paddles are pushed to and fro by the hydrostatic head of water acting on them. The reciprocating motion of the paddles can be used to operate a hydraulic piston, which in turn drives a hydraulic motor and generator to produce electric power. The motion of the gates is synchronized with the ram movement to provide automatic operation.

The STO is simple in concept, and, for very low heads, is cheaper to construct than a turbine system of the same power. It requires no dam or penstock, and will operate without a reservoir. In flood conditions the gates can be held at their mid-way position to provide minimum flow resistance, or the water can simply be allowed to flow over the barrage.

The STO is ideally suited for use as a replacement for diesel generating stations in rural or island communities that are not connected to electricity grids. There are large numbers of such stations operating in the less developed countries, and their fuel costs are frequently a severe economic drain on these countries. Even in countries with well developed interconnected electricity networks the STO may be able to compete with fossil fuel plants, provided suitable sites are available.

An ideal site for the STO is on an irrigation canal, where the flow is well regulated. In such a situation the maximum amount of energy can be produced because the system will be operating at close to full power for most of the year. A series of STO barrages can be built at suitable sites along a canal, providing total power without the added cost of transmission. This can represent an important cost saving.

For river flows which are less well regulated, a given annual electricity production requires a larger, more expensive system. Nevertheless, even here an STO system can compete with grid-derived power, particularly if the savings in transmission costs are taken into account.

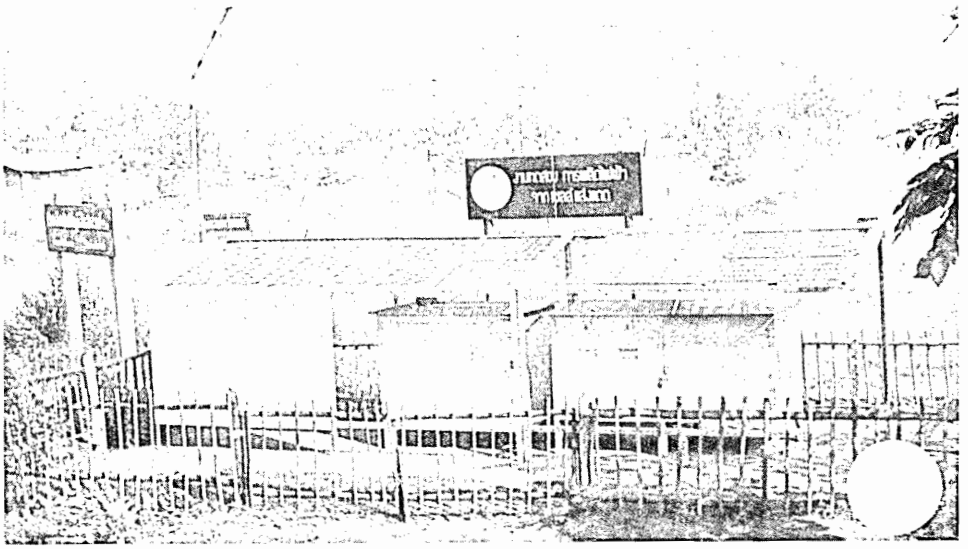
In some circumstances the use of the STO to generate power from tidal flows can be economic. Indeed the prototype STO which is scheduled for construction in 1985, is to be installed at a tidal estuary in the island of North Uist, off the North-West coast of Scotland.

Approximately 40 to 50% of the cost of a STO installation is accounted for by the civil engineering. This part of the cost will vary with local conditions. In addition, the cost of the barrage will decrease in proportion to the installed power as the available head increases. For these reasons exact cost figures for an STO installation cannot be given without a site survey; but, as a guide, a range of between US$1300 and US$2500 per kilowatt installed can be given. Sites having higher heads will tend to be at the lower end of this range, while sites with low heads or unfavourable conditions will have installed costs towards the top of the range (these costs are for a complete installation, including all civil works, the mechanical and hydraulic components, the electrical system and control equipment).

The manufacture of the STO is for the most part relatively simple, and in many countries could be contracted out to local manufacture, either on a sub-contract basis or by means of a licence agreement. Patents are in force, or pending, in over 30 countries. Operation of the STO is largely automatic, and the nature of the device is such that local manpower could quickly be trained in supervisory duties. Maintenance is similarly straightforward, requiring the same sort of skill levels as would be available in a local garage repair shop.

(Source: *SHP News*, No. 4, 1985).

Non-Conventional/ Renewable Energy Resources Projects for Electricity Generation — Thailand



Solar cell panels for radio communication and lighting, Sankamphaeng, Chiang Mai.

Since the world oil crisis in 1973, the Electricity Generating Authority of Thailand (EGAT) set up the Special Energy Division at the Energy Technology Department to investigate and demonstrate technologies and the potential of the locally available non-conventional/ renewable energy resources for electricity generation. Four major groups, namely the Solar Energy Group, the Wind Energy Group, the Geothermal Energy Group, and the Solid Fuel Group have been set up to undertake projects in their specific fields.

Solar Energy Group

The group will study both direct conversion (photovoltaic system) and indirect conversion (thermodynamic system) of solar energy into electricity. A demonstration solar power plant will be built.

Wind Energy Group

The group will gather wind energy data to assess the potentiality of wind energy applications in Thailand. Cooperation has been established with other institutions in Thailand to study the feasibility of wind turbine construction locally. The group has also installed and tested wind turbines purchased from abroad.

Geothermal Group

This group is responsible for further development of well known geothermal resources in northern Thailand for electricity generation.

The group set up the Thai geothermal working group in 1977, cooperating with representatives from the Department of Mineral Resources (DMR) and Chiang Mai University (CMU). Since then the working group has progressively investigated most of the hot spring areas. Scientific data on various aspects of more than 30 hot springs in northern Thailand have been made available.

Of the most promising areas, the Sankamphaeng and Fang areas have been selected for further studies. The working group will explore a deep reservoir in the Sankamphaeng area and build a 100-300 kWe binary cycle demonstration plant in Fang area with technical cooperation from the governments of Japan and France.

Solid Fuel Group

This group is responsible for evaluating the economics and techniques of exploiting the low-grade lignite, oil shale and tar sand available in Thailand. A feasibility study of the new technology for combustion systems will be conducted and a small pilot extrac-

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Egyptian Windfarm Proposal

A spokesman for Meridian Corp., a consulting firm involved with several wind/photovoltaic remote power projects in Egypt said a request for proposals to build a 250 kW windfarm will probably be issued in "mid- to late March." Meridian, of Falls Church, VA, is a subcontractor to the engineering firm Louis Berger International, Inc., which is working on the wind/ PV projects in conjunction with the Egyptian Electricity Authority and the Cairo office of the U.S. Agency for International Development (USAID).

Current plans call for the windfarm to be built near Ras Ghareb on the Red Sea, and to operate in a fuel-saving mode for an existing power station and transmission grid. Two other project proposals are also expected this year — one in September for a desalination project in which either wind turbines or a PV array will supply 20-40 kW (peak) of power for desalination systems along the Mediterranean and Red Sea coasts, and one in November for a village power installation with small wind systems, PV's, or hybrid systems in a remote power application.

Meridian will be extensively involved in the projects, preparing designs, developing hardware specifications, and monitoring performance of the systems, among other activities.

(Source: *Wind Energy Weekly*, Vol. 5(192), 1986).

Non-Conventional/Renewable Energy Resources Projects for Electricity Generation — Thailand

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tion plant will be considered.

Current Status

Solar Energy Projects

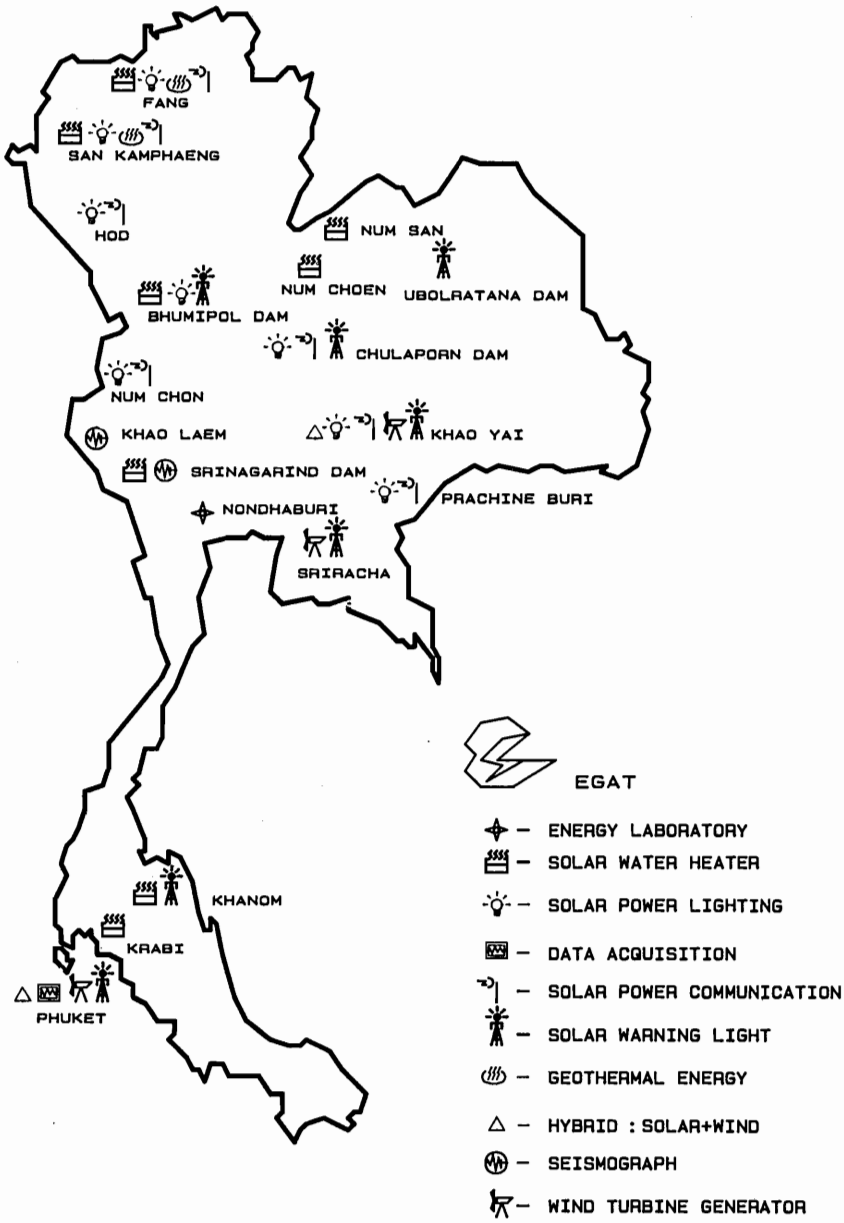
- A feasibility study of a 3 kWth central tower system, conducted jointly with Chulalongkorn University, has been completed.
- A feasibility study of a 5 kWth distributed collector system, in collaboration with King Mongkut's Institute of Technology Thonburi, is nearly completed.
- In cooperation with King Mongkut's Institute of Technology North Bangkok, a parabolic collector system has been built and tested.
- Flat plate collectors for solar hot water systems at EGAT's guest houses have been designed, constructed and tested. The capacities of the solar hot water systems are as follows:

Bhumipol Dam	4,800 litres/day
Srinagarind Dam	7,200 litres/day
Krabi Plant	2,200 litres/day
Khanom Plant	1,200 litres/day

- Research on encapsulation of high temperature silicon solar cells in a pressurized water-cooled pyrex glass tube, in collaboration with Chulalongkorn University, has been completed.
- Small-scale photovoltaic applications, with a total power of 8 kWp, have been installed in many remote areas of EGAT's offices for warning lights, radio communication, lighting, radio-relay stations, etc.

LOCATION OF ALTERNATIVE ENERGY DEVELOPMENT PROJECTS

ELECTRICITY GENERATING AUTHORITY OF THAILAND



830 W., 1 kW., Phuket

Wind Energy Project

- 1 kW propeller wind turbine has been constructed and tested at the Prince of Songkhla University.
- 1 kW Darrieus wind turbine is being studied in cooperation with King Mongkut's Institute of Technology Thonburi.
- 1 kW Aerowatt and 830 W ASEA wind turbine generators were installed at Laem Promthep, Phuket.
- 2 kW Dunlight wind turbine was installed at the radio-relay

station, Khao Fah Phah, Nakorn Rajasima.

Geothermal Project

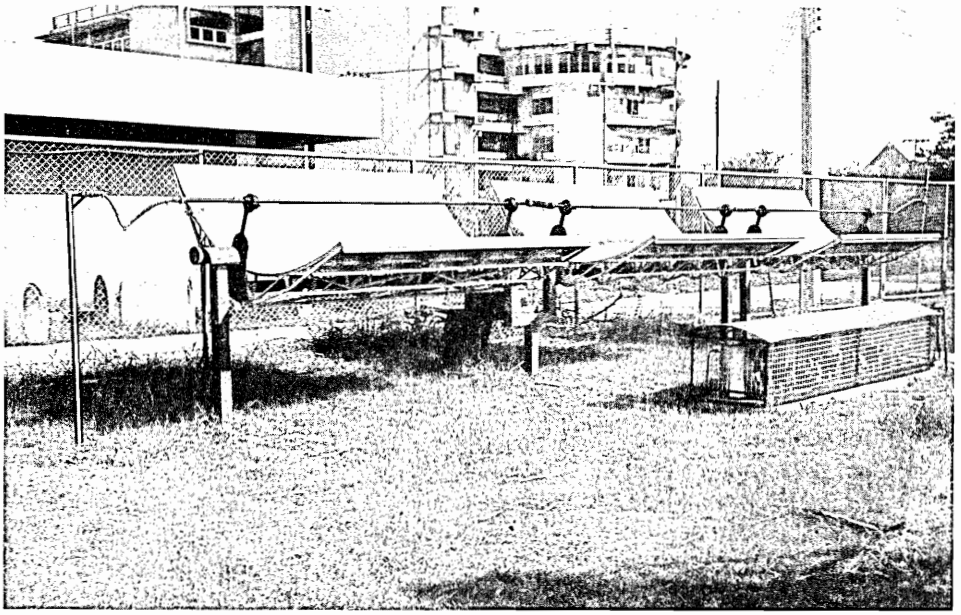
- Sankamphaeng Area: With technical cooperation from the Japan International Cooperation Agency (JICA), the working group performed geological, geophysic, and geochemical surveys of six exploratory wells of 500 m depth, two of them with hot water. The GTE-6 gives a flowrate of 5-6 litres/second at 110 °C, about 2 bars of pressure.
- Fang Area: With the close cooperation of French agencies namely the Bureau de Recherche Geologique et Miniere (BRGM), Geowatt and Agence Frencaise pour la Maitrise de l'Energie (AFME), 12 exploratory wells of 100 m depth were drilled which give a total hot water flowrate of 14-15 litres/second.

According to a feasibility study by BRGM, a 120 kWe binary cycle power plant can be installed, and it is planned to commence this project in 1986.

Solid Fuel Project

- In cooperation with the USA, a feasibility study of 40-50 MW fluidized bed combustion system using low-grade lignite is expected to be completed in 1986.
- The group, as a member of the oil shale development subcommittee, has explored oil shale sources in Mae Sod, Tak Province. It was found that at the present time it was not economical to develop the resources.
- The group, in cooperation with DMR and the Ministry of Defence, has explored and drilled some exploratory wells at the tar sand resource in Fang, Chiang Mai Province. The quality and quantity of the reserves are such that it is not feasible to develop them.

Source: Extracted from *EGAT's Projects on Nonconventional/Renewable Energy Resources for Electricity Generation* compiled by Kamol Takabut, Electricity Generating Authority of Thailand (EGAT), November 1985.



EGAT-KMITT parabolic trough system development

CRRERIS

Electrical Appliance Efficiency

A report entitled *Energy Efficiency of Common Electrical Appliances* has recently been released.

The report is the result of a collaborative effort between the Commonwealth Regional Renewable Energy Resources Information Service (CRRERIS) and the United Nations Pacific Energy Development Programme (PEDP) based in Suva, Fiji.

The first section was written by PEDP. It provides a general context in which Pacific Island governments can consider policy options relating to the energy efficiency of electrical appliances common to the region — lights, air conditioners, refrigerators and freezers. The benefits and costs of these options are discussed.

The second section was written by Enersol Consulting Engineers, of Sydney, Australia, under a contract to CRRERIS. It is a discussion of the technical material relating to these appliances. It includes a description of their operating characteristics, the standards that apply to them, the ways of conserving energy using existing appliances and, where available, their energy efficiency under relevant test conditions. Inverters, which may be applicable as power supplies for common appliances in remote regions, are also discussed.

The report is aimed at a range of audiences, principally users, policy makers and technical researchers.

Users

Consumers who purchase and operate these common appliances will find brief information on how to reduce the electricity consumption of these devices. However, efficient operation has not been the main thrust of this report and users should seek advice from their energy information or energy management centres. Also, as is

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INNERTAP

INNERTAP Gets IDRC's Financial Support

The Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP), which initially consistied of five member countries, — Indonesia, the People's Republic of China, the Philippines, the Republic of Korea and Thailand — is one of the four regional pilot projects established with Unesco's support.

INNERTAP's pilot operation for the past two years has enabled it to establish national network nodes which serve as formal and informal mechanisms for collecting, processing, analysing, repackaging and disseminating information on NRSE (new and renewable sources of energy) among various user groups, and effective coordinating links with operating regional NRSE information services and resources such as CRRERIS (Commonwealth Regional Renewable Energy Resources Information System, based in Australia), AIT/RERIC (Asian Institute of Technology/Renewable Energy Resources Information Centre, based in Bangkok), ESCAP's Regional Network on Biomass, Solar and Wind Energy, and AIBA (Agricultural Information Bank of Asia, based in the Philippines).

In order that additional activities can be undertaken by INNERTAP to make its services progressively more effective and responsive to users' needs, financial support was solicited from the International Development Research Centre of Canada to augment Unesco's contribution from its regular programme funds. The recently approved project was developed with the following projected outputs for a period of 3 years:

- A system for providing technical inquiry services on NRSE information at both regional and national levels; an expanded, computerized bibliographic database containing references to documentations generated by the member countries which can be accessed systematically;
- The INNERTAP Bibliographic Database Index (to be published twice a year);
- Fifteen information packages/brochures on specific subject areas/technologies determined to be of priority in the member countries;
- Workshops aimed at evaluating and identifying the services INNERTAP should offer to make it more user-oriented;
- Document delivery: and
- Translation of documents into the language understood by the enquirer.

Electrical Appliance Efficiency
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pointed out in the first section by PEDP, policies on appliance efficiency and operation, including information programmes, should be part of an overall energy management programme.

Policy Makers

The feasibility and implications of various policy options are considered in detail by PEDP. These are not intended to be prescriptive but form part of the critical decision-making process by energy planners and governments. It should be noted that implementation of some regulatory measures is made difficult by the many and rapid changes that occur in the 'white-goods' industry, i.e. change of company ownership, model numbers, compliance with standards, etc.

Technical Researchers

The bulk of the report, Section 2, contains technical details, and a lot of these are concerned with a description of the standards and test procedures employed by manufacturers, consumer bodies and government authorities. Conclusions on comparative energy efficiency are difficult to draw because of the origin of appliances and the consequent differences in standards under which equipment is tested. Readers will find that the observations in Section 1 will assist them in keeping the technical detail in perspective.

The report is intended to stimulate dialogue on these relatively common appliances, in the context of national energy planning and management programmes. While there is an emphasis on the Pacific basin, readers in the whole Asian-Pacific region will hopefully find the report worthwhile.

Copies of the report are available (at a cost of AU$30 each) from:

CSIRO Publications Sales,
P.O. Box 89,
East Melbourne, Victoria, 3002
Australia

Cheques should be made payable to 'CSIRO *Collector of Monies*'.

DIARY OF FORTHCOMING EVENTS

1986

- **April 29 — May 2, 1986, Oakland, CA, USA**

Alternative Energy Development: Partnership in Operation Conference

Sponsored by Renewable Energy Institute, Edison Electric Institute, Pacific Gas & Electric Co.

For further information: Paul Alliegro, Pacific Gas & Electric Co., 77 Beale Street, San Francisco, CA 94106.

- **June 3-5, 1986, Boulder, CO, USA**

11th Passive Solar Conference

For further information:
American Solar Energy Society Inc.
2030 17th Street
Boulder, CO 80302
USA.

- **June 3-5, 1986, Anaheim, CA, USA**

Renewable Energy Technologies Symposium and International Exposition (RETSIE 86)

The RETSIE 86 Symposium will address some of the most critical commercial challenges facing the renewable energy industry, and explore areas for opportunity and growth. Organized by the Renewable Energy Institute, with special assistance from the U.S. Department of Commerce and the California Energy Commission, the Symposium will draw upon leading financial and energy experts from the U.S. and around the world.

Each day of the symposium has its own special theme. Together, the three days provide a comprehensive program for energy companies, investors, government officials and other professionals interested in learning more about where the renewable energy industry is headed.

For further information: Barbara Flynn, Renewable Energy Institute, 1001 Connecticut Ave., NW, Washington, D.C. 20036, USA.

- **June 11-13, 1986, Herning, Denmark**

DANWEA 86.

The conference will focus on technical as well as on economic aspects to give participants an up-to-date information on the most recent technology and market developments. Furthermore, the conference will provide an excellent forum for the exchange of information, experience and viewpoints.

It comprises two main sections – one focusing on commercial aspects in wind energy utilization, the other focusing on technical and scientific aspects.

Both sections will include a number of distinguished and experienced speakers.

For more details contact: Association of Danish Windmill Manufacturers, Handvaerksradet Viborg, Gl. Vagt, Lille Sct. Hansgade 20, DK 8800 Viborg, Denmark.

- **September, 1986, Boston, MA, USA**

Windpower '86

For information contact: Linda Grey, American Wind Energy Association, 1017 A King St., Alexandria, VA 22314, USA.

1987

- **August 31 — September 18, 1987, Trieste, Italy**

Workshop on Non-Conventional Energy Materials

For details contact:
International Centre for Theoretical Physics
34100 Trieste, P.O.B. 586,
Miramare, Strada Costiera 11,
Italy

- **September 13-18, 1987, Hamburg, Federal Republic of Germany**

ISES Solar World Congress 1987

The 1987 Solar World Congress in Hamburg will follow the example set by the preceding ISES World Congresses, acting as a multidisciplinary forum for solar energy experts from all over the world. Besides tackling general issues, the Congress will include special workshops and poster exhibitions dealing with Advances in Solar Energy Technology, particulary in the following fields:

- o photovoltaic technology
- o wind
- o solar thermal energy
- o use of passive solar energy
- o heat pumps
- o biomass technology

The issues which will be discussed include

- o research assignments
- o fundamentals
- o systems
- o economic efficiency
- o energy scenarios
- o uses in developing countries, etc.

For other details contact:
ISES Solar Weltkongreß 1987 e.V.
c/o Hanseatic Congress Management GmbH
Am Weiher 23
D-2000 Hamburg 20
Federal Republic of Germany

- **September 28 — Oct 2, 1987, Lausanne, Switzerland**

ICBEM '87 International Congress on Building Energy Management

Building energy management is a fast growing and rapidly changing field of considerable scientific, technical as well as economic and social importance.

The aim of ICBEM '87 is to present the state-of-the-art together with ongoing research in selected fields such as:

- o Ventilation, air movement in buildings, air quality
- o Control and regulation of heating and ventilation
- o Field measurement and auditing
- o Building planning process and design tools
- o Energy strategies and the occupants
- o Solar energy use
- o Daylighting and artificial lighting
- o Building concepts for hot climates
- o Building regulatory process
- o Case studies on the above listed topics

For more details contact:
ICBEM'87 Secretariat
p.a. Prof. Andre P. Faist
EPFL – LESO Building
CH – 1015 LAUSANNE, Switzerland.

PUBLICATIONS RECEIVED

WIND ENERGY

— Field Measurements on the CWD-2000 between 85-03-28 and 85-08-10 (R-765-D), Henk Oldenkamp and Niko Pieterse, 1985, 78 p.
Available from: Consultancy Services Wind Energy Developing Countries
P.O. Box 85
3800 AB Amersfoort
The Netherlands

— The Wind-Diesel Test Facility at Riso National Laboratory, Riso-M-2534, Per Lundsoger, Helge Aagaard Madsen, Riso National Laboartory, Roskilde, Denmark, 1985, 22 p.

— Some Results of CWD's Test Fields (R-780-D), Joop Van Meel and Paul Smulders, 1986, 12 p.
Available from: CWD at the above address.

RENEWABLE ENERGY

— New and Renewable Energy in Six SADCC Nations, B.M. Murphy, Inter Pares, Ottawa, Ont, Canada, 1986, 39 p.

— Rural Energy Planning in the Developing Countries of Asia, Proceeding of the Workshop, Food and Agriculture Organization of the United Nations, Rome, Italy, 1983, 60 p.

BIOMASS ENERGY

— Biomass Energy — A Monograph, E.A. Hiler and B.A. Stout, (Eds.), Texas A & M University Press, College Station, TX, USA., 1985, x+313 p.

— Energy from Biomass, 3rd E.C. conference, W. Palz, J. Coombs and D.O. Hall (Eds.), Elsevier Applied Science Publishers, London, U.K., 1985, xxv+1211 p.

— Energy from Biomass — An Indian Experience, O.P. Vimal and P.D. Tyagi, Agricole Publishing Academy, New Delhi, India, 1984, xvi+440 p.

SOLAR ENERGY

— Reference and Calibration, A Compilation and Evaluation of Designs Developed within IEA SH & C TAS III, Performance Testing of Solar Collectors, H.E.B. Anderson, Swedish Council for Building Research, Stockholm, Sweden, 1986, 38 p.

A Special Package for RERIC Members

RERIC aims at answering renewable energy questions, with particular regard to applications in tropical regions. The main topics covered by RERIC are solar energy, biofuels, wind energy and small-scale hydropower. The center's regular publications are a quarterly newsletter (RERIC News) and the Renewable Energy Review Journal (two issues a year). The RERIC Holdings List, and Abstracts of AIT Reports and Publications are issued occasionally, as are other miscellaneous publications and research reports.

MEMBERSHIP FEES: Members from USA, Canada, Europe, Australia, New Zealand, Japan — individual = US$40, institutions = US$75; all other countries individual = US$25, institutions = US$40; supporting members = US$120. Publications can only be obtained on a membership basis.

AIR MAILING CHARGE: Members from Asian countries, excluding Thailand, US$9; all other countries US$15.

Indian members can also pay their fees in rupees (invididual = Rs. 300 and institutional = Rs. 540.00, including surface mail charges) through COSTED, India. (Please send M.O./cheque, etc. made payable to "COSTED", Indian Institute of Technology, Madras 60036, India, indicating that the fee is for RERIC membership).

For further information write to: **The Director, Library & Regional Documentation Centre, A.I.T., G.P.O. Box 2754, Bangkok 10501, Thailand.**

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Subscribe now to NETLINK, *Aslib's new publication on local area networks (LANs).* NETLINK *brings together product news, reviews, users' accounts, and longer articles on the practical applications of local computer networks. Regular features include: discussions of LAN standards; definitions of terminology; LANs END, the lighter side of networking.* NETLINK *is bi-monthly, and costs only £12 for six issues. For further details contact: Aslib Publications (Sales), Information House, 26–27 Boswell Street, London WC1N 3JZ.*
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RERIC news

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200 m³/day Solar Sea Water Desalination Pilot Plant

By Dr. Bakr H. Khoshaim
Solar Program Director, KACST P.O. Box 6086, Riyadh 11442, Kingdom of Saudi Arabia

IN 1980 SOLERAS (The Saudi Arabian-United States Program for Cooperation in the Field of Solar Energy) sponsored the design of several solar-based desalination technologies. The design objectives included the energy-efficient and cost-effective production of 6000 m^3/d potable water from brackish or sea water. After reviewing several concepts and making extensive technical and financial evaluations in 1983, including reverse osmosis, multi-stage evaporation, and indirect freezing powered by different energy concepts (wind, line focus collectors, central receiver, and point focus dish collectors), SOLERAS asked the Chicago Bridge and Iron Company (CB&I) of Oakbrook, Illinois, to build their proposed solar-powered desalination pilot plant in Yanbu, Saudi Arabia, using the indirect freezing point focus collector concepts.

System Description

The plant (Solar Energy Water Desalination Engineering Test Facility) consists of two major networks, an energy collection network and an energy consumption network. Each of these is independent of the other, and can be broken into subsystems to further describe the plant. The energy

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tool — wind and sun compendium — Development of wind and solar energy for water pumping — cwd

CRRERIS — Incorporates news from the Commonwealth Regional Renewable Energy Resources Information Service (CRRERIS) and Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP). — INNERTAP

200 m^3/day Solar Sea Water Desalination Pilot Plant

From P. 1

collection subsystem collects energy in the form of heat and puts it into the energy storage subsystem. The energy storage subsystem holds the heat giving it up only as required by the energy delivery subsystem to drive a steam engine. The energy delivered by the steam engine directly drives the refrigeration subsystem compressor, providing the refrigeration required by the desalination subsystem. The absorption refrigeration subsystem uses exhaust steam to provide additional capacity to condense ammonia in the refrigeration subsystem.

Energy Collection Subsystem

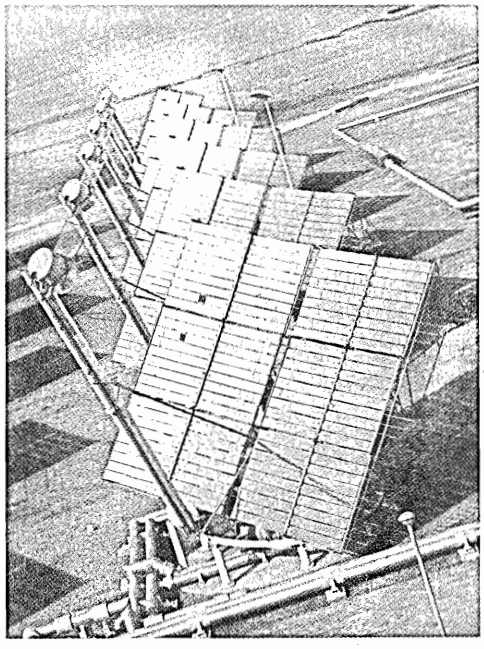
The energy collection subsystem consists of several components, including 18 solar collectors. The solar collectors are two-axis tracking point focus concentrators with individual tracking controls. Each collector has 80.3 m^2 of reflective area with 98% reflectivity, a 350-500:1 concentration ratio, and a 0.6 kW/m^2 collection threshold. The heat transfer fluid is syltherm 800. The auxiliary oil heater is a direct-fired heater capable of supplying all of the primary energy required to operate the plant.

Energy Storage Subsystem

The energy storage subsystem consists of two molten salt storage tanks, one for hot salt, and one for warm salt. It functions via the storage and release of thermal energy from molten salt. Warm salt is heated in the salt/oil heat exchanger in the energy collection system. The heated salt is accumulated in the hot salt storage tank. The hot salt then passes through the salt/steam heat exchangers, where superheated steam is generated for power. The used, or warm salt, is then accumulated in the warm salt storage tank.

Energy Delivery Subsystem

The energy delivery sybsystem consists of the steam engine, the



steam generation heat exchangers, and the steam condensate handling equipment. Steam generated by heat from the molten salt is superheated. The steam expands in the steam engine, rotating its shaft, which provides the power essential for the operation of the refrigeration compressor.

Refrigeration Subsystem

The refrigeration subsystem is closely associated with the desalination subsystem. The refrigeration subsystem provides the cooling required to make ice in the desalination subsystem. The subsystem refrigerant, anhydrous ammonia, is vaporized in the freezers, and the vapor, after passing through a liquid vapor separator, enters the compressor. The vapor compression is minimized by utilizing the melt water as a low temperature heat rejection medium.

Desalination Subsystem

The desalination process is known as the indirect contact heat transfer freeze desalination process. As the name implies, desalination is accomplished by the freezing or crystallization of water molecules from the brine into essentially pure water ice; the term "indirect contact" refers to the fact that no mixing occurs between the process fluid or product water and the refrigerant.

Ambient temperature sea water is pumped into the system and is precooled via heat exchange with the cold plant output streams. A portion of the feed is cooled by the rejected concentrated brine in the heat exchanger; the remainder of the feed is cooled by the product water in the heat exchanger. The two cooled feed streams are joined and enter the freeze loop of the system.

The freeze loop comprises freezer recirculation pumps, the indirect contact freeze heat exchangers, and an ice-brine slurry separator vessel. As brine passes through the freeze exchangers, ice crystals of essentially pure water are formed in the brine. In the slurry vessel, brine and ice slurry are drawn off.

The washer/melter vessel is a combination of a countercurrent gravity wash column and an annular ice melter which surrounds the wash column. The concentrated brine and ice slurry from the freeze loop enters the bottom of the countercurrent wash column, in which the ice rises slowly due to its buoyancy. The rising ice forms a semi-rigid, porous pack of ice crystals which is flooded with the concentrated brine.

The draining of the brine from the ice creates a drained ice pack at the top of the wash column. By distributing a portion of the plant's fresh product water over the top of the drained ice pack, the ice crystals are rinsed of the saline brine which adheres to their surfaces. Although a small portion of this wash water may be recycled through the brine drain, most of the fresh water adheres to the ice pack crystals and is carried upward with the pack. At the top of the wash column, the pack of fresh ice and water is scraped outward

by rotating blades and allowed to fall into the annular ice melter at less than 500 ppm.

Data Acquisition

The facility has a central control system which provides data acquisition and data reduction, analysis, and reporting.

Data acquisition encompasses three broad areas:

a. environmental data;
b. process performance data; and
c. operation and maintenance logging.

Preliminary Tests Results

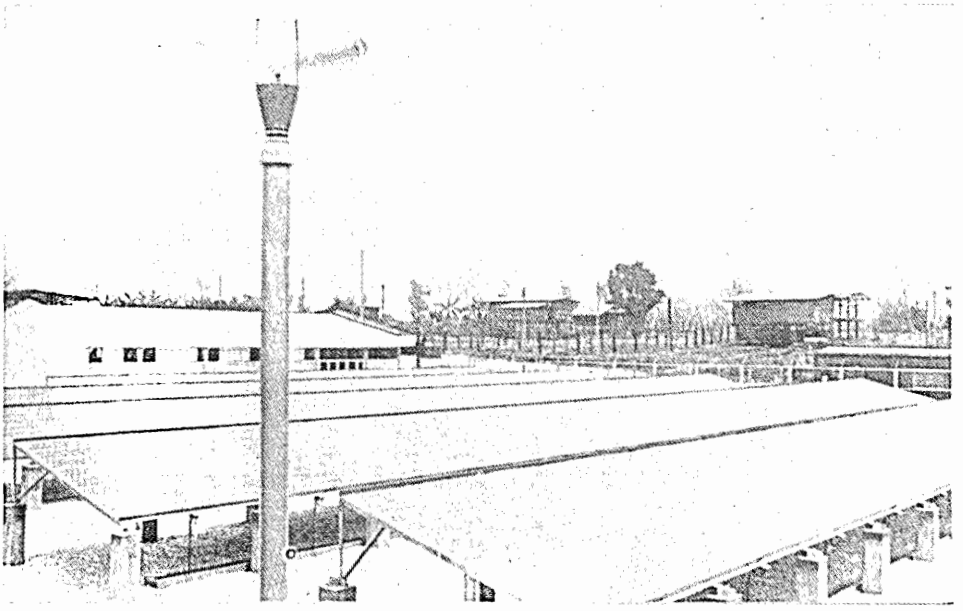
During the start-up of the system, the pilot plant performed at 91% of the target production level. Table 1 shows the conditions and different parameters of some typical tests.

The SOLERAS 200 m^3/day Solar Sea Water Desalination Pilot Plant has been constructed and is under an extensive testing program. Preliminary results are very encouraging, reaching 91% of the baseline design values. The direct freezing technology is operating well with very few technical difficulties. The success of this pilot plant will put solar sea water desalination technology far ahead of any other existing solar desalination process.

Table 1. Days of typical system performance to date.

	03/13	04/16	04/17	04/19
Solar peak, W/m^2	668	815	691	939
Solar daily total, kWh/m^2	2.6	7.3	4.6	8.5
Energy from solar collectors, kWh	Loss	2 205	896	3 130
Collector operating time, hours	3.5	.9	6	8
Sky condition	Cdy/Dty	Clear	Clear	Clear
Energy from fossil heater, kWh	11 764	8 051	15 500	10 900
Energy in storage, kWh at beginning of day (00.00 hrs)	4 700	5 536	4 600	5 300
Thermal energy added to salt, kWh	10 070	12 111	11 600	11 400
Thermal energy into steam genr., kWh	10 819	11 767	14 500	13 800
Product water, m^3/day	88	111	161	168
Weighted ppm in product water	317	551	474	478
Desalination operating time, hours	24	24	24	24
Salinity, %	10.0	10.0	10.0	10.0
Freezer delta temp., °C	4.0	2.3-2.6	2.2-3.8	3.3-4.0

Thailand's First Solar-Power Plant



The solar-power plant in Tak (Bangkok World, 9 July 1986)

The first solar-powered electricity plant in Thailand, under the Provincial Electricity Authority (PEA), is located at Ban Den Mai Soong in Ban Tak District of Tak Province. The plant has been in operation since July 1986, and is one of three new solar-powered stations being set up by the PEA as part of efforts — dating from the oil crisis of the early 1970's — to utilize alternative energy sources other than petroleum products.

The other two stations are located at Ban Wang Mee in Pak Thong Chai District of Nakhon Ratchasima Province, and Ban Mae Kasi in Lad Yao District of Nakhon Sawan Province. PEA officials pointed out that construction of all three stations, begun last December, has now been completed and electricity produced by these solar-powered systems will be sold to the public at the same rate as that produced by other sources. Because of the advanced technology and high investments required, the PEA obtained from the Japanese Government a grant aid valued at 483 million yen or 52 million baht. The grant aid came in the form of equipment for the construction of the plants, which was undertaken with the advice of Japanese technical experts.

The plants operate on a photovoltaic system, with solar cell panels transforming sunlight into electricity which is distributed in AC current ranging from 230-240 V. The production capacity at Ban Den Mai Soong in Tak and

Cont. P. 6

Use of Solar Distilled Ethanol from Sweet Sorghum as Cooking Fuel

The rural household sector consumes about 57% of the total energy used in India. About 90% of this energy is used for cooking, whereas the remaining 10% is used for lighting, hot water, etc.

The use of ethanol for cooking, which would reduce the use of conventional fuels, has been explored by the Nimbkar Agricultural Research Institute (NARI), Maharashtra, India.

However, with the debate going on to decide whether a particular piece of land should be used for producing food or fuel, it is extremely attractive to be able to use sweet sorghum (Jowar), which is a dual purpose crop. It provides grain from its earhead and sugar from its stalk. This sugary juice can then be converted into alcohol via the regular route of fermentation and distillation. The bagasse (stem residue after the sugar is extracted) is also an excellent fodder. Thus from this one crop, food (grain), energy (alcohol) and fodder (bagasse and leaves) can be obtained.

Besides being a dual-purpose crop, sweet sorghum has a great tolerance to a wide range of climatic and soil conditions. It is a short duration crop, maturing in 100 to 140 days (as compared to 12 to 18 months for sugarcane), and is cheaper to grow and requires less water than sugarcane.

The plan for producing ethanol from sweet sorghum has been carried out in the following stages:

a) breeding of a variety of sweet sorghum which has a high sugar content;
b) development of bacterial strains to increase juice fermentation;
c) distillation of fermented mash by solar energy;
d) use of ethanol as a cooking fuel; and
e) analysis of the energy output/input for the production of ethanol from sweet sorghum.

Breeding

The aim is to breed sweet sorghum varieties having at least 90% sucrose, so that they will be suitable for the manufacture of sugar and jaggery. This work was started in 1970, and since 1981 it has been supported by a research grant from the U.S. Department of Agriculture.

Initially 19 lines received from the U.S. Department of Agriculture and 45 lines developed at this institute were evaluated, and were found to give a maximum stripped stalk yield of 38 t/ha and a maximum juice purity of 85%. By crossing, selection and back-crossing some lines giving as high as 48 t/ha stripped stalk yield and 90% juice purity in F_6 generation were obtained. Many of these improved lines are also more pest-resistant and have a bolder grain (28 g/1000 seeds) than the original germplasm (15 g/ 1000 seeds). The original lines also had a red, brown, or chalky-white grain colour which was not acceptable to the consumers. The improved lines have a pearly-white grain colour. The high yielding American lines were photo- and thermo-sensitive, and thus could not be planted during winter. The new thermo- and photo-insensitive lines give a very high yield in the monsoon season as well as in the winter season.

Fermentation Studies

A modest program in the selection of various yeast strains suitable for fermenting sweet sorghum has been started. Fourteen strains of *Saccharomyces cerevisiae* were obtained from NCIM (National Chemical Laboratory, Pune) and tested for fermentation of sweet sorghum juice. Among the parameters studied were temperature, pH, sugar content and % inoculum.

Out of the fourteen strains tested, 4 (NCIM No. 3317, 3318, 3319 and 3320) gave an average alcohol output of 7-8% (v/v) whereas others gave only 4-5% (v/v). The sucrose content of the solution was 17%. The maximum alcohol percentage obtained with the four strains was 12%. Studies are at present under way to further narrow down the choice of strains to one.

Distillation by Solar Energy

Distillation takes up about 70-85% of the total energy consumed in ethanol production. The existing alcohol technology, therefore, results in a net negative energy value. If ethanol is ever to become an economically viable fuel for an industrial society, then it should become net energy positive.

Thus distillation of ethanol by solar energy does provide one of the solutions to the problem mentioned above, a study of solar distillation is being carried out.

Various vacuum distillation units have been tested and analyzed. Fig. 1 shows a laboratory-scale solar distillation unit. The unit works in thermosiphon mode. A vacuum is produced in the morning, so distillation takes place in a partial vacuum. It is possible to distill 40-60% ethanol by solar energy using these units. An average day (5 kWh/m^2-day insolation) yields 1.4 kg/m^2 per day of 40% ethanol. The amount of ethanol distilled is inversely proportional to its percentage and directly proportional to the solar radiation.

The efficiency of the distillation unit for distilling 40% ethanol is about 13%, and compares extremely favourably to 2-3% obtained from existing fossil fuel-fired ethanol distillation plants. A pilot plant has therefore been designed and is in the process of being set up to distill about 40-50 litres of 90% ethanol. The solar collector area is 35 m^2 and the solar heated water at 70°C will be used for dis-

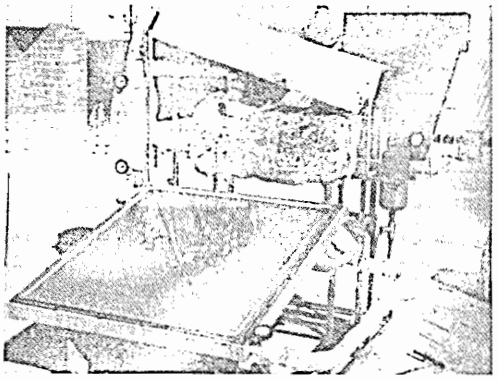


Fig. 1 Alcohol solar distillation unit.

tillation. Since the distillation is taking place at such a low temperature, the whole plant will be run in a vacuum. It is estimated that the plant will be commissioned by mid-1986.

Use of Ethanol as a Cooking Fuel

Laboratory tests were conducted on the feasibility of using a wick stove on 40% ethanol-water mixture. It was found that below a 70% mixture the wick stove did not light up. This was because water together with ethanol was drawn up by the capillary action of the wick and thus interfered with the combustion of ethanol.

Similar tests were also conducted on a pressurised kerosene stove (Primus type), and again mixtures of less than 75% did not light up. The reason was that existing primus stoves are designed for kerosene, which has a different heat of vapourization as compared to the ethanol-water mixture and thus the atomization of the fuel does not take place for proper combustion.

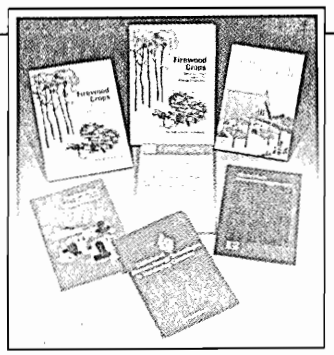
However, a free surface combustion of an ethanol-water mixture took place at 40% concentration and up. If the ethanol was heated up, the combustion could take place even at lower concentration levels. Thus a wickless stove was designed, fabricated and successfully tested to run on 40% ethanol concentration. The stove was a 3 kW burner and the final mixture (after complete burning of ethanol) concentration was between 3-4%. This was drained off from the stove and could become the feedstock for a solar still.

The efficiency of the stove was found to be between 30-35% which compares very favourably with the 20-25% efficiency of kerosene stoves.

Energy Analysis

An energy analysis for ethanol production from sweet sorghum was made, and it was found that the energy output to input ratio is 3.94, which is very high, far exceeding the output/input ratio of any other ethanol producing crop. In the case of solar distillation (with 40% concentration output), the ratio is 3.55. The main reason for these high energy ratios is that sweet sorghum is a dual purpose crop.

For further details contact:
Nimbkar Agricultural Research Institute
P.O. Box 23, Phaltan 415523
District Satara, Maharashtra, India.
(Source: Nimbkar Agricultural Research Institute, Report of Energy Research and Development Activities 1981-1985, Shriram Press, Phaltan, March 1986).



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Photovoltaics Development in India

In India, the Department of Non-Conventional Energy Sources (DNES) has the responsibility for the development, production and application of solar photovoltaic (PV) devices, and Indian scientists working in this department and elsewhere have made significant contributions to the development of PV systems. There are four basic areas of activity in the development of the engineering and technology of PV systems which include the development of basic raw materials, particularly silicon; solar cells and modules; balance of-system (BOS) components; and complete system engineering.

The technology so far developed relates mainly to the processing of single crystal silicon wafer into solar cells and their design and development for different applications. Several improvements and newer techniques in cell and module fabrication have been introduced in production, leading to a reduction in production costs. These include screen printing of front and back contacts, polishing and texturisation, testing and encapsulation.

Silver paster for screen printing has been developed by Central Electronics Ltd., and another public sector undertaking, Bharat Heavy Electricals Ltd., has launched a production programme based on in-house technology. Average cell efficiencies of 10 to 11% have been achieved at BHEL and CEL using CZ wafers. Some experimental work using semi-crystalline wafers is also in progress.

In the National Physical Laboratory, scientists have developed technology for the fabrication of thin CdS:CuS solar cells. These cells are formed over an ordinary window glass substrate in which semiconducting layers in polycrystalline form are built up using vacuum deposition and chemical processing. These are totally encapsulated to withstand the climatic changes.

To evaluate the reproducibility of the technology and the control over process variables, a laboratory level batch production facility has been established. Several hundreds of cells have been fabricated having a conversion efficiency in the range of 5-6%. These cells have shown remarkable stability over a number of years.

During the Sixth Plan, the DNES implemented a comprehensive programme of R&D pilot production and demonstration relating to PV technology. The programme led to the development of indigenous technology for production, the creation of an initial infrastructure for the manufacture, installation and maintenance of PV systems and promoted awareness among potential users.

Mettur plant

An indigenous plant to produce pure silicon was commissioned at Mettur in Tamil Nadu last year. The plant envisages an annual production of 25 tonnes of polycrystalline silicon and conversion of part of it into single crystal ingots and wafers. The indigenous process uses high pure silicon tetrachloride (STC) as raw material. The silicon produced at the plant costs between Rs750-850/kg (= US$60-68/kg), which is competitive with imported silicon.

The silicon project is the outcome of a unique 15-year collaboration between Mettur Chemicals and two scientists of the Indian Institute of Science — Prof. G. Suryan, a physicist and Prof. A.R. Vasudeva Murthy, a reputed chemist considered to be the father of the silicon industry in India.

Amorphous silicon

An integrated programme on amorphous silicon cells has made steady progress. Plasma deposition facilities for experimental work have been established at the Indian Association for the Cultivation of Science, Calcutta, the Indian Institute of Technology (IIT), Delhi, and the University of Poona. Silane gas, which is an essential input for amorphous silicon production, has been produced in small quantities at the IIT, Kharagpur, and the Indian Institute of Science, Bangalore, and is being tested for its quality.

Amorphous silicon solar cell technology has also been identified as one of the science and technology missions during the Seventh

Thailand's First Solar-Power Plant

From P. 3

Ban Mae Kasi in Nakhon Sawan is 50 kW, while the capacity at Ban Wang Mee in Nakhon Ratchasima is 20 kW.

As PEA officials have pointed out, by producing solar-powered electricity, the PEA is expanding its capacity to supply electricity to the people in remote areas. It is also likely to increase its knowledge of technology in this field for future projects.

The solar projects add to the hydro-electricity generating systems the PEA has established around the country. These projects are in line with a government policy, prompted by the oil crisis of the 1970's, that called on all agencies responsible for providing energy services to the public to find sources of energy consisting of other than oil products.

In keeping with the same policy, the PEA aims to supply electricity to the public, especially those in remote, rural villages that cannot be connected with the PEA's supply system through power transmission lines.

Source: Bangkok World, 9 July 1986.

Plan. With a view to accelerating the activity in this area and supporting the R&D programmes, the DNES proposes to set up a pilot plant for making amorphous silicon solar cells and modules.

Research on other aspects of PV technology such as photoelectrochemical solar cells, thin film devices based on compound semiconductor materials such as copper indium diselenide, on implantations, and laser annealing systems has continued in several institutions. The DNES is making efforts to promote and evaluate indigenously produced silicon to assess its stability for PV production. Solar cells and modules made from such materials have been found to be comparable in performance to devices made from imported silicon.

At IIT, Kharagpur, researchers are working on ways to change farm waste into a high tech energy product. They have found that rice husks contain about 18% silica, commonly known as white ash. The researchers are now working on a cheaper way of reducing silica to fine grain silicon. They hope to use recyclable aluminium in the reduction process, and polycrystalline ingots ready for use in solar cells.

There are at present two programmes in operation for the production of solar cells and modules in the country. One is at Central Electronics Ltd., and the other at BHEL, where a production capacity of 1 MW has been installed.

About 40 R&D projects covering materials, cell fabrication, development of systems, concentrating systems, and newer types of cells have so far been funded by the Department of Science and Technology and the DNES.

Whereas scientific research on solar cells and materials is fully supported in the academic institutions, the product development activity has been given priority in the public sector companies.

A five-year National Solar Photovoltaic Energy Demonstration (NAPSED) project was initiated in October 1980 with a view to developing cost-effective photovoltaic technology; manufacture at the pilot level of at least 1 MW per year by 1985, effective system design, engineering and integration; system deployment and demonstration; collection and analysis of field data; education and manpower training. The production of solar cells from April to September 1985 under this programme was 126.11 kW. A capacity of 1 MW annual production was however substantially built up.

Among the achievements of the NAPSED programme are:

- The technology for solar cells and module production has been developed from bench scale to commercial scale. A commercial project for upscaling the production to reach in stages a level of 5 MW per year has been taken up by Central Electronics Ltd., based on the technology generated in the NAPSED programme. The technology for the manufacture of modules has been transferred to Rajasthan Electronics & Instruments Ltd. by CEL.
- A variety of systems have been designed, developed and field-tested under the programme. These include water pumping systems for drinking water supply and micro irrigation, street lighting units, community lighting systems, community TV, power supplies for offshore platforms, power pack to energise some of the weather monitoring equipment needed by the first Indian Scientific Expedition to Antarctica and battery charging. A BHEL-made PV system for battery charging has been successfully used by the Indian Expedition to Antarctica in 1985-86.

The Government proposes to set up a National Silicon Facility during the Seventh Plan to accelerate research in this vital high technology area.

Source: The Hindu (India's National Newspaper), 18 June 1986.
(Information sent by: Dr. A Jagadeesh, President, Society of Science for the People, Andhra Pradesh, India).

Solar Energy in Israel

Israel is often regarded as a leader in solar energy development, and indeed preliminary solar energy studies in Israel have been carried out since the 1930s. The following outline indicates briefly what has been achieved, and which areas and technologies Israel plans to develop in the future.

PAST

1930s & 40s

— Preliminary solar energy studies are undertaken by Professor Dov Ashbel of the Hebrew University of Jerusalem (radiation measurements) and Professor Nathan Robinson of the Technion (radiation measurements, collectors).

1945

— The idea of an artificial saline solar pond is first proposed by Dr. Rudy Bloch.

1954

— Applied research in the utilization of solar energy is begun at the National Physical Laboratory in the Prime Minister's Office, under the direction of Dr. Harry Z. Tabor. Selective surfaces were developed for improving the efficiency of solar collectors. The research was financed by the Rothschild Foundation at the request of the Prime Minister, David Ben Gurion.

1955

— At the First International Conference on Solar Energy held in Arizona, USA, Israel exhibits, for the first time, a commercial collector with a selective surface. The conference placed Israel on the international scene in the utilization of solar energy.

1957

— Work is begun at the National

Cont. P. 8

Solar Energy in Israel

From P. 7

Physical Laboratory on the development of a small turbine suitable for operation with solar collectors. The working medium for this turbine is an organic vapor instead of steam.

1958

— The first industrial plant in the world for selective blackening is inaugurated in Israel.
— Research on saline solar ponds (based on Dr Rudy Bloch's original proposal) commences under the direction of Dr. Tabor. Experimental ponds are built at Sdom and Atilt.

End of the 1950's

— Research in solar energy is inaugurated at the Negev Arid Zone Research Institute, Beersheva. One of the projects was the development of a parabolic trough tracking collector, but doubts as to its economic viability (because of low oil prices at the time) led to cessation of further work.

1961

— A 3 kW turbine, developed at the National Physical Laboratory, and a new type of solar collector, are exhibited at the U.N. International Conference on New Sources of Energy held in Rome.

1964

— Ormat, a company to develop the Israeli turbine, is established.

1974

— The Scientific Research Foundation, under the direction of Dr. Harry Z. Tabor, renews R & D on solar ponds. A number of experimental ponds are built, one in Eilat. In 1975 the Foundation receives financial support from the Ministry of Trade and Industry.

1977

— Work commences on the erection of a solar power station at Ein Bokek, comprising a 1.85 acre saline solar pond and a 150 kW turbine developed by Ormat. The project was undertaken by Solmat (a company established the same year by the Scientific Research Foundation and Ormat) and supported by the Ministry of Energy and Infrastructure.

1979

— The Solmat experimental solar power station begins operation.

1980

— The Ministry of Energy and Infrastructure decides to finance the building of a 60 acre solar pond operating a 5 MW power station near the Dead Sea. Beit Ha 'Arava is chosen as the site.
— A regulation requiring the installation of solar water heating systems for all new buildings not exceeding 9 stories is passed.
— Operation of the Eshed plant for solar air conditioning at the Sheba Medical Center (Tel-Hashomer) begins.

1981

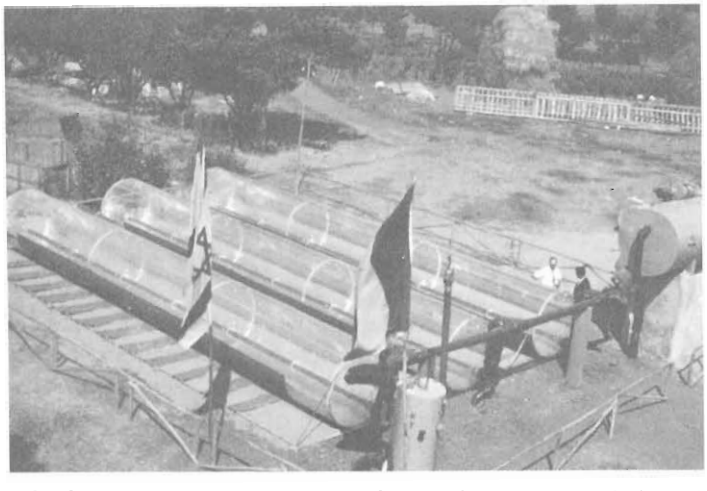
— A demonstration plant to provide industrial steam to the Tapud factory at Shaar Hanegev is erected by Luz Industries. The plant employs concentrating parabolic trough collectors.

1984

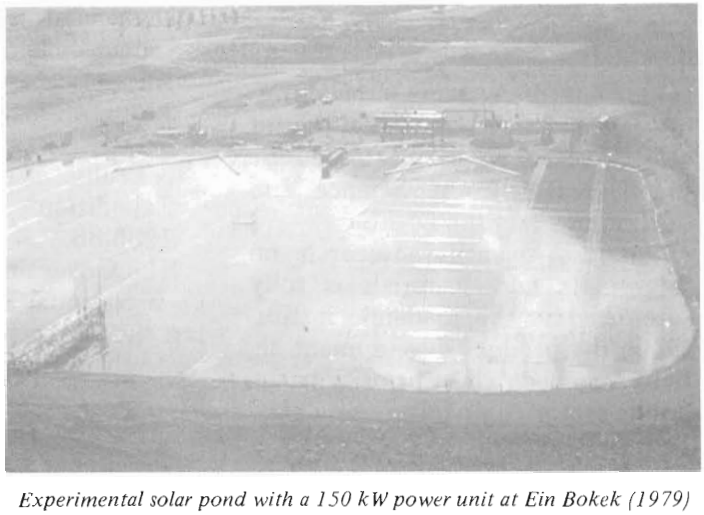
— The solar power station at Beit Ha'Arava is connected to the national electricity grid.

Present 1985 — 1986

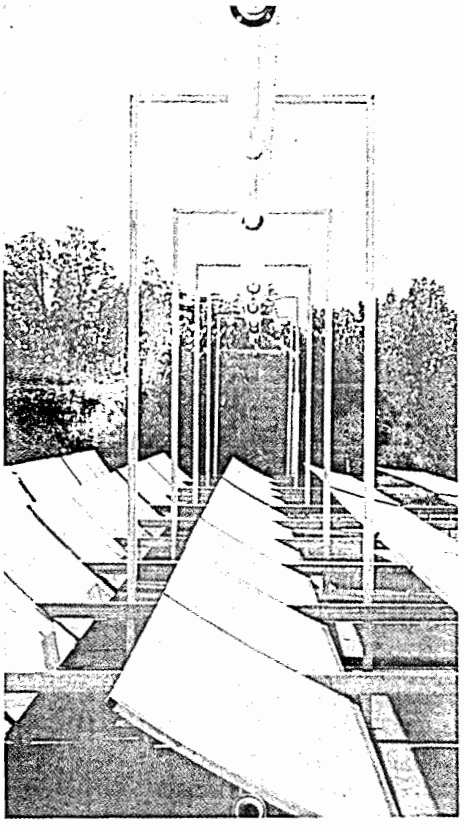
— About 650,000 households (55% of all households) use solar water heaters.
— 130 firms manufacture flat plate



The 3kW capacity solar power unit developed at the National Physical Laboratory which was exhibited at the U.N. Conference on New Sources of Energy (Rome, 1961).



Experimental solar pond with a 150 kW power unit at Ein Bokek (1979)



A solar installation for supplying steam at kibbutz Nir Eliyahu (Pimat).

collectors. A number of companies produce selective coatings. More than half a million units have been exported to over 20 countries. In 1984, the exports amounted to more than 7 million dollars.

- The 5 MW solar power station is in operation at Beit Ha'Arava. Luz Industries of Israel are in the process of completing their second power station in California, with a capacity of 30 MW. The company has signed an additional contract with Southern California Edison for building five more power stations, each with a 30 MW capacity. The value of the contract comes to about 500 million dollars.
- Demonstration plants comprising either parabolic trough collectors for industrial process heat (up to 95°C) or concentrating tracking mirrors for producing steam are currently in operation at four different kibbutzim.
- A solar pond with floating collectors for supplying hot water is in operation as a demonstration plant at Kibbutz Maoz Haim.
- Solar energy is being used for heating water for swimming pools and for ritual baths (mikvot).
- Over 20 "solar houses" (having passive systems to exploit solar energy for comfort heat) have been designed and built.
- A number of photovoltaic systems have been installed to illuminate military pick-up points and junction sign posts. Small photovoltaic systems are being employed for special purposes, where it is not possible or not economic to be connected to the national electricity grid.
- Research into most facets of solar energy is being carried out in academic institutions and industry.
- A solar furnace, with a 50 kW capacity, is being used at the Weizmann Institute of Science for high temperature scientific experiments.
- A central field at Sde Boker for testing various technologies for generating electricity from solar energy is being established.

FUTURE

1987

- A solar tower for carrying out scientific experiments in solar energy conversion will be built at the Weizmann Institute of Science.

1988 – 2000

- Solar power stations (thermal and/or photovoltaic), with an overall capacity of 200 to 500 MW, will be in operation. The higher capacity is more likely to be reached if the price of energy increases more rapidly than predicted or if there is a technological breakthrough.

For further details on R&D on solar energy in Israel contact: Ministry of Energy and Infrastructure, Office of the Chief Scientist, 234 Yafo, Jerusalem, Israel.

Solar Dryers—Their Role in Post-Harvest Processing

The Solar Crop Drying Project (SCDP) of the African Energy Programme (AEP), as initiated by the Commonwealth Science Council (CSC), has the objective of improving traditional methods of sun drying crops and commodities in Africa by the development and introduction of appropriate solar drying techniques. The progress of SCDP since its inception in 1979 is documented in CSC reports CSC(81) AEP-4 and CSC(82) AEP-10. The research programme has been funded from local (national) sources and by the Overseas Development Administration (ODA) of the United Kingdom.

In 1983 the Tropical Development and Research Institute (TDRI) was appointed by CSC to participate in the SCDP by the provision of information and advice on solar crop drying technology. Following a consultant's visit to the researchers in all 7 countries participating in the SCDP; Gambia, Ghana, Kenya, Mauritius, Tanzania, Uganda and Zimbabwe, it was recommended that a Training Workshop be held to overcome shortcomings that were identified in certain areas of solar drying technology. This recommendation was accepted by CSC and the Workshop was held at the Jacaranda Hotel, Nairobi from 19-30 November 1984.

The objectives of the workshop were:

i) to provide basic information and instruction on solar crop drying techniques encompassing the range of disciplines involved;
ii) to promote the three-stage concept of initial project evaluation, experimental investigation, and project extension as a methodology for successful projects; and
iii) to strengthen links and improve liaison between researchers by

Cont. P. 10

Vertical-Shaft Axial-Field Generator for Small Hydro

The generator has an axial-field configuration which is characterised by its airgap magnetic flux running in a direction parallel to the machine shaft, as shown in Fig. 1. In this arrangement, the stator and rotor are coaxial and located side by side, unlike the conventional machine in which the stator and rotor are concentric cylinders, one placed inside the other.

The stator core shown in Fig. 1 is laminated with silicon steel in the form of a coiled spring. The mechanical strength of the core is increased by securing the straps on the inner and outer end rings, as shown in Fig. 2, and an end plate on one side of the stator core. Radial slots are made on the other side of the stator core. The teeth are of sector shape. The tooth width varies along the radial direction, ranging from a minimum at the inner circumference to a maximum at the outer circumference. With open slots, each armature tooth has a uniform cross-sectional area, and so the tooth flux density is uniform from the surface to the root of the tooth, unlike conventional machines

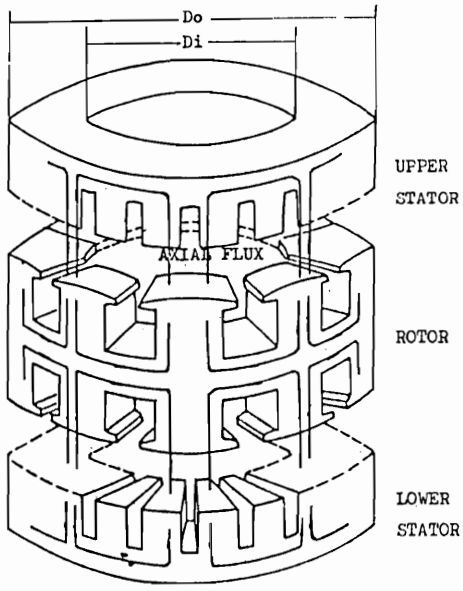


Fig. 1 Double-stator axial-field generator, showing steel cores only

where the tooth tapers, causing high flux densities at the tooth roots. The slots can have a rectangular shape. The main slot insulation can be a mica cell. Each conductor is insulated with mica tape having paper or fabric backing. For the machine installed in a small hydro, double layer lap winding with diamond coils can generally be used because of their easy connection for multi-turns. Singleturn wave winding may be used in the case of large generators. For ventilation purposes, a number of concentric cooling ducts are made on the stator core, as shown in Fig. 2.

An experimental model was constructed in the laboratory of the University of Hong Kong. Experimental and calculated results agree with each other satisfactorily. The machine has been put into synchronism with the power supply system in Hong Kong and runs smoothly with the rotor floating at different preset positions.

The vertical-shafted axial-field generator has many advantages over its radial-field counterpart when used in small hydropower plants, which are usually constrained by various factors such as the large capital investment, the lack of resource inventory and the technical-intensive nature of the plant. The machine is smaller in size and lighter in weight because its stator and rotor are readily separated. Its modular design will be particularly suitable for the small station developed by stages. The cost of the

Solar Dryers—Their Role in Post-Harvest Processing

From P. 9

means of case studies, discussion periods and design projects.

There was a total of 18 delegates from 9 African countries. In addition to those from the 7 countries participating in the SCDP, funded by the ODA, there were delegates from both Zambia and Malawi funded by the International Development Research Centre (IDRC).

The lecture notes for the Workshop were prepared by the Chemical Engineering Section of TDRI in consultation with other Sections of the Institute.

The intention of the Commonwealth Science Council in organizing and funding the workshop was that the participants from many African countries will widen their appreciation of the many factors relevant to their national Solar Crop Drying Projects currently operating as part of the African Energy Programme.

This manual on *Solar Dryers — Their Role in Post-harvest Processing* (1985, 337 p.) is intended to provide an introduction to basic theories of drying, an outline of the principal operating features that can be used to classify the many designs of solar dryer developed to date, and a detailed account of the construction and operation of the three most popular types of solar dryer. Information is included on the theory and design of flat-plate solar collectors which are an integral part of many dryers. It is important to realize that solar drying, or any drying technique for that matter, is not an operation carried out in isolation and therefore sections have been included on pre-drying processes and techniques, methods of quality assessment and analysis, storage and

plant will be further reduced drastically when the rotating body of the whole set of hydro-electric units is supported by the magnetic attraction within the machine, and

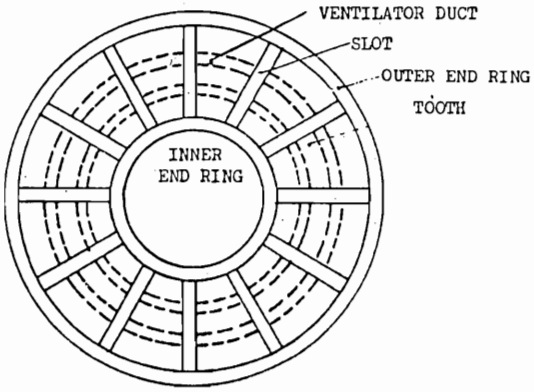


Fig. 2 Stator core

the thrust bearing is eliminated.

In order to test the characteristics and performance of an axial-field generator of full size, a new design method and procedure for the machine is being developed and its feasibility in a commercial power system is being examined. A 160-kW machine is being manufactured in southern China, and will be installed in a small hydropower station near Guangzhou. This machine is the first of its kind in the world, and is expected to produce revolutionary effects in the construction and operation of small hydro.

(Source: SHP News, No. 1, 1986).

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packaging techniques.

Recommendations on experimental methodology for the evaluation, development and extension of solar drying techniques are also provided, together with notes on basic economic considerations. Worked examples of drying theory, dryer design and economic analysis are provided.

The manual is available from:
Commonwealth Science Council
Marlborough House
Pall Mall
London SW1Y 5HX
UK

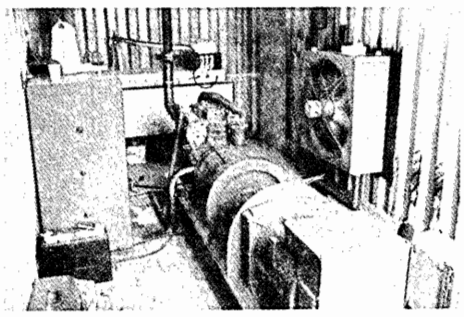
Test Facility for Wind/Diesel Systems—Denmark

The Test Station for Windmills at Risø has tested windmills for many years. As part of the wind/diesel programme the Test Station has established a dedicated facility for the testing of wind/diesel systems of the same standard as those already existing for grid-connected windmills. At first the test facility will be used for testing two systems being developed as part of a bilateral project with Risø National Laboratory, Denmark, and Chalmers University of Technology, Sweden. In the long run, the intention is to develop standard test procedures for the standard testing of commercially available wind/diesel systems in the same way as is being done for grid-connected windmills at the test station.

The test facility is basically a local independent grid, in which the load is a programmable load bank with resistors and inductive load. The load bank can simulate the load patterns in terms of power demand and power factor for the sites where the system being tested is intended to operate.

The windmill of the W/D system is erected on a universal foundation, and the diesel generator set is installed in a container. The container is a part of the test setup and is equipped with a fuel system, cooling facilities and a number of sensors for the measurement system. The active part of the load bank is also installed in a container. An office trailer is located close to the diesel container. The trailer contains the central power switchboard and the measurement computer. All components of the W/D system are coupled via the power switchboard through a permanent system of underground power cables. Likewise, all sensors of the data acquisition system are connected to the central measurement computer by a system of underground signal cables. The data acquisition system is permanently coupled to 40 transducers for the types of measurement listed below:

- Wind speed and wind direction are measured by a cup anemometer and a wind vane, respectively, mounted on a boom on the met tower at hub height.
- Air temperature and barometric pressure are measured by shielded transducers at the base of the met tower.
- Active and reactive power flow and power factor are measured for each component by fast responding transducers (time constant 80 msec) mounted in the respective modules of the power switchboard. The readings are also shown on meters on each module of the switchboard.
- Voltage and grid frequency are measured by transducers in the switchboard on the local and grid lines, respectively. These readings are also shown on metres on the switchboard.
- Diesel temperatures and fuel flow are measured by transducers in the diesel container.



Risø's experimental W/D system installed in the diesel container with fuel tank, engine cooler and simulator.

For more details contact: Per Lundsager or Helge Aagaard Madsen, the Test Station for Windmills, P.O. Box 49, DK-4000 Roskilde, Denmark.

(Extracted from "The Wind/Diesel Test Facility at Risø National Laboratory", a paper presented at the Delphi Workshop on Wind Energy Applications, Delphi, Greece, 20-22 May 1985).

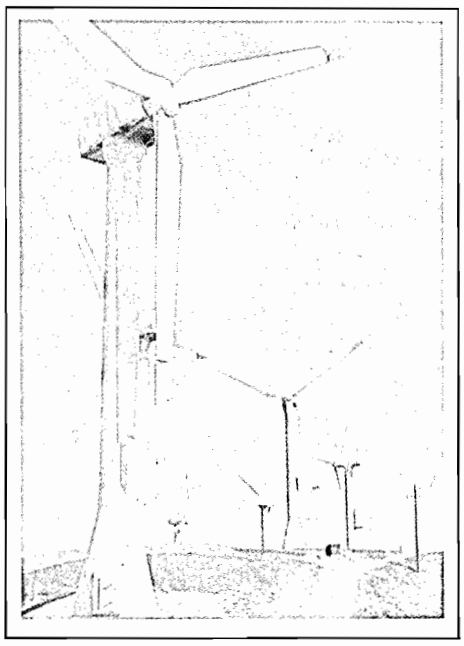
New Projects of James Howden Group (UK)

James Howden & Company Limited of Glasgow (UK) has recently received orders for the supply of wind generators for the following new projects:

1 MW Wind Turbine for CEGB at Richborough

This £2.4 milliion order from the Central Electricity Generating Board (CEGB) is to design and manufacture a 1 MW wind turbine generator to be sited at Richborough in Kent. The total project value of £2.8 million is to be financed by the CEGB, the Department of Energy, and by a grant from the European Economic Community (EEC).

The wind turbine generator will have a rotor 55 m in diameter, mounted on a 45 m high tubular steel column. It will achieve its rated output of 1 MW at a wind speed of 13 m/s (approximately 30 m.p.h.).



Howden HWP-330 Wind turbine generator

Work on the design of the CEGB machine will start immediately and the wind turbine generator is expected to be commissioned in the latter half of 1987. This project marks the next step in the Board's wind power programme.

The 1 MW machine is based on the successful range of medium-sized wind turbine generators developed by Howden which have been sold to Utilities in the United Kingdom, and exported to Barbados, Canada, and to the United States.

25 MW Wind Farm in California

This 25 MW wind farm in California, comprising 75 × 330 kW machines, has been ordered by a major U.S. institutional investor on a leveraged lease basis for a sum of US$48 million. This is the first major wind farm development to use such large machines. Another Howden subsidiary, Howden Wind Parks Inc. of California, was responsible for the site infrastructure, obtaining permits and the power purchase contracts, wind surveys, and financing, and its skills will be used in the future for windfarm developments both in the U.S. and overseas. The electricity generated from this development represents a yearly reduction of over 100 000 barrels of oil imports, or a reduction of US$2.5 million in the USA oil import account.

On the same site, the company

Implementing Viable Micro-Hydropower Plants

Although worldwide interest in harnessing waterpower resources by means of micro-hydropower plants (less than about 100 kW) has increased, few publications are available to assist those implementing such projects. Most of these publications deal only with a few specific topics, giving an incomplete and sometimes biased perspective of all the issues involved.

Other publications deal primarily with larger small-hydropower plants, leaving developers of micro-hydropower sites with few options but to reduce the scale of designs and approaches to implementation that are more appropriate for large plants. Consequently, these latter publications unconsciously promote the development of micro-hydropower schemes that do not take advantage of the unique factors encountered in implementing plants at the "micro" end of the small-hydropower range, factors which must be considered if this resource is to be harnessed cost-effectively.

There is in fact no publication which documents the wide range of experiences already gained over the years by those who have implemented their own micro-hydropower schemes, especially in developing countries. Most publications cover some aspects of the basic theory and possibly cite a few actual examples, but they largely leave it to the site developer to rediscover on his own the lessons already learned by others. This does not encourage the implementation of viable, cost-effective schemes.

The *Micro-Hydropower Sourcebook*, which has just been published, focuses specifically on the implementation of micro-hydropower schemes, recognizing the needs and constraints found in developing countries. In addition to covering theoretical aspects in a straightforward manner, it documents many practical experiences gained in developing countries worldwide. It covers topics from reviewing a variety of techniques for measuring head and flow and estimating streamflow characteristics to selecting and laying out sites and designing the necessary civil works to discussions of turbines, governing, electrical aspects, and comparisons of mechanical versus electrical power generation. It includes descriptions of designs, operation, sizing, etc. of each component of a scheme; equations, formulas,

has installed 10 Howden 60 kW machines and a demonstration machine rated at 750 kW. The 750 kW machine has been selected by Pacific Gas and Electric Company of California, one of the major U.S. power utilities, as the reference design for a conceptual study of a 100 MW wind farm for their Sky Valley site in California.

Whilst the current market for wind turbine generators in the U.S. has been created by Federal and State tax incentives to encourage alternative energy development, a recent report by the Electric Power Research Institute (EPRI) quantifies the potential economic market for the sale of wind turbine generators to the American Utilities between the years 1990 and 2000 as around US$20 Billion.

Note: The capacity of the Howden's wind turbine for shetland is 750 kW and not 150 kW as was mentioned in RERIC News, 8(4), 1985, p. 13.

For further details contact: D.C. Gilmour, James Howden & Co., Ltd., Old Govan Road, Renfrew PA4 OXJ, U.K.

(Source: Extracted from the UK Press Releases provided by James Howden and CEGB).

and graphs prepared in metric units; solved problems on anchor stability, vent sizing, canal design, turbine operation, etc.; cross-references throughout the text in addition to a complete index; and is spiral bound for easy use. This publication has over 200 photographs documenting experiences around the world and over 200 drawings.

Further details regarding this publication are available from NRECA International Foundation, Attn: Sourcebook, 1800 Massachusetts Avenue NW, Washington, D.C. 20036. Single copies of the Source-book are available at US$ 32.50 plus shipping costs ($5 for surface mail; for air mail, $9 for Latin America, $13 for Europe and Africa, and $18 for Asia and the Pacific). Rates for multiple copies, bulk orders, and developing country students and volunteers are available on request.

Opportunities for Energy Conservation in Thailand

From a World Bank report[1], Thai industries consumed 29.6% of the total energy consumption in Thailand in 1983 (see Table 1). The amount was equivalent to 2.74 and 2.59 MTOE of traditional and modern fuels, which are mainly petroleum products.

Traditional fuels such as rice husk and bagasse are consumed in rural agricultural based industries, while urban industries mainly use modern fuels.

As Thailand spends approximately 40% of the total export earning on the import of crude oil and petroleum products, effective energy conservation programmes in the country could lessen the burden on foreign exchange, in addition to reducing the production costs in Thai industries.

The transport sector consumed over 30% of total energy demand in 1983. The figure appears to be very high in comparison to consumptions in developed countries, for example, approximately 15% for transport sector in Japan. The potential for energy conservation in this sector therefore seems to be quite high.

As the ADB report[2] for the National Energy Administration in 1984 indicated, Thai industries could save US$112 million per annum, or about 3.7 million barrels of crude oil equivalent, through improved energy uses at a total investment of US$699 million. Energy audits and analyses were conducted in 49 companies representing nine industry divisions, namely food and tobacco, textiles, wood and wood products, papers, chemicals, non-metallic products, basic metals and others. Results of their findings are given in Tables I-III of the report.

A JICA report[3] in 1984 contains results of energy audits carried out in six types of industries, namely ceramic and glass, paper, textiles, metal, chemicals, plastic and food. The report concluded that in the 55 factories analysed, 464 MWh of electricity and 96 $\times$ 10^6 litres of fuel oil could be saved by appropriate energy conservation measures.

Opportunities for energy conservation also exist in large buildings. A detailed energy audit in a hospital reveals that one steam genera-

Cont. P. 15

Table 1.
Patterns of Energy Consumption in 1983[1], in '000 toe

	Rural	Urban	Total	% of Total
A. By Sector				
Households				
Traditional fuels	4180.3	295.2	4475.5	24.8
Modern fuels	381.2	418.7	799.9	4.5
Cottage industry	380.0	–	380.0	2.1
Industry				
Traditional fuels	2363.0	–	2363.0	13.1
Modern fuels	229.2	2363.8	2593.0	14.4
Agriculture	449.9	–	449.9	2.5
Transport	1427.8	4237.3	5665.1	31.4
Fishery	680.9	–	680.9	3.8
Commerce/Government	–	615.9	615.9	3.4
Total	10092.3	7930.9	18023.2	100.0

CRRERIS

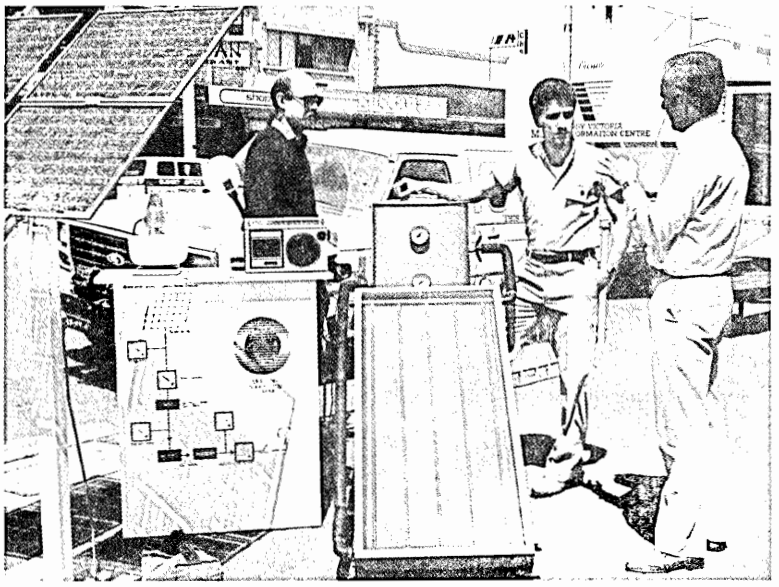
Victorian Solar Energy Council

The Council's objectives are to systematically encourage the commercialisation and maximum market penetration of feasible solar products, with an emphasis on Victorian manufacture; and to contribute to the Government's long-term strategy for a shift in the Victorian economy away from the dependence on fossil fuels towards greater reliance on solar based renewable energy.

For operational purposes solar energy includes the renewables, wind energy, tidal energy, geothermal and fuels produced from biomass and wastes.

The functions of the Council are:

- o The encouragement and promotion of solar energy in Victoria;
- o The encouragement and promotion of the manufacture of systems and components for the utilisation of solar energy;
- o The review and evaluation of solar energy research, development and demonstration projects being undertaken in Australia, and elsewhere, particularly in relation to their relevance in Victoria;
- o The encouragement and support of solar energy research, development and demonstration projects;
- o The maintenance of an effective liaison with any organisation concerned solely or partly with research into, or the development, demonstration, or manufacture of systems and components for the utilisation of solar energy;
- o The publication of ways in which solar energy can be used industrially, commercially and domestically, and the contribution which solar energy is able to make to Australian and Victorian energy resources; and
- o The provision of advice to industry, commerce and the public on the application of solar energy and the efficiency of its use.



V.S.E.C. promotion in country, Fred Darby and Gordon Williams.

During the past year, the Council has been able to bring to fruition several important projects which substantially strengthen the role of renewable energy resources within the Victorian energy economy. A landmark in this respect was the official launch in December 1985 of the Victorian Government Renewable Energy Strategy Policy, this document now forms the basis for government energy planning in the short and medium term. Another most important development was the creation of the City of Shepparton as a Solar City and the Greater Shepparton Region as a Solar Region in Victoria. Close liaison was established and is now being maintained between VSEC and the Greater Shepparton Development Committee to ensure that the full potential of this new status can be translated into practical achievements within that region.

As in the past, close cooperation on projects is continuing with the Gas and Fuel Corporation of Victoria in terms of collector testing, with the State Electricity Commission in terms of wind power utilisation and remote area power systems, and with the Department of Industry, Technology and Resources on a wide range of policy initiatives such as the potential for the harnessing of geothermal energy in Victoria. Contacts established with trade associations such as the Electrical Development Association of Victoria, the Master Plumbers Association, and the Solid Fuel and Wood Heating Association, will lead to cooperative and collaborative work in many sections of the Victorian renewable energy programme.

Stemming from the earlier work on the Victorian Biomass Study, attention has been focussed on the production and utilisation of ethanol as a transport fuel. This initiative is seen as important not only in terms of energy savings but also in terms of the balance of payments situation, and the State transport infrastructure. Industry interaction in the "flexible fuel" car programme is being provided by the Ford Motor Company, the Sarich Rotary Engine Company, the CSIRO Division of Energy Technology and the Environmental Protection Authority.

The overall educational thrust of VSEC's programmes has been strengthened with the completion of the Primary School Teaching Package and the current development of the Post-Primary Teaching Package. Emphasis is being placed on information dissemination and a technical advisory role as the essential pre-requisites to the industrial technology transfer process.

Energy conservation in buildings is being addressed through the Solar Efficient Design programme in conjunction with the Ministry of Housing, the Public Works Department, the Department of Industry, Technology and Resources, and the GMI Council.

Solar product commercialisation has been achieved by several Victorian industries including developments in solid fuel appliances with Coonara Heaters Pty. Ltd., in solar photovoltaic water pumping with Mono/Suntron and in solar domestic hot water systems with the Somer Solar roll formed selective surface panels and the Siddons Industries solar boosted heat pump systems.

To assist with forward planning for the coming year the Council has identified several key objectives. These include:

- o Establishment of the first Australian Solar Display Village incorporating the GMI Five-Star Design Rating for solar efficient designed houses and backed by the Housing Industries Association & the Greater Shepparton Development Committee.
- o Implementation of the remote area power supply monitoring programme.
- o Solar educational training programmes to be launched at the Technical College (TAFE) and Secondary School levels and back-up material will be developed for the Primary School educational package launched this year.
- o The continuation and extension of the computerised outdoor testing facility for solar domestic hot water systems.
- o The introduction of a solid fuel appliance testing programme in conjunction with the Solid Fuel and Wood Heating Association.
- o Inauguration of a Solar Advisory Service to handle industrial and commercial enquiries on an on-going basis.
- o The installation of the first 75 kW grid connected wind aerogenerator at Breamlea in Victoria.

As well as the research and development programme, VSEC provides general information on renewable technologies. Publications available are:

- o Legal Aspects of the Practical Application of Solar Energy Technology in Australia — Main Report — Vol. 1.
- o Victorian Energy Planning Program. Government Energy Policy Statement — Renewable Energy Strategy.
- o Solar Space Heating — The Patch Primary School.
- o Solar Pool Heating — Beaurepaire Pool — University of Melbourne.
- o Solar Pool Heating — Box Hill Indoor Recreation Centre.
- o Solar Domestic Water Heating — Cobram Hospital.
- o Public and Institutional Pools in Victoria — Computer Inventory — Fields, Coding and Advice on Retrieval — September 1983.
- o Biomass Potential Study of Victoria — Vol. 1. Overview with Summary, Conclusions and Recommendations.
- o Greenhouse Commercialisation — Market Study — Main Survey.
- o The Solar Heating of Public and Institutional Pools in Victoria.
- o Solar Jobs in Victoria — The Economic Impact of the Solar Industry.
- o Survey of Owners of Solar Heating Systems.
- o Public Attitudes Towards Solar Energy.
- o Theory and Design of Solar Thermal Systems.
- o Solar Energy — An Introduction to the Principles and Applications.
- o Solar Desalination — Proceedings of UNIDO/VSEC Workshop, September 1983.
- o Solar Industrial Process heating — North Eastern Dairy Co. Ltd.
- o Industrial Process Heating — Warrnambool Woollen Mills.
- o Solar Heating of Public and Institutional Pools in Victoria — A Design and Instruction Manual
- o Renewable Energy Education — Report on Future Directions in Education About Renewable Energy for VSEC and Victorian Education Department.
- o Impacts of Solar Water Heaters on the SECV and GFCV.

For further information on the work on the Victorian Solar Energy Council contact:
Elizabeth Hauer,
Public Relations Officer,
Victorian Solar Energy Council,
10th Floor,
270 Flinders Street,
Melbourne, VIC. 3000.
AUSTRALIA.

Opportunities for Energy Conservation in Thailand

From P. 13

tor was more efficient than the other, hence the less efficient one should be kept as a stand-by unit; analysis of chiller units led to the same recommendation[4].

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4. Prida Wibulswas, et.al, *Energy analysis in a Thai private hospital,* A Progress Report, ASEAN Working Group on Energy Research, Bangkok, June 1986.

Contributed by Dr. Prida Wibulswas, Energy Technology Div., Asian Institute of Technology, Bangkok, Thailand.

INNERTAP

ENERCON Annotated Bibliography

This bibliography is an index to energy conservation publications available in the participating countries of the Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

Energy conservation nowadays is considered as important as energy resource development. Studies in many countries have shown that a given increase in energy utilization could be obtained at a lower cost by investing more in conservation than in resource development programs. However, one of the major requirements for an effective energy conservation program is the availability of detailed information on technologies, energy production and its utilization. By and large, this calls for a strong information service infrastructure which would link two of its main components, namely, generators and users of energy conservation information for without the other, information, which is in itself a major resource, would be useless. As a start therefore, INNERTAP has come out with this annotated bibliography which covers contributions from Korea, China, Indonesia and the Philippines. It hopes to discover, identify and record all energy conservation publications available in these countries to satisfy information demands. This present publication plays emphasis on locally produced information, however, major foreign publications are included. This bibliography will be updated to include other publications which the member countries of INNERTAP failed to include.

Manual on Energy Conservation and Audit in Industries

This manual is a compilation of the experiences discussed and lessons learned during the First Chinese National Seminar/Workshop on Energy Conservation and Audit in Selected Industries held on September 9 to 13, 1985 in the city of Wuhan, People's Republic of China.

The oil crisis precipitated by major oil-producing countries in the early seventies have had far-reaching and dire consequences. Manufacturing and industrial plants have not been spared from the ill effects of the leap-frogging cost of fossil fuels. Obviously, the high cost of petroleum has scaled up the cost of production. As a counter-measure, plant managers, engineers, decision-makers and workers down the line have joined forces in initiating and adapting in-plant conservation measures and energy management policies with the objective of reducing energy consumption without compromising safety and productivity.

Many countries have found out that an organized energy conservation program can hold down both energy usage and energy cost without disrupting plant production. Notable energy management achievements have been reported through such simple plant maintenance and operating practices as reducing unnecessary lighting in warehouses, optimizing maintenance schedules to keep equipment in good operating conditions, planning production schedules to minimize energy technologies in the plant's operation. It has been repeatedly demonstrated that conservation measures at different levels can reduce energy usage with remarkable cost savings.

The realization of the importance of proper and efficient utilization of energy has inspired Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP) to undertake the publication of this manual with UNESCO's financial assistance.

Further details regarding the *ENERCON Annotated Bibliography* and the *Manual on Energy Conservation and Audit in Industries* are available from:

Dr. Ibarra E. Cruz
INNERTAP Coordinator
PNOC – Energy Research & Development Center
P.O. Box 1031 MCC
Makati, Metro Manila
Philippines
Tel. No. 97-76-11
Talex No. 63776 PNOC-PN
22259 PNO-PH

RERIC Joined 5th Biogas Computer Conference

On August 24-29, 1986, the 4th International Symposium on Microbial Ecology was held at Ljubljana, Yugoslavia. An electronic extension was organized for this meeting, which enabled interested persons to participate in this "5th Biogas Computer Conference", either via the Computer Conferencing System (QZ-COM) at the University of Stockholm (Sweden) or via COSY at the University of Guelph (Canada).

Renewable Energy Resources Information Center (RERIC) of the AIT Library & Regional Documentation Center (AIT-LRDC), in cooperation with the Regional Computer Center (AIT-RCC), acted as a "node" for this computer conference. The AIT-LRDC has the required facilities for online access to QZ and has had the experience of participation in the 2nd and 4th Biogas Computer Conferences, 25-29 March 1985 and 4-6 March 1986 respectively.

Fourteen participants from six organizations in Bangkok attended the computer conference via AIT-Node. Those organizations are King Mongkut's Institute of Technology Thonburi (KMITT); Thailand Institute of Scientific and Technological Research (TISTR); Natural Resources Division of ESCAP; Chulalongkorn University; King Mongkut's Institute of Technology, Ladkrabang; and the Asian Institute of Technology. Funding for tele-communication costs was provided by the Karolinska Institute.

Computer conferencing is a text-based, electronic and asynchronous method of computer-based communication. Electronic messages are entered into a computer conferencing system which stores and delivers them for the receivers. As it enables geographically dispersed people to communicate rapidly, it can be used particularly for people who need to communicate quickly or regularly, for example, or for intensive discussion over a few days by groups of people, as in the case of this Biogas Computer Conference. It is cost effective when compared to other similar forms of text-based communication (postal mail, telegram and telex).

Required facilities for participating in the computer conference include a terminal (e.g. personal computer, software for telecommunication & modem, or teleprinter), a fast printer (100 characters/sec), direct dial (STD) telephone and/or packet-switched network account and the login number and/or password to access the host computer system.

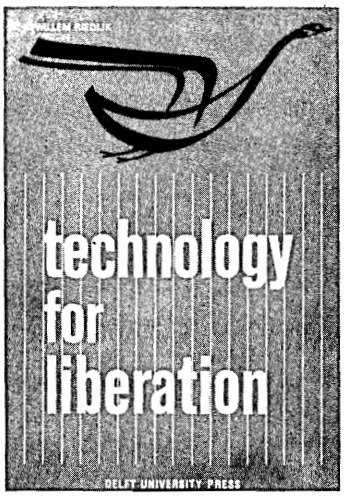
For further details on the computer conferences please contact:

Mr. Eng-Leong Foo
UNEP/UNESCO/ICRO Microbiological Resources Center
Department of Bacteriology
Karolinska Institute
S104 01 Stockholm, Sweden.
Tel: 46+(0)8+340560 ext. 1627
Telex: 17179 KIBIC S

Technology for Liberation—Appropriate Technology for New Employment

In 1982, Willem Riedijk, published a study entitled *Appropriate Technology for Developing Countries.* It highlights the development towards an integrated theoretical framework of appropriate technology (AT) and the three basic elements — self-development, self-management and self-sufficiency. The study also gives a number of related technical examples of appropriate technology in developing countries.

A new book by Riedijk entitled *Technology for Liberation — Appropriate Technology for New Employment* elaborates on theoretical concepts and practical examples of projects in this field. There



are three basic parts. The first part deals with the relation between technology and society and its consequences. The second part contains two chapters on the contents and concepts of a theory of appropriate technology and its methodology. The third and last part gives four examples of projects evaluated with this theory in industrialised and developing countries, as well as a chapter on the application of the theory to education.

Riedijk's new book (1986, X + 262 pp./ISBN 90-6275-244-6/Dlf. 39.85) is available from:

Delft University Press
Stevinweg 1
2628 CN DELFT
The Netherlands.

Multi-Fuel Ice-Making Machine, Final Report

Under the sponsorship of the French National Agency for Energy Management (AFME), a prototype intermittent ammonia-water absorption refrigerator has been designed, manufactured and tested at the Asian Institute of Technology (AIT) and has been undergoing field operations during the last year in a remote rural island in the South of Thailand. The system can be fuelled by any biomass residue, and except for this, is completely independent of any source of conventional fuel. The unit can produce about 25 kg of ice per cycle, and two cycles can be run over a single day. The unit has no rotating parts and does not require the operation of any ammonia valve. Thus, apart from cleaning and painting, the maintenance requirements of the units should be low.

The final report, entitled *Multi-Fuel Ice-Making Machine*, describes the operating principle of the unit, the design considerations to be taken, the experimental results obtained, the economic attractiveness of the unit and the feedback obtained from field operations. The theoretical work done with respect to modelling the thermodynamic and heat transfer performance of the various components and the simulation model developed are also described and discussed.

A complete set of full drawings of the present 25 kg/cycle unit giving all the necessary manufacturing details of the various components are also available (but have not been included in this report). These can be obtained on request from the authors — Prof. G.Y. Saunier and Dr. T.A. Reddy.

For further details please contact: Dr. T.A. Reddy, Division of Energy Technology, Asian Institute of Technology, G.P.O. Box 2754, Bangkok 10501, Thailand.

Solar Cooling and Refrigeration —A Report Sponsored by UNESCO

The great advantage of using solar energy in refrigeration and cooling applications is that the maximum amount of solar energy is available when the demand is also at a maximum. There are two quite different major applications. The first is in the cooling of buildings of all types, ranging from individual houses to large public buildings such as hospitals. The second is in refrigeration for food preservation, with a secondary application in the storage of vaccines for medical purposes — a vital need in many of the developing countries.

This report entitled *Solar Cooling and Refrigeration* by J.C. McVeigh, was initiated by the Energy Development and Coordination Section of the Division of Technological Research and Higher Education, UNESCO, as part of their overall programme for training and awareness in solar energy applications. The main objectives of the report were to examine solar cooling and refrigeration systems, including their economic potential, especially in the developing countries. The report includes many examples of practical systems and research and development programmes. The final chapter includes recommendations for training in solar cooling and refrigeration. There are over a hundred references and the appendices include an annotated bibliography.

The report is available from:
The Division of Technological Research and Higher Education
UNESCO
7 place de Fontenoy
75700 PARIS, FRANCE.

PUBLICATIONS RECEIVED

ENERGY

- *AAECP Energy Projects, Energy Conservation: Hotels and Hospitals*, Progress Report (January — June 1986), ASEAN Working Group on Non-Conventional Energy Research, 1986, 23 p.
- *Direction and Scope for Food/Energy Studies*, Rene Codoni and Supachat Sukharomana, Asian Institute of Technology and Kasetsart University, Bangkok, Thailand, 1986, 58 p.
- *1985 Annual Report*, Public Utilities Board, Singapore.
- *Annual Report 1985*, Technology and Energy Unit, Caribbean Development Bank, 1986, 17 p. + Appendices.
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- *A Study on the Production of Combustible Gas from Rice Hulls*, Korea Energy Research Institute, 1980, vii+78 p.
- *Growing Power: Bioenergy for Development and Industry*, A.S. Miller, I.M. Mintzer and S.H. Hoagland, 1986, vii+100 p. Available from: World Resources Institute, 1735 New York Avenue, NW, Washington, DC 20006 USA.
- *Proceedings of the FAO/FHI Regional Technical Consultation on Agricultural Wastes and Solar Technologies for Energy Needs in Farms*, FAO Regional Office for Asia and the Pacific, Thailand, 1983, vi+205 p.
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— *Directory on New and Renewable Sources of Energy Activities in Indonesia,* Directorate General of Electric Power and New Energy, Department of Mines and Energy, 1985(?).

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SOLAR ENERGY

— *Design Principles and Concepts for Passive Environmental Control in Residential Buildings in Fiji,* D. Kumaran, Master Degree Thesis, Agricultural Association School of Architecture (UK) xvii+193 p.

— *Photovoltaic Systems in Remote Locations — An Experience Summary,* A.F. Ratajczak, U.S. Department of Energy, Division of Photovoltaic Energy Technology, 1985, 16 p.

WIND ENERGY

* *On Passive Safety and Control Mechanisms for Waterpumping Windmills,* R728D, A.R. Logtenberg, 1986, 140 p.

* *BWEA-Meeting on Small Wind Powered Systems 7th,* May 1986, R791D, P.T. Smulders, 1986, 17 p.

* *Benchmark Test of Power Curve Computations Specification of Three Multiblade Rotors,* R793D, J.V. Meel, A. Kragten and G. van Kuik, 1986, 10 p. +Figures.

*These publications are published by and available from: Consultancy Services Wind Energy Developing Countries, P.O. Box 85, 3800 AB, Amersfoort, The Netherlands.

HYDROPOWER

— *A Practical Guide to Design and Implementation in Developing Countries, Micro-Hydropower Sourcebook,* A.R. Inversin, NRECA International Foundation, Washington, D.C., 1986, xiv+285 p.

DIARY OF EVENTS

- October 20-23, 1986, Paris, France

7th International Symposium on Alcohol Fuels

This event is sponsored by the French Institute of Petroleum.

For further information: Yolande Rondot, Direction des Relations Exterieures, 1-4 Ave de Bois-Preau, 92506 Rueil-Malmaison, France or E.E. Ecklund, US Dept. of Energy, CE-151, Washington, DC 20585, Commercial Phone: 202-252-8055, FTS: 252-8055.

- October 27-28, 1986, Quebec City, Quebec Canada

Canadian Wind Energy Conference '86

The conference topics are:
- o Renewable energy policy
- o Wind resource
- o Research and development
- o Demonstration programs
- o Technology developments
- o Performance and operational experience
- o Wind turbine hybrid systems
- o Applications
- o Economic and legal issues
- o Government programs and policies
- o International developments

For more information, contact: Bonnie Jahnke, Conference Coordinator, Passmore Associates International, 209-135 York Street, Ottawa, Ontario. K1N 5T4. (613) 234-3602.

- October 27-31, 1986, Sevilla, Spain

7th European Photovoltaic Solar Energy Conference

This conference is sponsored by the Commission of the European Communities.

Further details from: Dr. G. Grassi, Conference Secretary, Commission of the European Communities, DG XII, Rue de la Loi 200, B – 1049 Brussels, Belgium. Commercial Phone: 322-2356801

- February 15-19, 1987, Dallas, TX, USA

Sixth ASME Wind Energy Symposium

The symposium is sponsored by the Solar Energy Division of the American Society of Mechanical Engineers. It will be held at Lowes Anatole Hotel, Dallas, TX.

For details contact: Angela Gallagher, ASME, PO Box 59489, Richardson, TX. (214) – 358-7601, Telex 795529.

- April 7-9, 1987, University of Reading, UK.

Fifth International Conference on Energy Options

The Role of Alternatives in the World Energy Scene, to be held at the University of Reading, UK, and organised by the Institution of Electrical Engineers.

Papers are invited on the following topics – policy and economics, including electricity demand management; energy efficiency and conservation; combined heat and power; advanced fossil fuel systems; wind; tidal; hydro, including low head; wave; OTEC; solar thermal; solar photovoltaic; geothermal and biomass.

For details contact: Conference Services, IEE, Savoy Place, London WC2R OBL, United Kingdom.

- September 23-24, 1987, University of Reading, UK

Small Engines and Their Fuels in Developing Countries

This conference, organized by the University of Reading, I.T. Power Ltd. and the Institute of Energy, will be the second on the subject of small engines and their fuels. It follows from the successful 1984 Conference attended by participants representing many developing countries, industry, universities and international agencies.

The theme of the conference will be the contribution of small engines and their fuels to the energy supply of rural communities especially in developing countries.

The conference will, it is hoped, help to establish the areas in which developments are required to facilitate the implementation of alternative fuel pro-

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Diary of Forthcoming Events

From P. 19

grammes and related energy conversion systems. The conference will be a forum for the reporting of field experience.

Exhibition

There will be an exhibition of equipment which it is planned will include examples such as Stirling engines, steam engines and gasifiers.

Abstracts of papers (250 words) should be submitted by 30 August 1986. If accepted, the full written paper of about 5000 words must be submitted by 16 January 1987.

Papers should be related to one of the following topics:

Engines: In the range less than 10 kW preferred, but no more than 100 kW – technical and economic appraisals.

Fuels: Production, utilisation and economics.

Case studies: Performance of complete systems and socio-economic appraisal of systems.

Further information may be obtained from:

Dr G. Rice
Conference Chairman
Department of Engineering
University of Reading,
Whiteknights, PO Box 225
Reading, Berkshire RG6 2AY
United Kingdom
Telex No. 847813 RULIB G
Telephone No. (0734) 875123, ext: 7325

- **May 1988, Copenhagen, Denmark**

European Conference on Wind Energy

The EEC Commission has announced plans for the organisation of a European Conference on Wind Energy to be held in Copenhagen, Denmark, in May 1988.

The conference will be within the framework of the Commission's current R&D programme on wind energy which expires at the end of 1988 and will enjoy the support of the Danish authorities.

It is open to all those with an interest in the technology and application of wind energy. For further information contact:

Mr W. Palz, Commission of the European Communities, Directorate-General (XII) for Science, Research and Development, 200 Rue de la Loi, B-1049, Brussels.

- **June 29-July 24, 1989, Kensington, NSW, Australia**

Energy Usage in Rural Industries of Developing Countries

This course presented by the combined resources of several Schools of the University of NSW and Biomass Energy Services & Technology, a private energy consultancy.

Many rural industries use wood or agricultural residues as their major energy source. In some instances up to 30% of fuel wood consumption is by these industries.

As wood becomes more scarce and its cost increases the viability and success of small and medium scale rural industries is threatened. The fuel wood crisis may be addressed by a number of appropriate interventions, such as local production of wood, substitution of alternative energy sources, introduction of improved furnaces and more efficient processing equipment. The course provides information on how to plan and implement "energy for rural industry programmes", and the design and testing of biomass fuel furnaces and engines for agricultural, building, ceramics, metal processing and fabrication industries and preparation.

Course Outline

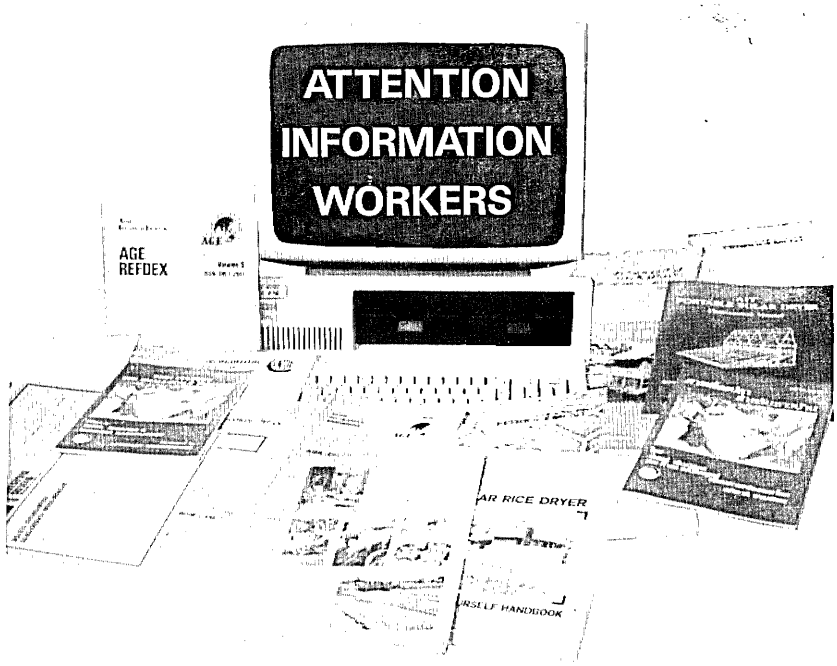
- o Energy assessment for rural industries.
- o Planning and management of appropriate interventions.
- o Evaluation of existing technologies used in food and agricultural, building, ceramics and metal processing and manufacturing industries.
- o Designing and testing new technology or modifying existing technology.
- o Integration of fuel production and energy conservation.
- o Monitoring, evaluating and training in rural energy programmes.

Participants

The course is intended for Senior Project Personnel, both women and men, from Government and Non-government organisations concerned with energy sources and usage in rural industries.

For further details:

Dr. Bill Lawson
School of Architecture
University of NSW
P.O. Box 1
Kensington, NSW 2033, Australia



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For details contact:
Director
Library and Regional Documentation Center
Asian Institute of Technology
P.O. Box 2754
Bangkok 10501, Thailand
Tel. 5290100-13
Telex: 84276 TH

RERIC news

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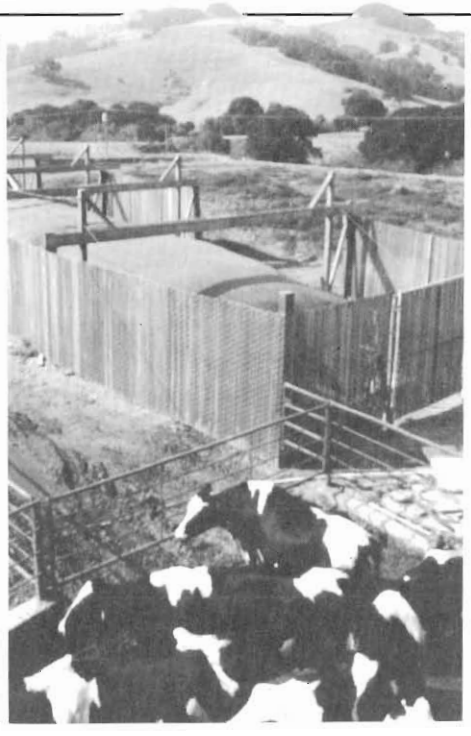
Marindale Dairy Biogas Energy System Generates Profit



Right: Marindale Dairy's 90,000 gallon earthen-wall plug-flow fermenter before installation of heat exchanger, hypalon cover and insulation.

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Manure disposal can be a big headache for farmers with large, confined herds. Marindale Dairy of Novato, California, has overcome that problem and has generated added income as well by implementing a methane fermentation system that transforms cow manure into electricity. A loan from the California Energy Commission (CEC) enabled Marindale to install the first full-scale plug-flow design in California.

The Problem: Energy Costs and Waste Volume

Marindale's herd of 320-340 milking cows is housed in concrete-floored, free-stall barns for most of the year. In the past, waste disposal was a matter of scraping the manure into large, shallow pits, then draining the liquids for field-spraying. The remaining manure solids were hauled away at extra expense. The result: a foul odor and high disposal costs.

As energy costs increased, the Marindale owners decided to capture the biogas produced by fermenting the manure and converting it into electricity — thus cutting energy costs while solving their waste disposal problems. A no-interest loan was obtained through the Biomass Demonstration Program of the CEC to purchase the needed innovative equipment. Funded through the State Agricultural and Forestry Residue Utilization Act of 1979 (SAFRUA), this program shares the risk of implementing innovative biomass conversion projects with farmers and others in agriculture and forest industries.

Plug-Flow Design: A First for California

Marindale's system utilizes an earthen-wall plug-flow

Cont. P 3

tool — wind and sun compendium — Development of wind and solar energy for water pumping — cwd

CRRERIS — Incorporates news from the Commonwealth Regional Renewable Energy Resources Information Service (CRRERIS) and Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP). — INNERTAP

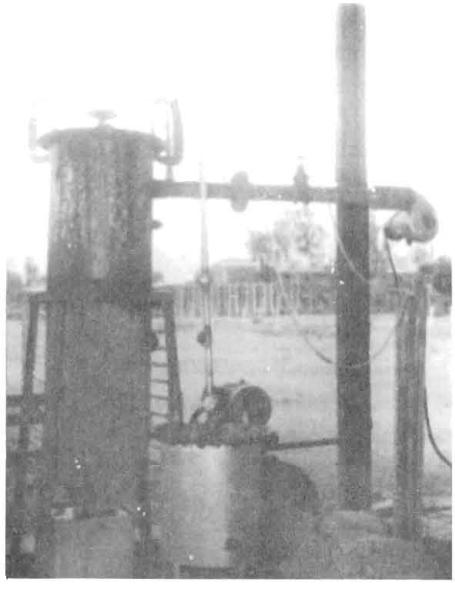
Development of Low Cost Downdraft Gasifier at the Alternate Hydro Energy Centre, University of Roorkee, Roorkee (India)

In India, about 60% of the total energy required is obtained from coal, oil and electricity, while the remaining requirement is obtained from biomass, firewood, and agricultural and forest wastes, including animal dung cakes. The major use of biomass is in domestic cooking, direct combustion in industrial furnaces and boilers, electricity generation and in the production of oils and chemicals by means of biological and thermo-chemical processes.

Rapid deforestation is being caused by the tendency of people in rural and semi-urban areas to be more dependent on firewood for their energy needs in cooking etc. This is evident from the fact that against the total firewood requirement of 133 million tonnes/year, availability is only 49 million tonnes/year, thereby creating an extra requirement of 84 million tonnes of firewood annually. The problems of shortage and the rising cost of wood, coupled with the depletion of natural fuels, call for the serious thought that is being given to the production, conversion, utilization and conservation of wood or woody biomass.

Development of the gasification process is one of the most promising solutions to the above problem, and work has been carried out by various R&D organizations on the development of economical processes in this line.

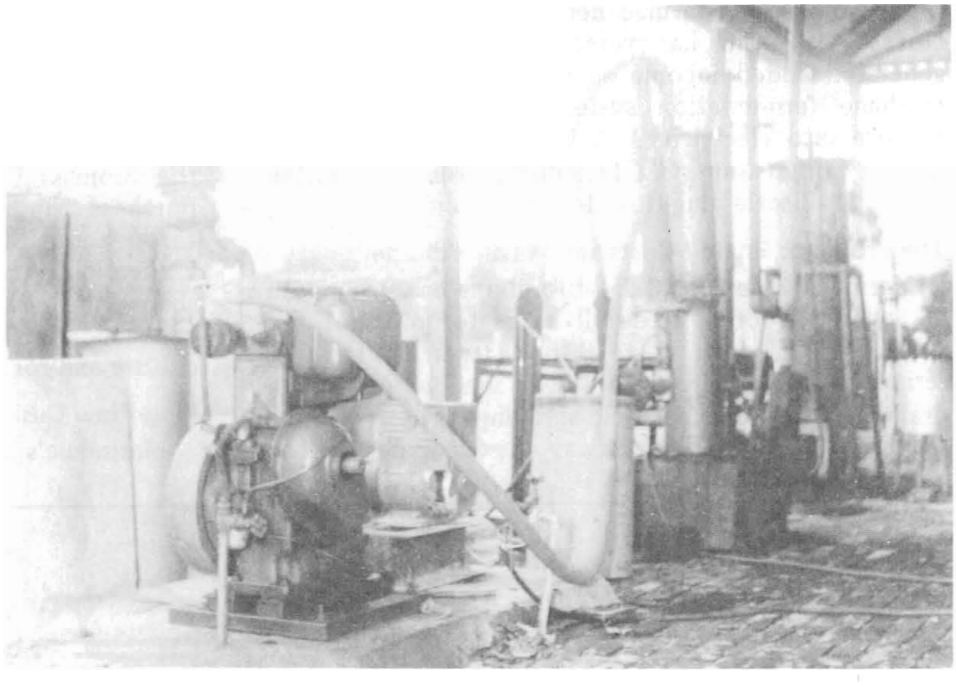
The Alternate Hydro Energy Centre at the University of Roorkee in India has been working on the development of a gasifier system for the last 3 years, and they have successfully developed a 20 kg/h wood-chip fuelled gasifier system for thermal and power generation purposes. The gasifier system consists of a reactor, a scrubber-cum-purifier, an internal combustion (I.C.) engine, a synchronous generator and an electrical control panel. The reactor has a length of 1.08 m and a diameter of 0.035 m and is equipped with a grate, a throat, an air-injection pipe and an ash collection pit.



The low-cost downdraft gasifier at the Alternate Hydro Energy Centre, Roorkee, India.

The operation of the gasifier requires filling the gasifier up to the throat with charcoal and then with wood chips ($\approx 4 \times 4$ cm), and then closing the cover-plate tightly. The ignition is started by placing a flamed kerosene oil soaked piece of cloth inside the ignition port and then by blowing air using a hand/electric only operated blower. It takes about 15-20 minutes to reach a temperature of about 850°-900°C. At this temperature, combustible gases start emerging from the gasifier, and burning is tested at the flare. The gas samples are drawn at 10 minute intervals and analyzed for gaseous components. When the gas with appropriate amount of H_2 and CO starts coming, it is allowed to pass through the purification train in order to facilitate the I.C. engine operation.

Experience of operating the gasifier for 300 hours has shown that the system operates well and with few problems. The main problems encountered were tar deposition



The gasifier system at the Alternate Hydro Energy Centre, Roorkee, India.

and the cleaning which was required after every 30/35 hours of continuous operation. Columns packed with granulated silica gel, charcoal and glass wool were used to prevent tar entry into the gas going to the engine cylinder.

The performance characteristics of the gasifier system have been determined and are summarised below:

Gasifier type	: Downdraft type
Capacity	: 20kg/h wood chips having 6% moisture content
Air requirement	: 1.3 kg air/kg wood chips
Air-flow rates	: 0.50-0.55 m^3/minute
Gas composition	: H_2, 14-20%; CO, 17-24%; CH_4, 1-2%; C_2H_6, 0.1%; CO_2, 8-12%; O_2, 2.5-5.0%; N_2, 48-52%.
Dry gas calorific value (Kcal/nm^3)	: 1200
Dry gas yield (m^3/kg)	: 2.07
Char yield (dry basis) (kg/100 kg)	: 3.29
Tar yield (kg/100 kg)	: 3.29
Water output (kg/kg wood chips)	: 0.045
Maximum operating temperature (°C)	: 900-950
Gasifier efficiency (%) (thermal application)	: 73.7
Gasifier efficiency (electrical power)	: 55.3
Replacement of diesel in I.C. Engine (%)	: 80-85
Electricity available taking into account	: 17.6 kWh

Efficiency (n) of gasifier (55.3%) I.C. Engine (25%) and Generator (98%) = 18.00 kWh

Attempts are being made to develop lime and brick kilns based on biomass gasification. It is proposed that the work should be carried out in collaboration with the Central Building Research Institute, Roorkee (India).

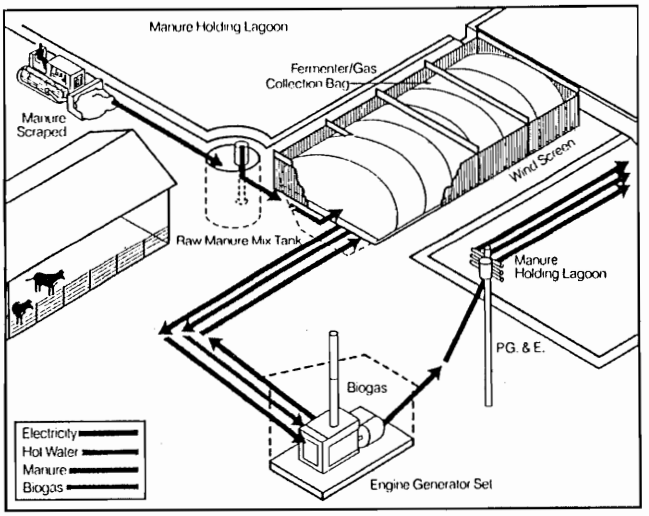
The Centre is also planning work on synthesizing methanol from lignocellulose. Work on the development of a fluidized bed gasifier, based on rice husk fuel, is also in progress.

(Information sent by: P.C. Sharma, Scientist, Structural Engineering Research Center, P.O. Box 10, GHAZIABAD-1 U.P., India).

Marindale Dairy Biogas Energy System Generates Profit

From P. 1

fermenter. Manure is scraped from the barns daily into a 10 000 gallon mix tank, to which milking parlor washwater is added to produce a thick but pumpable slurry. Cheese whey, energy rich and highly digestible, is also added to the mix tank. This provides a supplemental source of biogas for the system, and solves a whey disposal problem for a nearby creamery.



Marindale Dairy 50 kW plug-flow biogas system design.

The mixture is then pumped into an anaerobic digester — the system's most innovative feature. This 90 000 gallon plastic-lined earthen pit is covered with an expandable hypalon bag that holds the gas as it develops. To accelerate digestion, waste heat from the engine-generator set is pumped through pipes to the bottom of the pit, maintaining the manure at a temperature of 95°F. These conditions allow bacteria to break down the manure, producing 24 000-25 000 cubic feet of biogas per day.

The biogas fuels a 50 kilowatt (kW) induction-type engine generator which produces 330 000 kilowatt hours (kWh) of electricity each year. Annual revenues from the direct sale of this electricity to Pacific Gas and Electric Company exceed $23 500 — enough to completely offset Marindale's electrical demand.

Exceptional Results

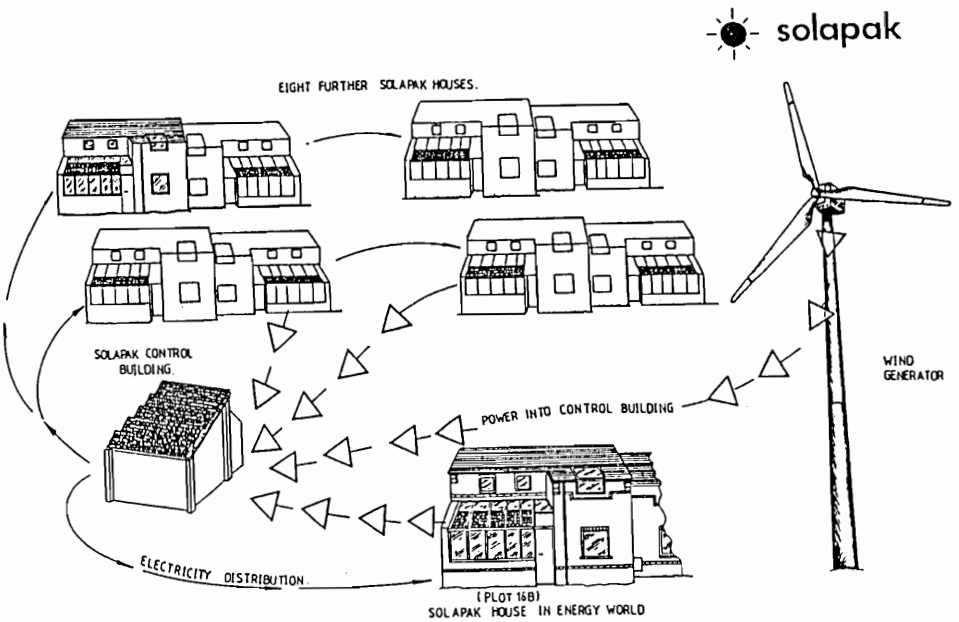
Since the project's start-up in January 1982, the system at Marindale Dairy has exceeded its anticipated biogas production level by 25 percent.

In addition, Marindale installed a by-product recovery system in the basic digestion system. The engine-generator provides hot water in the milking parlor and for heating nearby residences during the winter months. The system also includes a separator to recover fermented solids. These solids have not only proven to be superior animal bedding material, they also have market potential as a soil amendment and animal feed supplement. Marindale plans to market the remaining residues to receive additional savings. The liquids remaining after the separation process is complete may be added to animal feed as a protein supplement for heifers and non-lactating cows.

Marindale Dairy expects the methane fermentation system to pay back completely its $142 000 investment in four years. By utilizing biomass conversion technology, Marindale is now energy self-sufficient and has solved a sticky waste disposal problem.

(Source: Information was obtained from California Energy Commission Development Division, Biomass/Cogeneration Office, 1516 Ninth Street, Sacramento, California 95814, (916) 324-3463).

Solapak — Solar/Wind Project



'Natural' electricity for British houses'

Solapak, Britain's foremost solar electricity company, is undertaking a pioneering project using the energy of the sun and the wind to power houses in Milton Keynes' exciting 'Energy Park', in Buckinghamshire.

Each house has a bank of solar arrays set into the conservatory roof, and the wind power is provided by an 18 m high wind generator. Solapak's control building supports a further seasonal tracking solar array and contains specially designed control, energy storage and monitoring equipment. The electrical grid can provide back-up if necessary and the results are being closely monitored by the Open University. The first phase of construction work is now complete.

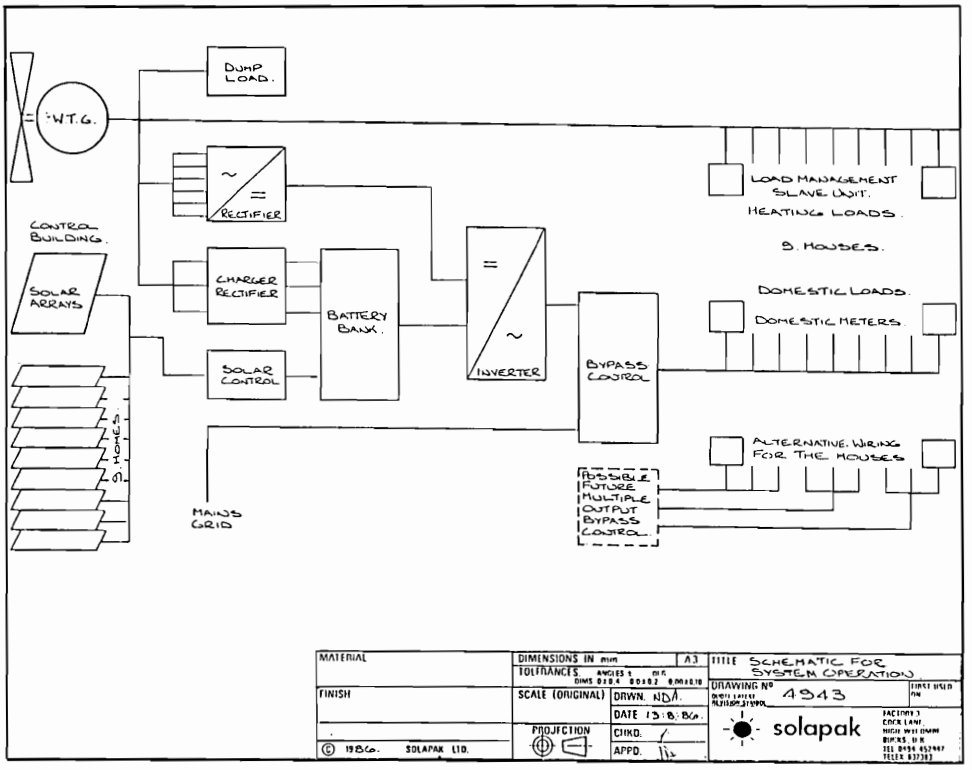
Project Technology

The wind turbine (40 ft diameter blades) and the solar arrays have a combined output approaching 30 kW which is cabled into the control building.

In designing the system, Solapak's engineers took account of the higher proportion of sun in the summer and wind in the winter. The advantage of this cogeneration concept is that the output of wind and solar together closely matches the seasonal electrical demand. A battery bank provides storage to meet the occasional shortfall, while central controls ensure an efficient and high quality power supply and automatically switch into the mains if necessary. The householder does not need to activate these controls himself, although an indicator in each house will show when the electricity being used is from natural sources.

The schematic block diagram below shows the main sub-systems. The solar array is divided with about half on the control building itself and the remainder distributed in the conservatory roofs of the nine houses. The latter use solar panels each 2.6 metres long and specially designed for architectural integration. About half of this length contains solar cells while the rest is clear to increase the incoming light and enhance the passive solar design features of the houses. The array on the control building is assembled onto long steel tubes which are mounted so that they can be rotated to maximise the seasonal output.

The wind turbine generator is a proprietary model, already proven for autonomous operation on islands off Scotland, but redesigned for the needs of this project. It



generates three-phase AC power and controls the level of energy output to maintain a substantially constant rotational speed while operating. The turbine also houses a starter motor to ensure that even light winds are not wasted and a compressor for the emergency braking system. Further safety is provided by wind tip control of the blades.

At the heart of the control equipment is an uninterruptable power supply which feeds power from the wind turbine and the solar-charged batteries through to the houses. It automatically switches to the grid, should this be required. Additional controls regulate the solar charge into the batteries which can also be topped up by the wind turbine. There is a substantial bank of mains switchgear providing further manual control for maintenance and safety purposes.

The monitoring system includes data logging and a computer which analyzes and displays the data. A special meteorological station is included as part of the system.

Project Participation

The idea for the project came from Solapak Limited who are running the programme and provide the solar content. A number of other British firms have been subcontracted to assist with the scheme. *Costain International Limited* contributes to the project management and engineering. *IRD (International Research and Development)*, part of the NEI Group, is providing the wind generator, and the AC controls were supplied by *Powernetics Limited*. Storage *batteries* are from *Tungstone Batteries* and control switchgear from *Blackburn Starling*.

Of the £1/2 million cost of the project, 40% is contributed by the Energy Directorate of the *EEC* and a smaller percentage promised by the *UK Department of Trade and Industry*.

The system will be installed on a development of nine houses built by *Persimmon Homes* and designed by *Architects Tuckley Associates*, while system performance will be monitored by the *Open University*. *Milton Keynes Development Corporation*, and the *East Midlands Electricity Board* contribute logistical and technical support.

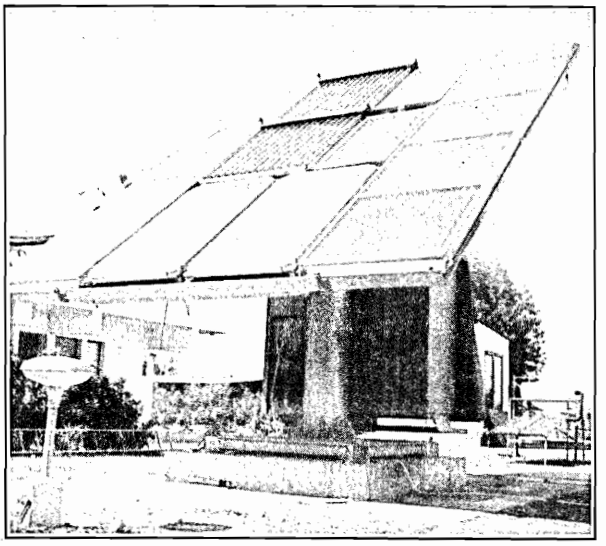
Energy Park

The *Milton Keynes Development Corporation* have designed an area for energy-efficient buildings, both industrial and domestic, within the town. To promote this concept they staged the Energy World exhibition, of some 50 houses within the Energy Park area, open to the public for four weeks from late August 1986, followed by a business exposition in September.

Background data on the Solar/Wind Project and further details may be obtained from:

Solapak Limited
Factory Three
Cock Lane
High Wycombe Bucks, HP13 7DE
England
Telephone: 0494 452941
Telex: 837383 SOLAPK G

High Technology for Testing of Solar Thermal Collectors



AIT Solar collector testing system.

Since the installation of a solar test facility at the Energy Park of the Energy Technology Division at The Asian Institute of Technology (AIT), Bangkok, in 1984, many modifications have been made to adapt the system to the local climate and to improve the accuracy and repeatability.

The device is now operational and is capable of testing up to four collectors simultaneously under very precise predetermined conditions of input temperature and mass flow-rate. The sun-tracking panel of 30 m^2 is controlled by a microcomputer, separate from the PC for data collection and processing. This provides the scientist and student in this field with a better understanding of thermal processes and solar collector performance.

In this context, readers should note that it is possible to carry out, on the request of manufacturers, comparative quality testing under tropical conditions according to ASHRAE and DIN standards.

For further details please contact:
Mr. J. Van Winden
Energy Technology Division
Asian Institute of Technology
P.O. Box 2754
Bangkok 10501
Thailand

ARCO Solar G4000 Thin Film Silicon Solar Electric Module

The ARCO Solar G4000 is a 30 Watt solar electric (photovoltaic) module that generates electricity from sunlight using advanced Genesis thin film silicon (TFS) technology.

The 16" X 40" (40.6 cm X 121.9 cm) G4000 is a monolithic circuit of micro-thin silicon alloy layers deposited directly onto a glass superstrate. The unique G4000 cell circuitry pattern results in increased module efficiency.

The electrically active glass superstrate is permanently bonded to a tempered glass substrate using ethylene vinyl acetate (EVA) for moisture resistance, UV stability and electrical isolation. The laminate is edge-sealed with special polymers for further environmental protection and is framed with lightweight, anodized aluminum to provide structural integrity and easy mounting to support structures.

Separate positive and negative junction covers are mounted securely at each end of the module. A wired in bypass diode reduces potential power loss from partial shading within an array. The self-locking, low profile junction covers enable the module to be flush mounted, and connections are easily made using readily available standard wiring.

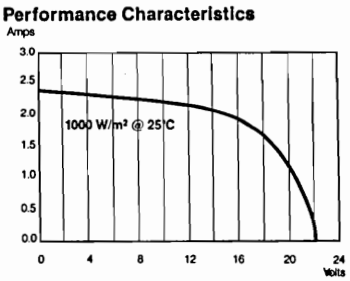
For further details contact:
ARCO Solar, Inc.
P.O. Box 2105
Chatsworth, CA 91313
Tel: (818) 700-7000
Telex: 674838
or Showa ARCO Solar (Far East) Pte. Ltd.,
10 Anson Road,
18-24, International Plaza,
Singapore 0207
Telephone: 2212433 I.D.D.: 2222146
Telex: ASISPR RS 20061

Electrical Characteristics

Efficient conversion of both direct and diffuse light
Monolithic solid state electrical circuitry for superior reliability
Computer designed cell pattern for high conductivity
Circuit laminated between layers of glass using ethylene vinyl acetate (EVA)
Tempered glass substrate for increased rigidity and durability
Rugged, lightweight black anodized aluminum framing
Junction covers with self-locking lids for safety and environmental protection
Wired in bypass diode to reduce potential power loss from partial array shading
Junction covers designed for easy field wiring and module flush mounting
Laboratory tested for wide range of operating conditions (−40°C to +90°C, 0 to 100% humidity)
External grounding screw for electrical safety
Module leakage current of less than 40μA at 3000 VDC electrical voltage isolation
Ground continuity of less than 1 ohm for all metallic surfaces
Series connection up to nominal 48 Volts DC
Three-year limited warranty on power output*

Physical Characteristics

Performance Characteristics



The IV curve (current vs. voltage) above demonstrates typical power response at 25°C cell temperature.

Power Specifications

Model	G4000
Power (minimum)	**30.0 Watts**
Current (typical at load)	1.9 Amps
Voltage (typical at load)	16.0 Volts
Short Circuit Current (typical)	2.35 Amps
Open Circuit Voltage (typical)	22.0 Volts

Power specifications are at standard test conditions of: 1000 W/M², 25°C cell temperature and spectrum of 1.5 air mass.

These charts are for estimating purposes only, specifications are subject to change without notice.

National Institute o (Pakistan)

The National Institute of Silicon Technology was set up in Islamabad in April 1981 with the assistance of the United Nations and Pakistan's Ministry of Science & Technology.

The objectives of the Institute are the transfer of silicon technology and the acquisition of indigenous skills, information, research and production facilities to support the development of silicon microchips, silicon semi-conductor electronic devices, silicon-based plastics and solar cell technologies in the country, by assisting and advising the government and appropriate industries through its institutional and research and development activities.

Installed and Commissioned Research & Development Facilities in Phase — I

- Arc furnace for production of metallurgical grade silicon from quartz (commercial collaboration)
- Siemens reactor for conversion of metallurgical grade silicon to polysilicon
- Hamco 6" crystal puller
- I.D. saw for cutting wafers
- Diffusion furnace for diffusion and alloying
- Screen printing machines

Small Wind Generators Production in China

Plans have been made for China's first small wind power generator factory. The machines will be based on a Swedish design.

The Chinese government has estimated that its annual need for wind machines generating 1 kW or less is around 30 000 units. Hua Rui, the state-owned company, is working with SVIAB of Sweden who pioneered the development of low-cost, low-power wind ma-

Silicon Technology

- Vacuum evaporation systems
- Chemical processing facilities
- Solder fountain
- Environmental chamber for testing the solar panels
- ICAP and FTIR spectrometers for impurity analysis
- Photolithography laboratory
- Various measurement equipment

Research and Development Facilities to be added in Phase – II (1986-1990)

- Facilities for amorphous and polycrystalline routes for solar cells and devices
- Float-zone technique for making "silicon chips" for electronic components and electronic devices
- Development of storage batteries
- Appliances division for the development of low voltage appliances
- Setting-up of pilot plant and possible commercialisation
- Setting-up of regional centres at Karachi, Quetta and Peshawar
- Initiation of research & development facilities for other semiconductor materials such as gallium arsenide etc.

Potential uses

The activities of the National Institute of Silicon Technology are likely to revolutionize many facets of socio-economic life, such as:

- Power generation (domestic & commercial)
- Rural electrification (remote houses, mountain shelters, holiday resorts etc.)
- Village power (social centres, medical centres, cottage industries)
- Lighting (domestic and commercial)
- Military applications
- Signalling and warning (air navigation, warning signs, off-shore platforms, navigation, railroad traffic)
- Signalling and data recording (floods, meteorological stations, pollution recording stations, oceanic data recording platforms)
- Communications (educational TV, radio telephones, TV and radio transceiver stations, satellite signalling stations, telemetry)
- Refrigeration (domestic uses, food-stuffs)
- Water pumping (drinkable water, irrigation systems, remote control for electrovalves)
- Desalination
- Cathodic protection (bridges, gas and oil-well heads, gas, oil and water pipelines)

For further details contact:
National Institute of Silicon Technology
Islamabad
Pakistan.

chines.

SVIAB's machines incorporate several features which keep maintenance to a minimum. For example the units have carbon fibre reinforced blades which can absorb much of the violent vibration experienced in high winds.

There is also a mechanism to ensure that the wind generator continues to operate in high winds. This uses a simple vane to show wind direction. Depending on the wind speed, the vane changes the angle of the blades relative to the wind. At high wind speeds, the hinged vane starts to move away from the main turbine shaft, turning the blades out of the wind. Even at wind speeds in excess of 60 m/s, when most turbines are forced to shut down, the SVIAB unit can still generate power by turning its blades so that they are at right angles to the wind.

Even though at present the cost of the SVIAB's 650 W machine is not very attractive, if mass production begins in China then this should bring down the price. The Chinese are also hoping to export some of the machines.

(Source: Modern Power Systems, August 1986)

'Flying Windmill' Development in Australia

A flying windmill, designed to fly like a kite and generate energy at the same time, is expected to undergo a field test in Australia soon.

The University of Sydney has designed an enlarged version of the Gyromill, which was successfully tested behind a car last year.

Gyromill II is designed to fly like a kite while a helicopter-type apparatus spins in the wind, generating electricity, which is then fed down along lines attached to the tether wires.

It was designed by a team led by Professor Bryan Roberts of the University's Department of Mechanical Engineering. Professor Roberts said the Gyromill could ultimately provide power for remote areas such as Antarctica by hovering about 300 m (1000 ft) above the snowdrifts to provide a pollution-free source of energy. He said a similar hovering device could also carry television cameras to give pictures of icepack formation as an aid to ship navigation.

If the wind dropped below the minimum necessary to generate electricity, power could be sent up the power lines to turn the rotor blades and keep the device aloft like a helicopter until the wind picked up or the machine was winched down.

Professor Roberts said Gyromill II could generate up to 3 kW (4 hp) in suitable winds.

Gyromill II weighs 20 kg (44 lb) and has twin contra-rotating rotors, each 4 m (13 ft) in diameter. The craft can be tilted back up to 30 or 40 degrees to the wind, depending on conditions. The rotors can rotate at up to 700 revolutions a minute.

(Source: Science and Energy Newsletter of Australia, June 1986).

Electricity from Light Winds

Mr. Rob Clarke of Wind Technology (Australia) has developed wind generators using the latest electronic process control devices which give a new dimension to remote power generation by producing power in wind speeds as low as 8 km/h (5 mph). The rotors use a Gu-25 aerofoil wing section designed by the University of Glasgow for high-performance gliders. This wing, which retains lift at low wind speeds has been adapted into a propeller. In very high winds its shape effectively governs its maximum speed by creating a vortex near the tip of the blade which disrupts airflow near the hub.

Although Wind Technology has concentrated on overcoming the problem of extracting electrical energy from light winds, the concept is also being applied to large machines being evaluated in the State of Victoria for inclusion in the main electricity grid. Later this year, a 75 kW model with 20 m (66 ft) diameter blades will be tested by the State Electricity Commission of Victoria at a windy coastal site near Geelong.

For average domestic use, Wind Technology offers three basic wind generators producing 1, 3 and 5 kVA, starting in winds as low as 13 km/h (8 mph). The generators charge heavy batteries producing a 240 volt alternating current (50 Hz), with automatic-start rotary inverters ensuring an output steady enough for even the most sensitive electronic equipment.

If necessary, back-up power is available from photovoltaic solar panels or diesel generators. A remote power generation system for domestic use might cost around A$10 000.

For industrial and community uses, larger wind generators have capacities from 20-90 kVA and feature variable pitch blades and an option for 415 volt AC power. They work in winds from 8 km/h (5 mph). In this case, a microprocessor monitors the winds, points the generator into the wind, adjusts the pitch of the blades and operates battery storage and back-up systems."

The wind generators are designed to withstand winds of up to 160 km/h (99 mph). If a hurricane is looming, one person with a hand winch can lower a generator in 10 minutes, using the pivoting base designed for ground-level maintenance. With blades and outer coverings of glass-reinforced plastic and gearboxes using synthetic oils, little maintenance is expected.

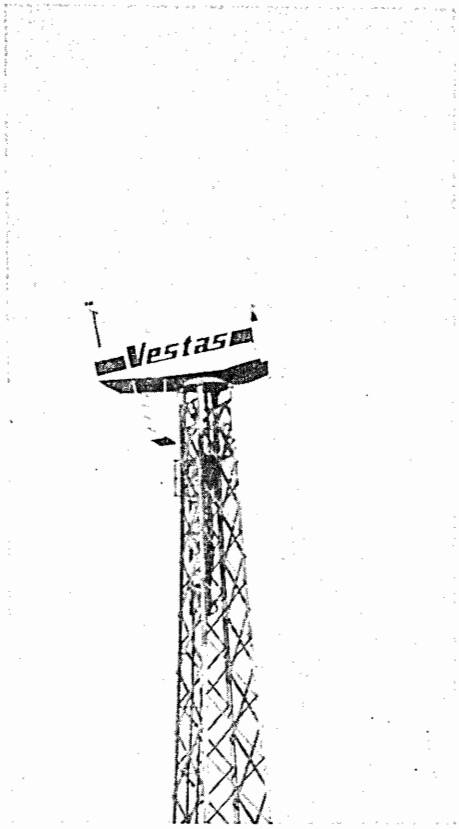
(Source: Science Newsletter, 2 June 1986, Australian Information Service, New Delhi).

New Project for VESTAS, Denmark

VESTAS Energy A/S has just signed a contract with ZOND SYSTEMS Inc., California, for delivery of wind turbines at a value of approximately DKK 350 millions.

To A/S VESTAS, which since 1982 has delivered more than 1800 wind turbines to the Californian market, this contract is the first step in adapting to a new market development in the USA.

The turbines contained in the order are of rather a new design, adapted to the future demands on electricity generating wind turbines. The turbine, which is named V25-200kW, has a rotor diameter of 25 m and a rated power of 200 kW. Furthermore, it features an advanced pitch regulation system, which makes the turbine more economical and, thus, more competitive. The annual output of a V25 turbine will equal the electricity consumption of 125 single-family houses.



Due to the improved economy, the wind turbine appeals to more "business-oriented" investors as opposed to the previous highly "tax-credit"-oriented market characterized by very favorable tax benefits for private investors.

However, the new turbine does not only appeal to ZOND SYSTEMS Inc. and the US market in general. The turbine is arousing wide international interest, and 4 turbines have already been erected, including one unit in Israel and one in Victory Garden, California. The new wind turbines are to be erected in the USA.

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DK 6940 Lem
Denmark
(Source: Press release, VESTAS Energy A/S, Denmark)

IEA Assesses EMI Effects of Wind Turbines

The wind energy research program of the International Energy Agency (IEA) has released preliminary technical information from an assessment of electromagnetic interference (EMI) effects of wind turbines.

The assessment was developed as part of general IEA work on "Recommended Practices for Wind Turbine Testing and Evaluation." According to the technical document released, wind turbines may generate EMI because radio, TV or other electromagnetic transmissions go both directly from transmitter to receiver and also indirectly, being reflected from the turbine rotor. The motion of the rotor causes a slight change in the length of the indirect path, and the indirect signal therefore arrives at the receiver at a slightly later time.

The document lists electromagnetic services that might be affected and comments as follows:

- **VOR** (VHF Omnidirectional Ranging): This is the aircraft navigation service. Current international and FAA (Federal Aviation Agency) regulations do not allow a structure the size of a wind turbine to be erected within 1 kilometer (0.6 miles) of a VOR station and "at present, there is no evidence to suggest that more severe regulations are required for wind turbines."
- **ILS** (Instrument Landing System): This service operates on a frequency similar to VOR and is "critical to aircraft approaching runways." "Where wind turbines are to be sited adjacent (about 5 kilometers (3 miles) dependent upon direction relative to the runways), it is essential to assess the impact on this service."
- **LORAN:** LORAN is a long range position finding service for ships that is similar to VOR. It operates on such a low frequency, however, that interference from wind turbines appears unlikely at present.
- **TV:** TV interference can be limited by careful siting. The report notes that teletext services, which are now beginning to be combined with TV signals, "are vulnerable to interference at lower levels than those required to degrade the TV picture."
- **Cellular radio:** This service is "designed to operate in an urban environment where severe amplitude fading (similar to the effect of wind turbines) occurs" and likelihood of interference is thought to be low.
- **Microwave:** The Danish national telecommunications agency has reported "severe interference problems on 7.4 GHz 8 Mbit/second data-rate microwave links operating with frequency shift keying modulation." The Danish and Dutch have developed compatibility guidelines which are presented in the document.
- **Satellite service:** Elevation angles should prevent interference, except possibly "on the 1.5 GHz mobile service where low gain earth station antennae are allowed."
- **Radar:** No information was available on experience with wind turbine effects. Many radar installations have anti-scattering equipment but may still encounter interference from turbine blade tips.
- **SOLAS:** The Safety of Life at Sea (SOLAS) emergency bands for ships in distress "could be adversely affected by offshore installations."

Copies of the document are available on request from:

B. Maribo Pedersen
Department of Fluid Mechanics
Technical University of Denmark
Building 404, Lundtoftevej 100
DK2800 Lyngby, Denmark

Remarks: According to R.J. Chignell of the British firm ERA Technology, Ltd., who spoke on the above topic at the recent European Wind Energy Conference in Rome, large wind turbines tend to generate interference at lower frequencies (HF, VHF, UHF and microwave), while smaller machines interfere with higher frequencies (UHF and microwave).

The problem of determining likely interference from a given turbine, however, is greatly complicated by the variety of turbines and towers that are commercially available today, Chignell said.

In general, he said, there are four criteria which must be present before EMI occurs:

1. There must be an electromagnetic transmitter (i.e., in remote areas, no problem may exist).
2. The wind system must modify the transmission signal. It always does, but in some cases the effect is very small.
3. The electromagnetic receiver must be within the area affected by the modification the turbine causes.
4. The receiver must be susceptible to the modified signal. A high-gain antenna, for example, may remove the problem.

(Source: Wind Energy Weekly, Vol. 5, No. 225, October 15, 1986).

Wind Turbine Development Centre in UK

From P. 10

every prospect of becoming a significant growth industry. UK exports can already be measured in tens of millions of pounds per year, principally to California in the USA, where some 10 000 machines, many of them on 'wind farms', provide the grid with up to 1000 MW of electricity generating capacity.

In the UK, wind turbines at locations such as Burgar Hill, Orkney are generating significant amounts of electricity, and a 3.3 MW machine, the largest in the world, is under construction.

(Source: Energy Digest, 15(3), 1986).

Wind Turbine Development Centre in UK

The Power Systems Engineering Division of the National Engineering Laboratory (NEL) is at present active in assisting a growing British wind turbine manufacturing industry. There are at present 25 companies offering machines for sale with approximately 100 other companies involved in supplying materials and components. Markets are emerging both at home and overseas to supply electricity or heat, or to pump water. The largest requirement is for wind turbine generators in various sizes up to a few hundred kilowatts.

The National Wind Turbine Centre (NWTC) has been created to assist companies by:

- providing independent accreditation of machine performance and quality;
- providing engineering and technical expertise to improve the design and cost effectiveness of machines; and
- seeking to promote reliability through assuring high standards of materials and quality of manufacture.

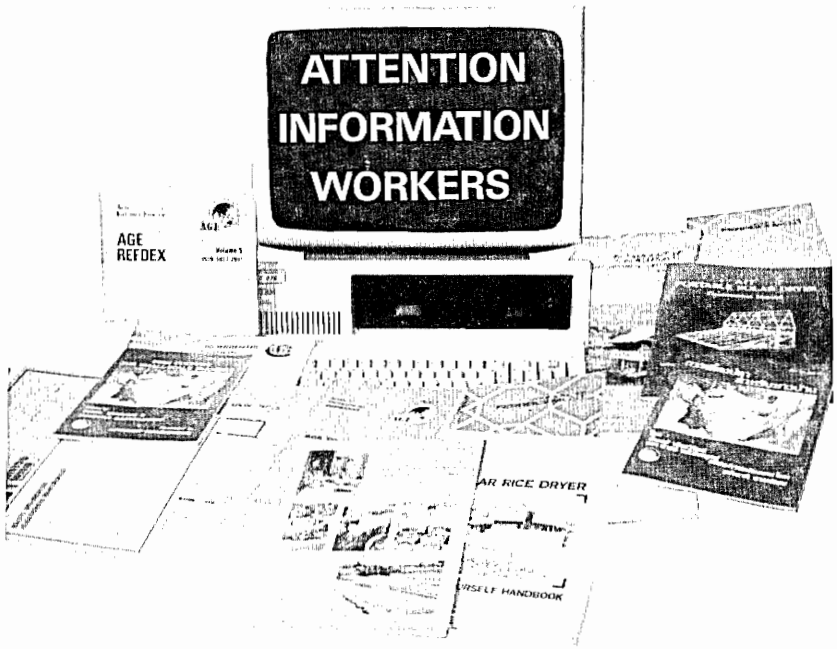
The Division is working with other centres in Europe and throughout the World on combined projects sponsored by the EEC and the International Energy Agency towards the creation of standards of safety, operation and manufacture. A main feature of NWTC is a test site at Myres Hill, some 8 km to the Southwest of NEL, near the village of Eaglesham. The site is on a moorland ridge 350 m above sea level with an open outlook and a clear view of the Irish coast. It comprises three universal concrete foundation pads capable of taking a wide range of both horizontal axis (the conventional type) and vertical axis machines. A further test pad of the same design is operational on a site adjacent to NEL's Whitworth building.

A further three major test pads are planned at Myres Hill as a second phase, if the anticipated growth in the industry warrants it. The 7 hectares of land within the fenced compound provide a great deal of space for other wind turbine activities. A high mast fitted with a wide range of anemometry and other meteorological instrumentation will provide information on the wind profile and the climate over a height of 50 m. NWTC intends to undertake research projects using these facilities, as well as existing facilities throughout NEL, to examine various aspects of wind turbine design as well as to provide a service to industry. A wide range of equipment exists for monitoring the machines, and the main data system involves collecting signals at a central building at Myres Hill and then transmitting this data by microwave link to the Division for analysis in a real time facility. The microwave link allows two-way communication, and some remote control activities may be undertaken in the future. Machines of different types can be accommodated and facilities for loading the machines are provided as follows:

- machines with induction generators will supply electricity to the National Grid;
- machines with synchronous generators will be connected to individual resistive load units with programmable controllers; and
- water pumping and direct heat production machines will utilise a 15 000 gallon water reservoir on the test site.

Over the course of the next few months, various turbines will be installed as the test site is fully commissioned in order to provide a service and back-up to what has

Cont. P. 9



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ASEAN Working Group on Non-Conventional Energy Research—Thailand (ASEAN WGNCER—Thailand)

The ASEAN Working Group is one of several sub-committees and working groups within the purview of ASEAN Committee on Science and Technology (ASEAN COST). The activities of the Working Group in Thailand are summarized as follows:

1. **Participating Thai Government Agencies:**
   - National Energy Administration, NEA
   - Thailand Institute of Scientific and Technological Research, TISTR
   - Electricity Generating Authority of Thailand, EGAT
   - National Economics & Social Development Board, NESDB
   - Chiang Mai University, CMU
   - Chulalongkorn University, CU
   - Khon Khaen University, KKU
   - Prince of Songkla University, PSU
   - King Mongkuts Institute of Technology, KMIT

2. **ASEAN-US Energy Cooperation Project, Phase II**

   2.1 Training in water pumping technologies in Penang, Malaysia, — 1-16 December 1985.
   Participants: NEA (1), CMU (1), PSU (1), KMITT (1).

   2.2 Training in coal technology in Texas, USA, — August — November, 1986.
   Participants: NEA (1), TISTR (1), CMU (1), EGAT (1).

   2.3 Seminar/Training on energy conservation in buildings in Singapore — May 1985.
   Participants: NEA (1), CU (1), PSU (1), KMITT (1).

   2.4 Energy Technology Training Program at AIT
   The program is part of the ASEAN-US Energy Cooperation Project Phase III. Its objective is to develop the capability of ASEAN technical personnel. Under this program, seven scholarships have been made available to Thai officials to attend 4-month certificate programmes on energy planning and management/technologies at AIT. To date, five scholarships have been distributed among the following Thai government agencies: NEA (2), NESDB (1), TISTR (1), KMITT (1).

   2.5 Energy Information Dissemination — Renewable Energy Resources Information Center (RERIC).
   Through the USAID-ASEAN Energy Conservation & Management Project, RERIC is providing information services to the ASEAN members of the Project. RERIC's regular publications (RERIC News, Renewable Energy Review Journal, Abstracts of AIT Reports and Publications on Renewable Energy Resources, and RERIC Holdings List) are distributed to about 90 members in the ASEAN countries using funds provided by USAID.
   A survey to discover and define users' needs for renewable energy information and to obtain information on ongoing research and development activities will be conducted.

3. **ASEAN-Australia Economic Cooperation Programme**

   3.1 Energy Conservation Technologies
   - Energy Conservation in Industries
     Ten Thai participants were trained in Australia from April to May 1985. They were nominated from NEA (2), TISTR (1), CMU (1), CU (1), KKU (1), PSU (1), and KMIT (1).
   - Energy Conservation in Tobacco Curing
     This R&D project is conducted by the Department of Mechanical Engineering, CMU. One researcher from CMU was trained for the project in Australia from April to May 1985. Three progress reports have been published.
   - Energy Conservation in Hotels & Hospitals
     This project is coordinated by the School of Energy and Materials, KMITT. One researcher from the institute was trained for the project in Australia during April and May 1985. Two papers on the project have been published.

   3.2 Coal Technology
   - Training in Australia
     A participant from CMU received training in coal technology in Australia from January 30 to March 29, 1986.
   - Training in Indonesia
     Two participants from TISTR and CMU were selected for training in coal technology in Indonesia from September 15 to October 15, 1986.

   3.3 Biomass for Heat and Power
   - Biomass Gasification
     The Department of Mechanical Engineering, PSU is responsible for the project. Two researchers from the project were trained in Australia during February and

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ASEAN Working Group on Non-Conventional Energy Research—Thailand (ASEAN WGNCER—Thailand)

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March, 1986. Research equipment has been procured.

— Standard Method of Testing Biomass Stoves Performance

This project is being conducted by the School of Energy & Materials and NEA. For the project, two participants from NEA and KMITT were trained in Australia from 10 February to 7 March, 1986. Two progress reports have been submitted.

— Fluidized Bed Combustion

The Department of Chemical Engineering, CU, is responsible for the project. Two researchers were trained in Australia during February and March, 1986. Research equipment is being procured.

4. **ASEAN-Canada Energy Cooperation.**

Within the framework of ASEAN-Canada development cooperation, ASEAN-Canada Energy Seminar/Study Tour was organized for senior energy executives. Eight Thai participants were invited from NEA, TISTR, EGAT, DMR, NESDB, PSU, PTT and KMITT. The study tour lasted for 24 days, beginning in Montreal on 15 September 1986. The schedule included Ottawa, Toronto, Winnipeg, Calgary and ended in Vancouver.

(Contributed by Dr. Prida Wibulswas, Energy Technology Division, Asian Institute of Technology, Bangkok, Thailand).

Integrated Rural Energy Systems Association

The Integrated Rural Energy Systems Association (INRESA) is an association of individuals and organizations dedicated to improving the standard of living of rural populations in developing areas of the world, by undertaking to change significantly their supply and use of energy. With the support of the United Nations University (UNU), Tokyo, Japan, it provides a network of close cooperation among members from those areas involved in field projects.

The main objective of the Association is to research, develop, demonstrate and disseminate information about rural energy systems; and the common philosophy behind the projects of INRESA members hinges on the importance of successful integration of new technologies into the village context. Prime consideration is given to the interaction between technological innovation, local resources, and individual and collective socio-economic and cultural influences, using renewable energy technologies in order to meet more closely the basic village needs for food, water and energy. Depending on local conditions, emphasis is sometimes placed on labour-intensive techniques to ensure the success of the integration and propagation of rural energy technologies. Whereas many renewable energy systems developed in industrialized areas are only economical when delivering large quantities of power, rural energy systems developed by INRESA are adapted to individual needs. These systems are often small-scale in nature and are designed to meet the real energy requirements of the local population.

The INRESA Project Coordinator is Dr. Tom Lawand of the Brace Research Institute, McGill University, Montreal, Canada.

Current Activities

There are many common factors among the different integrated renewable energy systems of the various projects of the INRESA members. For example, windpower is being used for generation of electricity or water pumping in Colombia, Egypt, India, Peru, Senegal and Sri Lanka. Biogas or improved fuelwood stoves are being applied primarily for cooking in China, India, Indonesia, Nigeria, the Philippines, Senegal, Sri Lanka and Tanzania. Solar energy is also being used for agricultural drying in a number of projects.

Solar energy is used for passive solar heating in Algeria and for photovoltaic electricity in Senegal and Egypt. Gasifiers are used to generate electric power from locally produced charcoal in the Philippines.

Networking among these projects is the role of INRESA, and it is accomplished by a Newsletter, visits and workshops and video tapes, as outlined below:

INRESA Newsletter

A quarterly newsletter is published by the Secretariat, with the support of the UNU, for the benefit of the network members. The activities of members are reported, technological developments are highlighted, and new sources of information are reviewed. This Newsletter also contains news from the UNU and other international organizations interested in rural energy systems.

Interaction

Network members are able to interact through direct correspondence, visits to other INRESA projects, and through participation in INRESA sponsored workshops. Workshops are held approximately every 15 months. To date, they have been held in Guangzhou, China, December 1982; Cairo, Egypt, March 1983; and Montreal,

Canada, June 1985. The next INRESA Workshop is scheduled to be held in Colombia in late 1987.

Videotapes

Members are producing instructive videotapes which can be exchanged between projects. Current topics are biogas production in China and community development in Egypt.

In addition to the networking activities, other direct assistance is available in the form of training fellowships, project assessments, and mini-research projects, as outlined below:

Training

Network members are able to send Fellows to one of the UNU training centres, in line with the normal rules and procedures applicable to UNU Fellowships. Renewable energy training (conducted in English) is provided at the Indian Institute of Technology in New Delhi. Spanish language training is provided at the Universidad de Low Andes, Bogota, Colombia. UNU Fellows are also accepted for less structured, more individualized stagiaire training programs at the INRESA Secretariat in Montreal,

Cont. P. 14

Hangzhou Regional Centre (China)

The Hangzhou Regional Centre (HRC) is an institution concerned with small hydropower (SHP) development in the Asia-Pacific region. The centre is devoted specifically to training, information dissemination, research and development and also provides a consultancy service.

UNIDO (United Nations Industrial Development Organization) and ESCAP (Economic and Social Commission for Asia and the Pacific) jointly organized a workshop on mini hydropower in Kathmandu, Nepal. A second workshop and study tour was organized in Hangzhou/Manila in 1980. In response to recommendations from these two international meetings, the Government of the People's Republic of China took the initiative in establishing HRC. The centre received the formal support of UNIDO and ESCAP through the signing of a project document with UNDP (United Nations Development Programme) in November 1981. HRC is based on a national institute, the Exploration, Design and Research Institute for SHP, under the Ministry of Water Resources and Electric Power (MWREP). The Chinese Government invested 2M yuan (about US$1M at that time) between 1981 and 1983 for the construction of buildings in phase I for HRC, and for salaries and overheads for about 60 staff. To complement this, UNDP provided US$400 000 for various items of office equipment, audiovisual facilities and a desk-top computer.

Since that time, the Chinese government has invested a further 4 million yuan (about US$1.3M) for buildings in phase II, due to be completed later this year, and the staff has been increased to a total of more than 80, of whom 60 are professionally qualified. The Phase II buildings will include a 14-storey main block providing self-contained accommodation, training, research and office facilities commensurate with HRC's role as not only a regional but also an inter-regional and international centre.

HRC's regional role was strengthened in 1983 when it was agreed that the Centre should act as the Interim Secretariat for the Regional Network for SHP, the RN-SHP. This Network is not an institution but a co-operative arrangement, among member institutions in the region, appointed by interested member countries of ESCAP. So far, 17 countries have been nominated as RN-SHP Focal Points. Funding of RN-SHP activities is allocated from UNDP, part of which is channelled through REDP (Regional Energy Development Programme) to UNIDO, the implementing agency. The Chinese government has also made a significant input, and it is hoped that in the long run the RN-SHP will move towards a state of being self-financing.

HRC has been involved in a wide range of activities, not only through UN-funded activities of the RN-SHP in the Asia-Pacific region, but also on a bilateral basis with countries all over the world. In addition, there is a growing number of internal Chinese projects, a sign of the MWREP's determination to improve the standards of China's SHP stations in the areas of technology, economics and management. In this respect, HRC acts as a window to the outside world, not only by disseminating the results of China's experience, but also by gathering information on modern advances in other countries.

Some activities related to the use of water turbine-pumps (used mainly to pump irrigation water, but able to produce electricity when a generator is added) are also carried out by the center. Although not strictly in the field of SHP, HRC currently undertakes these activities on behalf of the Food and Agriculture Organization (FAO), pending the establishment of a Water-Lifting Devices Centre in China.

HRC welcomes further nominations from governments of Asia-Pacific countries. In addition, Co-operative Members from developed countries and donor organizations interested in SHP activities in the region are also being sought.

For further details contact:

The Director
Hangzhou Regional Centre
P.O. Box 544
Hangzhou
China.

(Source: Water Power & Dam Construction, April 1986)

European Cooperative Research Network on Rural Energy (Italy)

The European Cooperative Research Network on Rural Energy (CNRE) was established at an Intergovernmental Consultation in Paris (October 1981) followed by the First Consultation of the Networks in Rome (May 1982), when 21 European countries agreed on the objectives, structure and organization of cooperative research programmes. The actual research cooperation started by the end of 1982 with the establishment of the CNRE Secretariat operated by the FAO Regional Office for Europe.

The main objectives of CNRE, in which, at present, more than 200 scientific institutions from 25 countries are collaborating, are:

- to promote a more efficient use of traditional energy sources in agricultural production; and
- to increase the share of new and renewable sources of energy for and from rural sectors.

The network cooperation includes:

- the organization of a systematic exchange of scientific information, research and development experiences among European and interested developing countries;
- the selection of well-defined research topics of mutual interest to carry out joint research programmes with the participation of interested countries and scientific institutions;
- the collection and analysis of the results of national research programmes to prepare recommendations for the development of new energy technologies; and
- the establishment and testing of experimental technologies to promote the practical application of new and renewable energy resources.

To reach these goals in the framework of CNRE cooperation, technical consultations, workshops and professional training courses are organized on a regular basis by the networks and working groups; reports and bulletins of meetings and studies of joint research programmes are circulated to collaborating scientists; and a computerized Rural Energy Information System has been established to facilitate the exchange of information and technical economic development activities.

CNRE cooperation has been gradually extended to an increasing number of national institutions from countries outside the European region (mainly in the Mediterranean region). Selected developing countries are willing to participate in the exchange of scientific information and experiences and in joint research programmes. This type of extension of CNRE activity will encourage the adoption by developing countries of research results achieved in

Integrated Rural Energy Systems Association

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Canada.

Project Assessments

Any INRESA member may request that an independent assessment be made of its project by another member or another advisor. This can be done before the decision to implement a project, or at any later stage of development. The costs of such assessments are covered by the UNU.

Mini-Research Projects

Certain research funds are available for INRESA members from the UNU Renewable Energy Program to fund a series of small research, development and information dissemination projects which can ultimately benefit a number of the members' projects. These can be carried out by one or more INRESA members, who will work on them for 12 to 18 months, depending on the nature of each project.

These are mini-research projects, in that the total cost of each contract is in the order of US$5000. This includes a budget for small research expenditures, technicians, some instrumentation and an honorarium for the principal investigators.

The main thrust of each research proposal is to make a small concrete contribution to knowledge in the field. It is intended that the end result of each of these mini-research projects be printed in the form of technical notes or papers and issued by the UNU through a variety of mechanisms, such as publication in ASSET.

Priorities for mini-research proposals are in the following areas:

- research into new technologies, including instrumentation;
- field testing these technologies in a variety of settings;
- information dissemination of technologies through low cost mechanisms; and
- project evaluation and feedback.

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Brace Research Institute of McGill University
P.O. Box 900, MacDonald College
Ste. Anne de Bellevue, Quebec
Canada H9X 1CO

European countries and, at the same time, the development in European countries of new energy technologies requested by developing countries.

Close cooperation with United Nations' agencies and intergovernmental organizations working on rural energy development has been established and will be extended in rural energy developments in order to utilize the limited resources in a more efficient manner. This cooperation already involves the exchange of documents and publications, as well as the organization of joint seminars, training courses and workshops, such as the FAO/UNESCO working groups on Solar Drying of Agricultural Products and Solar Water Heating Systems.

The CNRE cooperation in the research network is voluntary. Cooperating institutions and scientists are free to collaborate in their own applied research programmes, free to exchange scientific information and experiences, available for international joint research and free to select subjects in a given field of their activity for cooperative research programmes. The CNRE network is a flexible organization, and cooperation is basically self-regulated.

The cost of research and development programmes carried out by the cooperating institutions within the framework of the network should be borne by the participating institutions themselves. However, the cost of a range of services in order to operate the research network's activity, including the expenditure of the CNRE Secretariat, the organizing of consulations, meetings and workshops, visits to collaborating institutions, is covered by FAO funds.

For more details contact:
Dr. K. Kocsis
CNRE
FAO Regional Office for Europe
Via delle Terne di Caracalla
00100 Rome
Italy.

(Source: Energy in Agriculture, Volume 5, pp. 97-99, 1986)

INNERTAP

Fourth Steering Committee Meeting of INNERTAP

The fourth Steering Committee Meeting of the Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP) was held in Beijing, People's Republic of China from 22-25 October, 1986. The committee reviewed regional networking activities, national networking activities, and related activities by the participating international institutions. INNERTAP's work program for 1987-1989 was also formulated.

Discussions, decisions and recommendations made at the meeting are summarized below:

INNERTAP regional and national network structure

In reviewing the activities at national and regional levels, the Committee indicated the advisability of considering holding steering committee meetings every two years instead of annually, given the present level of resources available and the level of development and stability of the NFPs in each participating country. Other schemes to complement the steering committee meetings should be explored, such as the use of more effective telecommunication facilities (teleconferencing, telefax, electronic mail etc.). The funds normally provided for the Steering Committee meetings could then be used to strengthen INNERTAP networking activities.

The Committee, after considering the pros and cons of the proposal, and keeping in mind the value of person-to-person contacts in discussing problems and resolving issues, decided to request the Regional Secretariat to study these matters and report on possible effects and cost implications at the 5th meeting of the Regional Steering Committee next year.

IDRC-supported INNERTAP activities

The participating countries of INNERTAP and UNESCO expressed grateful appreciation for the financial support given by IDRC to INNERTAP, indicating its confidence in the value and usefulness of its services to the region.

The NFPs strongly suggested that the three-year contracts issued by the Regional Secretariat be revised to cover only a period of one year at a time as governmental commitments normally run for a period of one year. A longer period would need, in some cases, special authorization which could delay approval.

Improving communication among NFPs and the Regional Secretariat

Reacting to the expressed need to enhance communication links within the network, the meeting was informed of the present services in this area such as AIT's computer network project, linking 5 universities in Thailand; and the existing electronic mail project provided by DATACOM in Seoul,

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Fourth Steering Committee Meeting of INNERTAP

From P. 15

Korea, which countries can avail themselves of at preferential rates. Further details on communication links and on the Regional Network on Informatics for Asia and the Pacific were requested.

The meeting argued that INNERTAP should also consider the use of telefax and other modern information technologies already available in the region.

Moving towards increased decentralization of INNERTAP activities

At present, inputting of information to the INNERTAP databases is done mainly through worksheets. Given that IBM-PCs and IBM compatible micro-computers are available at NFPs, the Regional Secretariat will start next year to have NFP inputting done directly on diskettes. Two INNERTAP products *(INNERTAP Directories of Experts and Institutions* and *Guidelines for the Preparation of Information Packages)* have been stored on diskettes and hard copy and can be made available for comments/amendments by NFPs.

In the case of preparation of specialized information packages, the guidelines provided by the Regional Secretariat are a step towards decentralization of this activity.

Promotion and marketing of INNERTAP products and services

The Regional Secretariat is preparing a draft promotion and marketing plan which will be sent for review and comments to the NFPs and other Steering Committee members and observers. INNERTAP strongly requested UNESCO to provide financial and technical support to enable INNERTAP to implement the plan.

In this connection, it was also suggested that possibilities be explored to make the INNERTAP databases available online, taking the experience of CRRERIS and AIT/RERIC into consideration.

Resource mobilization for INNERTAP activities at national and regional levels

The attention of NFPs was drawn to the need for developing project proposals which can be submitted to national and international funding bodies to speed up development of the national information infrastructure and network. UNESCO's assistance was offered to help countries develop such proposals under the framework of INNERTAP, as was done under the current IDRC-supported project, and the joint UNIDO-UNESCO activity. It was hoped that more resources of this type could be mobilized in addition to the gradual increase of funding from national sources as the services become better appreciated and demand from the various user communities inside and outside the country increases.

UNESCO-UNIDO joint activities

It was the first time a UNIDO representative participated in an INNERTAP Steering Committee Meeting, after the agreement reached between UNESCO and UNIDO to cooperate in the field of information activities on NRSE and energy conservation in industry.

The purpose of the participation was to enable the representative to become better acquainted with INNERTAP national activities and to introduce UNIDO's energy conservation information activities, particularly the ASEAN Energy Network which is a sub-network of INTIB. UNIDO/INTIB's information activities and its possible relationship with INNERTAP were discussed.

The proposed UNESCO-UNIDO Regional Seminar/Workshop on Energy Conservation Technologies in Small and Medium Scale Industries was also discussed. The workshop will be held in October 1987, jointly with the following meetings:

- 5th Regional Steering Committee Meeting of INNERTAP;
- INTIB Focal Points Meeting of the ASEAN Energy Network; and
- Workshop for INNERTAP, INTIB and RN-SHP representatives to finalize working relations.

Study grants

Study grants will be provided by UNESCO for two staff members of the Regional Secretariat to attend the two-week in-depth training program in the use of the micro CDS/ISIS software package, to be held at AIT in January, 1987. This is to be followed by training at AIT in factual/numerical database design and management, with visits to appropriate facilities at ESCAP and relevant national Thai institutions.

Rural Renewable Energy Exhibition

The projected roving Chinese national exhibition on rural energy systems scheduled for October 1986 was deferred until 1987. However, preparations have already been started and, in fact, some of the exhibits will be shown at the 40th anniversary celebration exhibition of UNESCO being organized in Bangkok.

Preparation of the INNERTAP work programme for 1987-1989

A draft workplan for 1987-1989 was submitted by the Regional Secretariat for consideration by the Steering Committee. After considerable discussion by the members, a revised work program was drawn up.

For further details on INNERTAP's activities please contact:

Dr. Ibarra E. Cruz
Regional Coordinator
INNERTAP
c/o PNOC Energy Research and Development Center
P.O. Box 1031 MCC
Makati, Metro Manila
Philippines

CRRERIS

Getting Out of a Hole
The fall and rise of the Renewable Energy Index

Jim Stockton,
Energy Information Service, CSIRO
P.O. Box 89, East Melbourne, Victoria, 3002 Australia

The Renewable Energy Index is an information service providing documents and reports on energy. We measure our success by the number of requests we receive. In 1984 the number of requests coming to the Network Centre from overseas began to decline. At the time, this was not noticed because the level of requests from within Australia was rising (Figure 1). The truth only became apparent when the statistics were analyzed at the end of the year.

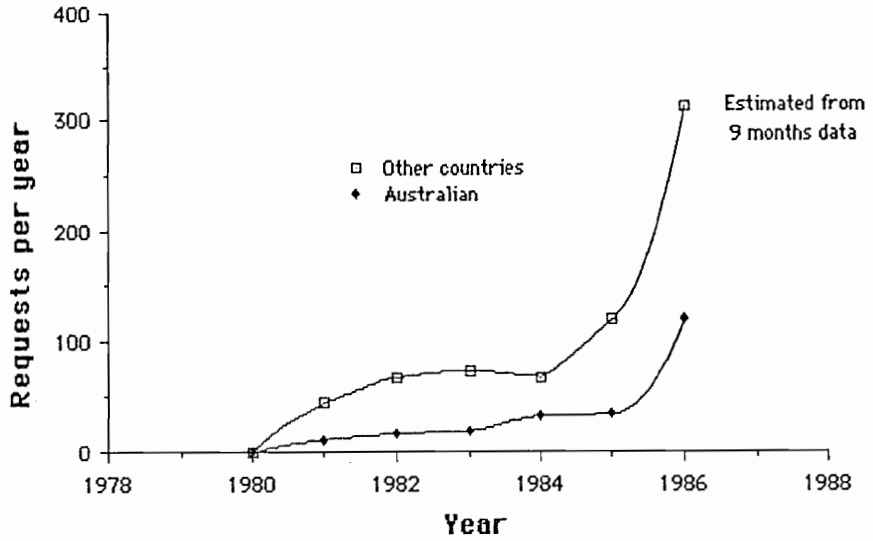

Fig. 1 Requests for information received at the network centre.

Climbing out

In 1985 we changed our role from database managers to information providers and changed our procedures to suit. This has been so successful that we intend to go on doing it. Here is how we do it.

1. Market research

We ask our clients what they want and how they want it. This is better than guessing at what they want.

We apply what our customers tell us, for instance, simplifying procedures for ordering documents or making subject requests. And, as a result of market research, a complementary product called the Renewable Energy Directory has been completely redesigned. The lessons we learned are now being applied to the Index.

We do the most valued things first. We respond to the user's priorities.

2. Keep it simple

We make everything easy to use. For example, we provide order forms and subscription forms which are easy to fill in. We write everything with the reader in mind. It is our job to make sure the reader understands what we are saying.

3. Go after your customers

We go to our users rather than have them come to us. For example, we run training workshops in their counties, using their facilities. Seeing how people are using our information service makes our training more practical and relevant. Figure 2 shows the effect of going to our customers. It is a graph of the number of requests per month for the last year. The high points occur in the months that we went overseas to run workshops and visit users.

Good promotional materials are essential. For example, when we needed a brochure for the Renew-

Cont. P. 18

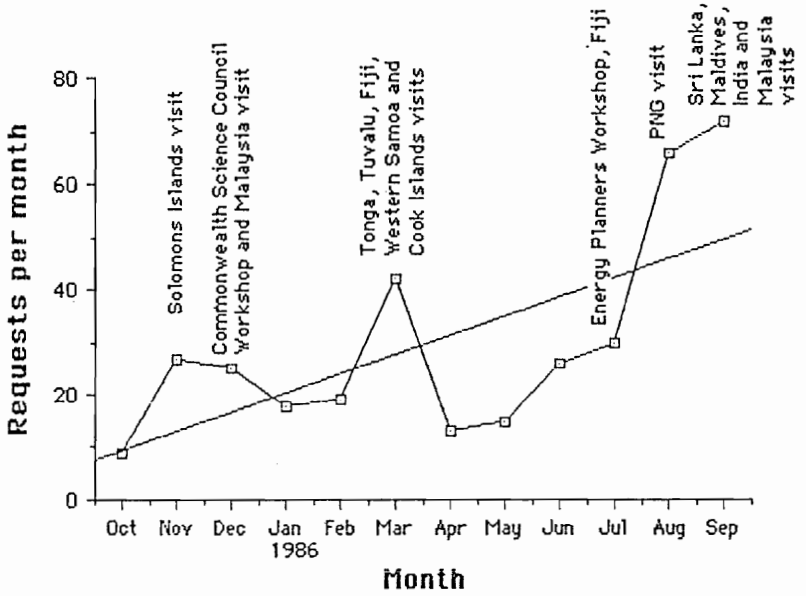

Fig. 2 Requests over the last 12 months.

Getting Out of a Hole
The fall and rise of the Renewable Energy Index
From P. 17

able Energy Index, we hired an advertising agency to do the job — the result is a good-looking brochure which brings in subscriptions.

4. Be accessible

Make it easy for people to get in touch. Telephone, telex and facsimile numbers are widely publicised so that people can contact us quickly in whichever way suits them. We even have an electronic mail facility so that customers can send us messages via their computer and by telephone.

We visit users and run workshops whenever and wherever possible.

5. Set targets

We set ourselves specific targets because knowing our aim increases our productivity. Our aim this year has been to double the number of requests. From the results so far, we may even treble them.

6. Monitor performance

We now keep monthly figures for the number of requests, so our performance is regularly and easily monitored. The results may be seen in Figure 2. As the number of requests goes up and down, we calculate a line of best fit through the graph to show the trend. This line shows that the number of requests have more than trebled in a year.

7. Go back to 1 and start again

In December we will analyze the year's results and plan for the next year. The information and energy games are constantly changing, and it is our job to provide what our users need. It is now time to return to market research to find out what our clients want — back to 1 and start again.

Acknowledgement

We would like to thank Penny Braybrook and Esther Martin who offered comments on the first draft of this note.

TRAINING COURSES

International Course on Rural Energy Planning

Date: 4 May — 4 July 1987

Organized by: Twente University, in cooperation with the International Institute for Aerospace Survey and Earth Sciences (ITC), both at Enschede, The Netherlands. The United Nations Environment Programme, the Commission of the European Communities and UNESCO have given financial support to the course.

Course objectives: The objectives of the 9-week course are twofold. First, it aims at the rationalization of an energy policy at a rural level embedded in the planning of the overall rural economy. Second, it aims at the reinforcement of the capabilities of rural decision-makers to negotiate on the basis of more specific analysis and planning.

The course will provide the participants with an understanding of: rural multi-objective analysis and planning (e.g. applied to energy problems); technological subjects (e.g. techniques for tapping the various possible sources for rural energy supply); problems of implementation and administration. The course will improve the participants' skill in dealing with problems of rural energy supply.

Participants will be able to specify the expertise required in the planning and implementation of rural energy supply and to direct the general effort in these fields.

Participants: The course has been designed for planners and decision-makers at the district level in various sectors of the rural economy as well as for regional planners. Relevant energy sectors of the rural economy are in agriculture, small-scale industries, communications, transport etc.

Regional planners may be involved in the development of natural resources, financing, energy supply etc. In addition, the course will be of interest to planners and decision-makers at the national level because of the competitive nature of regional and sectoral activities in comparison with other economic activities and with large scale energy supply. The course is open to government officials and other qualified candidates with some years of experience in development problems.

Program: The course deals with three parallel subjects to which equal attention will be paid: energy technology; energy planning; problems of implementation and administration.

Throughout the course case studies will be discussed in which the participants will take an active part. Demonstrations and visits to various sites will supplement the course. These include energy research centres and power plants in two or three European countries.

Diploma: Certificate of Attendance.

Requirements for admission: Applicants are required to have a B.Sc. or M.Sc. or the equivalent from a recognised university and at least two years' professional experience after graduation. Preference will be given to planners in energy in one of the sectors of the rural economy at district level. Since lectures, workshop-sessions etc. will be given in English, it is essential that participants have a good command of English.

Tuition fee: Dfl. 5,000.—

For other details contact:
Dr. W.S. Hulscher, Course Director
Twente University
Technology and Development Group
P.O. Box 217, 7500 AE Enschede
The Netherlands
(Tel. 053-893539
Telex 44200 thtes nl)

Master's Program in Development Technologies

Date:

Preliminary Studies: 2 March 1987 to 5 July 1987.

Master's Studies: 6 July 1987 to 13 December 1988.

Organized by: The University of Melbourne, Faculty of Engineering in Australia

Course Outline:

The main aim of the program is to provide suitable training for academic staff from engineering schools in developing countries, and it has been designed after consultations with senior engineering academics in these countries. It should also be useful for engineers in other types of employment in developing countries, as well as for Australians interested in working there. It will consist of formal coursework, seminars, laboratory work and practice classes, and a research or design project relevant to the needs of the student's country and the employing institution.

The program is supported financially by the Australian Development Assistance Bureau.

1. Coursework will include:
   - i General development studies on technical, economic and other aspects of national development; appropriate and inappropriate technologies; economic aspects of engineering; and engineering education problems in developing countries.
   - ii Technological studies

     In 1987 the following options will be available:

     (a) alternative energy technology; energy fundamentals; solar, wind and water sources; energy from wastes; renewable sources of fuels; fuel production and utilization; alternative fuels.

     Or selected units from:

     (b) Civil Engineering or

     (c) Agricultural Engineering

     or

     (d) Environmental Engineering.

     To meet individual needs, some units in the above scheme may be replaced subject to approval given elsewhere in the University, such as in the Faculties of Science, Architecture and Planning or Agriculture and Forestry.
2. A design or research project or another form of original inquiry is an important part of the program. This will take a minimum of 4 full months or the part-time equivalent, and a report is required. The project must be on a topic directly relevant to the needs of the student's home country and the employing institution.

Qualifications:

The usual minimum qualification is a bachelor's degree in engineering or surveying from an approved university. Graduates from other disciplines will be enrolled in a Master's degree appropriate to their first degree, although they will be supervised from within the Faculty of Engineering.

Students, especially those from developing countries, who lack the background necessary to proceed immediately to the Master's course will be required to undertake a period of preliminary studies which will consist of selected undergraduate coursework. Enrolment in the Master's program will be conditional on satisfactory performance in the preliminary studies.

The Course Co-ordinator is Dr. D.S. Mansell, and detailed enquires concerning the course may be directed to him at the following address:

Faculty of Engineering
The University of Melbourne
Parkville, Victoria 3052, Australia
Telegrams UNIMELB-PARKVILLE
Telex AA35185).

BOOK REVIEW

Water Current Turbines—A Fieldworker's Guide

(Written by Peter German, published by Intermediate Technology Publications Ltd., 9 King St., London, WC2 8HW, U.K. 1986. ISBN 0 946688 27 3 A4. 114 pp. incl. bibliography. U.K. price £10.00)

The prospect of large, strongly-flowing rivers providing a source of useful energy has engaged man's curiosity for a long time but there has been surprisingly little work published on methods of harnessing it. This book is more comprehensive than the title suggests. It not only gives an account of recent research into the development of water current turbines but also discusses the application of the energy produced for the irrigation of arid regions. It benefits greatly from the author's personal experience, over a number of years, of developing turbines in the laboratory and, in particular, of setting up serviceable working irrigation schemes on the White Nile in Sudan.

Different forms of water current turbine are dissussed and compared and recommendations are made based on field experience. The choice of pump is considered. The method of matching the pump to the turbine, so that the combination of turbine, pump and pipe system can operate with maximum efficiency, is carefully explained in detail with numerical examples based on field case studies.

The author emphasises the need to make sure that the water current turbine is the appropriate choice, as a source of power for irrigation, and that all alternatives are carefully considered before a final decision is made. To this end, the

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Biogas Technology, Transfer and Diffusion

Proceedings of the International Conference held at the National Research Centre, Cairo, Egypt, 17-24 November 1984.

The International Conference on the State of the Art of Biogas Technology, Transfer and Diffusion was held in Cairo, Egypt, from 17 to 24 November, 1984.

The Conference was organized by the Egyptian Academy of Scientific Research and Technology (ASRT), the Egyptian National Research Centre (NRC), the Bioenergy Systems and Technology project (BST) of the US Agency for International Development (US/AID) Office of Energy, and the National Academy of Sciences (NAS). A number of international organizations and agencies co-sponsored the Conference. More than 100 participants from 40 countries attended.

The purpose of the Conference was to assess the viability of biogas technology (BGT) and propose future courses of action for exploiting BGT potential to the fullest.

The Conference emphasized a balanced coverage of technical, environmental, social, economic and organizational aspects relevant to biogas systems design, operation and diffusion. It was organized to incorporate experiences that are pertinent, for the most part, to developing countries.

One of the important goals of the Cairo Conference was to identify a set of guiding principles for the most promising future investment opportunities relevant to BGT in developing countries. Evidence presented at the Conference seems to indicate that BGT can be applied with an expectation of success when, for instance:

- Its potential is extended beyond the renewable energy base by better demonstrating the system multiple outputs of prospective market value including sanitation, energy, fertilizer and animal feed supplements.
- It is used as an adjunct to agricultural-processing enterprises such as relatively large animal/animal product operations.
- Its application can affect management improvement in an existing activity with resultant economic pay-offs. The required institutional and financial support for successful applications of these technologies is more often available on a commercial or cooperative enterprise scale than in smaller scale operations. Developing such infrastructure on a smaller scale requires considerable government involvement and long periods of time to mature and would, therefore, be prohibitively difficult and expensive.

The proceedings of the conference, edited by M.M. El-Halwagi (1986, xv+720p.), is available from Elsevier Applied Science Publishers, Ltd. (Crown House, Linton Road, Barking, Essex IG11 8JU, England).

Biomass: Recent Economic Studies

A seminar in the CEC Research Programme on Energy in Agriculture, held in Brussels, Belgium, 10-11 October 1985.

Since 1976, the EEC and its member countries have undertaken economic research projects to familiarize themselves with the microeconomics of producing energy from agricultural and forest by-products. Particular attention has been paid to producing energy by means of combustion of dry by-products, and the use of methane produced by breeding and agribusiness by-products. These projects have shown that, except under specific and well-defined conditions, energy costs are generally very high. This means that using dry by-products, such as wood and straw as fuel, is of interest, especially if they are used locally. However, their marketing, even on a small scale, means that prices are considerably raised, owing to economic forces. The use of methane, upon which high hopes were based after the first oil crisis, is primarily limited to being an energy-saving purification process despite the increase in the price of oil.

Economists see no reason to reexamine these subjects, with the possible exception of regional approaches to the use of lignocellulose by-products. These are abundant but can only be used in limited quantities on farms or forest farms. Nonetheless, two fields seem worth investigating: *the economics of non-food crop production and the methods used to aid government decisions.*

These two subjects were singled out for study within the scope of the Community Energy and Agriculture programme and were studied by a working group of economists. They presented their work in Brussels in October 1985. The book entitlled "Biomass: Recent Economic Studies," edited by J.C. Sourie and L. Killen (1986, x+187p.), contains the text of these presentations and describes the initial results of ongoing research.

The book is available from Elsevier Applied Science Publishers, Ltd. (Crown House, Linton Road, Barking, Essex IG11 8JU, England).

PUBLICATIONS RECEIVED

BIOMASS ENERGY

o *Energy from Biomass*, Proceedings of a Regional Training Workshop, King Mongkut's Institute of Technology, Thonburi, Bangkok, Thailand, 3-7 March, 1986, ii+550 p.

ENERGY CONSERVATION

o *Energy Conservation with Tractors and Agricultural Machines*, Proceedings of Technical Consultation of el/n. 1a, Bruxelles, Belgium, 6-8 February 1984, Food and Agriculture Organization of the United Nations, 76 p.

GEOTHERMAL ENERGY

o *Application of Geothermal Energy and Industrial Thermal Effluents in Agriculture*, Proceedings of Technical Consultation of eln/n. 8, Rome, Italy, 21-24 January, 1985, Food and Agriculture Organization of the United Nations, 65 p.

RENEWABLE ENERGY

o *Renewable Energy Strategy, Government Energy Policy Statement*, Victorian Energy Planning Program, The Minister for Industry, Technology and Resources, Australia, December 1985, v+32 p.

o *Solar and Wind Power Technologies for Remote Applications*, Proceedings of a Training Working held at the University of Melbourne, Australia, 8-17 December 1985, vi+327 p.

Available from:
Commonwealth Science Council
Marlborough House
Pall Mall
London SW1Y OHX

RURAL ENERGY

o *Small Hydraulic Plants for Agriculture*, Report of the 1985 Workshop of the European Cooperative Networks on Rural Energy, Vienna, 16-18 September 1985, Food and Agriculture Organization of the United Nations, 21 p.

o *Heat Recovery in Agricultural Buildings*, Report of the 1985 Workshop of the European Cooperative Networks on Rural Energy, Ghent, Belgium, 11-13 September 1985, Food and Agriculture Organization of the United Nations, 17p.+ App.

o *Biomass Conversion for Energy*, Report of the 1985 Technical Consultation of the European Cooperative Network on Rural Energy, Freising, West Germany, 14-17 October 1985, Food and Agriculture Organization of the United Nations, 30p.+ App.

o *Resources and Energy Potentials in Rural Bangladesh: A Case Study of Four Villages*, CSC Technical Publication Series No. 191, A.K.M. Abdul Quader and K. Ikhtyar Omar, June 1986, vi+ 143 p.

Available from:
Commonwealth Science Council (CSC)
Marlborough House
Pall Mall
London SW1Y OHX

SOLAR ENERGY

o *Victorian Solar Energy Council, Annual Report 1984-1985*, 28 p.

o *Proceedings of UNESCO/FAO Working Group Meeting on Solar Drying*, Perpignan, France, 27-30 June 1984, Food and Agriculture Organization of the United Nations, 58 p.

WIND ENERGY

o *Pump Rod Forces Due to Hydrodynamic Effects in Piston Pumps* (R-813-A), Frits Verheij, Graduation Thesis, Department of Physics, Technical University of Eindhoven, October 1986, 119 p.

o *The Speed Controlled Leakhole* (SCL) (R-669-D), W. de Vaan, May 1984, 78 p.

o *Comparative Testing of Wind Measuring Equipment, part I: inventory and selection* (R-814-D), Hans Schotte, August 1986, 72 p.

o *The Physics and Mathematical Description of the Achilles Heel of Stationary Wind Turbine Aerodynamics: the tip flow* (R-812-D) (Paper given at the 6th European Wind Energy Conference, October 1986, Rome), G.A.M. van Kuik, October 1986, 7 p.

o *Field Testing of Water Pumping Windmills by CWD* (R-816-D), (Paper given at the 6th European Wind Energy Conference, October 1986, Rome) J.V. Meel, P. Smulders, H. Oldenkamp, A.V.D. Nat and F. Lysen, October 1986, 8 p.

o *A Method to Obtain a Wind Model for the Boundary Layer in a Representative Tropical Region* (R-818-D) (Paper given at the 6th European Wind Energy Conference, October 1986, Rome), E.H. Abu Bakr, M. Rutten, P.T. Smulders, G. Vossers and J. Wieringa, October 1986, 5 p.

o *Pump Research by CWD: The Influence of Starting Torque of Single Acting Piston Pumps on Water Pumping Windmills*, (Paper given at the 6th European Wind Energy Conference, October 1986, Rome), H. Cleijne, P.T. Smulders, F. Verheij and H. Oldenkamp, October 1986, 5 p.

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DIARY OF EVENTS

- March 28-April 3, 1987, Cuernavaca, Mexico

International Progress in Solar Ponds

The International Progress in Solar Ponds Conference will be a follow-up to the successful Solar Pond Workshop held in Alice Springs, Australia, in March of 1985. It is sponsored by the Electrical Research Institute of Mexico.

The conference will be preceded by a one week long seminar on the science and technology of solar ponds. The main goal of the seminar will be to disseminate the current knowledge on solar ponds in the Latin American Region.

The program will cover Salt Gradient Ponds, Honeycomb Ponds, Shallow Ponds, Roof Ponds, and Gel Ponds.

For further details contact:
Dr. Jorge M. Huacuz V.
Instituto de Investigaciones Electricas
Apartado 475
Cuernavaca, Mor., 62000 Mexico
Tel. (73) 14-38-11 Ext. 2080
Telex 17-3380-INIEME

- April 1-3, 1987, Edinburgh, Scotland

British Wind Energy Association 1987 Spring Conference

For details contact:
Jean Galt
c/o James Howden & Company Ltd.
Old Govan Rd.
Renfrew PA4 0XJ
Scotland.

- April 8-11, 1987, Putra World Trade Centre, Kuala Lumpur, Malaysia

Asian Energy/Power '87

Asian Energy/Power '87 is organised by Cahners Exposition Group, the world's largest organisers of high technology and industrial events. It brings together individuals of the energy and power industry from all over the Asia-Pacific region.

Apart from an impressive equipment display, two conferences will be staged concurrently. The programs cover power as well as energy subjects.

Topics in Energy

Energy for National Development

a. Energy use in cities of the developing countries
b. Energy policy as an aspect of national development policy
c. Forecasting demand for commercial energy
d. Forecasting demand for non-commercial energy
e. Incentives in and constraints on the promotion of the use of new and renewable sources of energy
f. Bioenergy use in developing countries:
   i) fuelwood and charcoal use
   ii) dendrothermal powerplants in the Philippines
   iii) biogas technology and development
g. International energy research and development
h. Activities of ESCAP and other international bodies in energy
i. Experiences and prospects in small hydropower development

Topics in Power

Power for the National Development Seminar/Workshop on Optimization of Electric Power Systems

a. Problems and prospects of power system planning and management in the ESCAP region
b. Methods and techniques for optimization of electric power systems and their application potential in developing ESCAP countries
c. Optimization techniques in power system expansion planning
d. Optimization of system losses and load management
e. Costs/benefit of load management through optimization
f. Training needs and prospects of TCDC working groups of the Regional Electric Power Utilities
g. Country papers contributed by participants.

PUBLICATIONS RECEIVED

From P. 21

o *Wind Energy for Water Pumping in Developing Countries* (R-817-D) (Paper given at the 6th European Wind Energy Conference, October 1986, Rome), P.T. Smulders, October 1986, 6 p.

All these publications are available from:
Wind Energy Group
Laboratory of Fluid Dynamics and Heat Transfer
Technical University of Eindhoven
P.O. Box 513
5600 MB Eindhoven
The Netherlands

Water Current Turbines—A Fieldworker's Guide

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book sets out detailed methods of comparing the cost-effectiveness of the various alternatives.

The book includes a useful analysis, contributed by Peter Burgess, of the socio-economic problems surrounding the setting up of such an irrigation scheme and refers to the human and social considerations in a situation where funds are scarce and the maximum use needs to be made of local resources.

The author has not hesitated to include the numerous small but invaluable pieces of practical advice that can only be contributed by one who has worked intimately with the real problems of the field situation. This is a particularly valuable aspect of the work.

The book is levelled at the technician working in the field but it also provides very useful information for those working in the laboratory and researching water power for the developing countries.

(Reviewed by E.P. Giddens).

For registration or further details contact:
Cahners Exposition Group Sdn. Bhd.
22nd Floor Menara Utama UMBC
Jalan Sultan Sulaiman
50000 Kuala Lumpur
Malaysia
Tel. 03-2305811
Tlx: MA 20106 CEG MA

- May 11-15, 1987, Orleans, France

Biomass for Energy and Industry

For details contact:
Dr. G. Grassi
Conference Co-chairman
Commission of the European Communities
DG XII/SDM 3/18, Rue de la Loi 200
B-1049 Brussels, Belgium

- May 12-15, 1987, Leeuwarden, Friesland Province, The Netherlands

International Conference on Windfarming

The conference is sponsored by the European Wind Energy Association.

For details contact:
J. Dragt
Netherland Energy Research Foundation ECN
P.O. Box 1, 1755 ZG Petten
The Netherlands

- June 7-19, 1987, Edinburgh, United Kingdom

Seminar on Solar Energy for Development

The British Council has been developing its successful program of short specialist courses and seminars over the last 30 years as part of its role of encouraging scientific and cultural exchanges between Britain and other countries. The aim of each program is to enable a small, selected number of academic and professional people to learn about recent developments relating to their work both in Britain and in other countries and to participate in international discussion at a high level.

The aims of the above seminar on solar energy for development are:
- to establish the principles of solar energy collection for heat, electricity and fuel;
- to survey the range of currently available solar hardware and design methods;
- to identify suitable matches between solar collecting technologies and energy needs, leading to a listing of priorities for implementation; and
- to examine the problems involved in promoting the use of solar technologies and integrating solar energy into existing patterns of energy supply and utilization.

In addition to a brief review of basic principles the seminar will include a survey of the latest developments in solar technology. The emphasis throughout will be on obtaining practical and cost-effective solar solutions to real problems and how to implement them. The seminar will include workshop sessions and members will be encouraged to participate fully throughout. Field visits to solar installations will be arranged, including a grain drying barn and solar houses. There will also be a visit to the Department of Architecture of Strathclyde University.

The seminar is designed for technologists and administrators who have an interest in or responsibility for assessing the potential for using solar energy in its various forms to aid the development of their countries. Some familiarity with the subject of solar energy will be required but participants need not possess specialized knowledge.

Application forms may be obtained from the Representative, the British Council. Applicants resident in Britain and candidates from the United States of America and from Switzerland should apply to the Director, Courses Department, The British Council, 65 Davies Street, London W1Y 2AA, UK.

- July 6-9, 1987, Lisbon, Portugal

1987 International Specialists Meeting on Solid Fuel Utilization

The meeting organized by the Portuguese Section of the Combustion Institute will be mainly concerned with systems for the production of energy from solid fuels, along with utilization. The solid fuels include coal, coke, petroleum coke, wood, agricultural wastes and urban wastes. Paper selection will be based upon a reviewed abstract of not less than 500 words.

Further details are available from the Symposium Secretariat, Portuguese Section of the Combustion Institute, Department of Mechanical Engineering, Instituto Superior Tecnico, 1096 Lisboa Codex, Portugal.

- August 19-21, 1987, Portland, Oregon, USA

Waterpower '87

For details contact:
American Society of Civil Engineers
345 East 47th St.
New York NY 10017
USA.

- October 19-21, 1987, Strasbourg, France

Uprating and Refurbishing Hydro Powerplants Conference and Exhibition

For details contact:
Carolyn Price-Alexander
Conference Assistant
Water Power & Dam Construction
Quadrant House, The Quadrant
Sutton, Surrey, SM2 5AS
England

- November 15-20, 1987, New York, USA.

International Symposium on Natural Circulation

The Multiphase Flow Committee of the Fluids Engineering Division and the Nucleonics Heat Transfer Committee (K-13) of the Heat Transfer Division of the American Society of Mechanical Engineers are co-sponsoring an international symposium on natural circulation during the ASME Winter Annual Meeting of 1987.

Purpose

Natural circulation finds many industrial applications: it plays an important role in solar heaters, decay heat removal in nuclear reactors, geothermal and other energy systems, as well as in high-technology systems such as electronic equipment. The purpose of the sysmpsoium is to provide an opportunity for engineers and scientists to present the state of the art and exchange ideas in this important area.

Scope

Papers dealing with analytical, computational, experimental and design-related work on all aspects of natural circulation flow phenomena will be considered. Some of the subject areas of interest are as follows:
- single and two-phase natural circulation in loops

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DIARY OF EVENTS

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- thermosyphon applications (heat pipes, solar water heaters, electronic equipment cooling, geothermal systems etc.)
- buoyancy-driven recirculation within a pool or enclosure
- natural convection flow in parallel channels
- interaction of natural circulation and forced flow
- buoyancy-induced oscillation and instabilities in closed-loop flows
- innovative thermo-fluid systems utilizing natural circulation
- other areas clearly relevant to natural circulation

For further details please contact:
Dr. J.H. Kim
Electric Power Research Institute
P.O. Box 10412
Palo Alto, CA 94303 U.S.A.
Phone: (415) 855-2671,
or Professor Y.A. Hassan
Department of Nuclear Engineering
Texas A & M University
College Station, TX 77843-3133
U.S.A.
Phone: (409) 845-4161

CALL FOR PAPER

SEMINAR ON RURAL ENERGY PLANNING AND TECHNOLOGY ASSESSMENT IN ASIAN COUNTRIES

The Institute of Nuclear Energy Technology and the Institute for Techno-Economics and Energy System Analysis both of Tsinghua University, Beijing are organizing a seminar on *"Rural Energy Planning and Technology Assessment in Asian Countries."* The seminar is to provide a forum for the exchange of experience among Asian countries both in rural energy planning and energy technology.

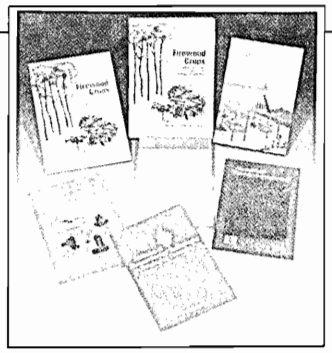
Topics to be covered include

- Energy policy in rural regions
- Methodology of rural energy planning and practical experience
- Development of rural energy technologies, i.e. biogas, economic fuelwood stoves, mini-hydropower etc.; economic and technical assessment and experience during their introduction and diffusion in Asian countries.

The seminar will be held in Beijing from September 1 until September 20, 1987.

Participants will be rural energy planners from Asian countries and researchers on rural energy technologies. Financial support from the Commission of the European Communities makes it possible to grant economy class airfares and DSA's to a limited number of participants.

Persons who wish to participate in the seminar should send a summary of the paper they intend to present and their curriculum vitae before April 31, 1987 to the Director of Beijing Energy Training Center, Tsinghua University, P.O. Box 1021, Beijing, China.



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RERIC, AIT-LRDC
P.O. Box 2754
Bangkok 10501,
Thailand.

BOSTID publications

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Winged Bean (50p.)
Calliandra (52p.)
Vector Biology (53p.)
Crocodiles (59p.)
Mangium (62p.)
Sowing Forest from the Air (64p.)
Opportunities for Control of Dracunculiasis (65p.)
US$5.50 Amaranth (80p.)
Agroforestry/Sahel (86p.)
Firewood Crops, Volume II (92p.)
Environmental Change/Sahel (96p.)
US$6.00 Leucaena (100p.)
Producer Gas (101p.)
Jojoba (102p.)
Alcohol Fuels (109p.)
CHEMRAWN (118p.)
Casuarinas (118p.)
Diffusion Biomass Technologies (120p.)
Water Buffalo (124p.)
Little Known Asian Animals (131p.)
US$6.50 More Water for Arid Lands (155p.)
Food, Fuel & Fertilizer from Organic Wastes (172p.)
Making Aquatic Weeds Useful (175p.)
Underexploited Tropical Plants (188p.)
US$7.00 Post-harvest Food Losses (202p.)
Energy Survey Methodologies (220p.)
Firewood Crops, Volume I (237p.)
Priorities in Biotechnology Research (261p.)

The following amount should be added to the listed price for air-mailing charges:
Asian countries (excluding Thailand) US$5.00 per copy
All other countries US$10.00 per copy

RERIC news

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Room 105 SA-18
Washington, D.C. 20523

Solar Drying of Bananas – A Successful Industrial Application in Thailand

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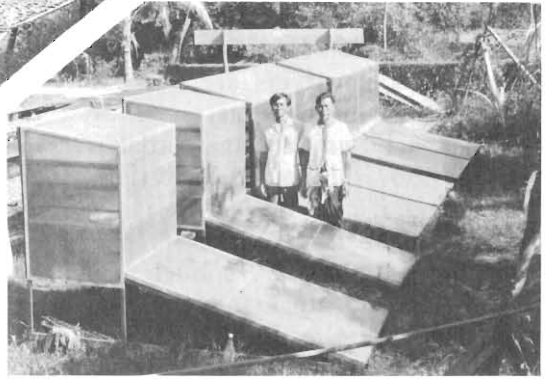

Fig. 1 Traditional sun drying of bananas in open air.

Fig. 2 Field testing of cabinet-type solar dryers at Amphoe Bang Krathum, Phitsanulok Province, in 1983. Capacity: 150 bunches of bananas.

Dried banana is the major product of Phitsanulok province in northern Thailand and brings in an annual income of about 125 million baht (approximately US$5M). Raw bananas are obtained from nearby provinces mainly from Phichit, Sukhothai, Kamphaeng Phet, Uttaradit, and Phetchabun. Three hundred households in Amphoe Bang Krathum, Phitsanulok Province, are involved in this dried banana cottage-industry. The peak production season is from October to February and the maximum production rate is about 900 000 bunches of bananas in six days (approximately 150 000 bunches per day or 50 tonnes per day, by weight) which results in a value of 500 000 baht a day. The annual revenue of 125 million baht consists of 75 million baht from dried bananas produced during the peak-production season and 50 million baht from dried bananas produced during the rest of the year.

Sun drying in the open air is the traditional method used for drying bananas (Fig. 1). Considerable losses, ranging from 50-100% of batch production, can occur during the rainy season, which can result in a maximum loss of 3 million baht per batch.

A cabinet-type solar banana dryer (Fig. 2) developed by the King Mongkut's Institute of Technology Thonburi (KMITT),[1,2] has been under field testing since November 1983 at Amphoe Bang Krathum with financial support from the United States Agency for International Development (USAID), and in cooperation with the Department of Physics and the Institute of Science and Technology of the Sri Nakharinwirot University, Phitsanulok Campus.

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wind and sun compendium

Development of wind and solar energy for water pumping

tool

cwd

CRRERIS

Incorporates news from the Commonwealth Regional Renewable Energy Resources Information Service (CRRERIS) and Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

INNERTAP

Solar Drying of Bananas — A Successful Industrial Application in Thailand

From P. 1

The test results showed that: 1) a temperature of 27-55°C inside the solar dryer was obtained while the ambient temperature was 25-37°C; 2) using the solar dryer, the drying time could be reduced by 1-2 days (traditional drying requires 5-7 days, but solar drying requires 4-5 days); and 3) dried bananas obtained were free of dust and contamination and were of better quality compared to the traditional dried ones.

Regarding the socio-economic aspects it was found that the solar dryer can dry about 50 bunches (500 pieces) of bananas per batch which is suitable for household use but is too small for industrial application. For drying 3000 bunches of bananas, which is the batch production rate of one household, 60 solar dryers are needed. This requires an investment cost of 150 000 baht which is unaffordable by the poor villagers. In addition, it was found that during the rainy season the bananas dried in the solar dryer are not dry enough and are infected by fungi, and in winter the temperature in the dryer is not high enough to kill larvae of fruitflies which may contaminate bananas during the preparation process.

The Research Team of the Sri Nakharinwirot University, Phitsanulok Campus, has modified the dryer and enlarged it 12 times to be 2 m wide, 6 m long, and 2 m high. This modified KMITT solar dryer costs 50 000 baht and can dry 600 bunches of bananas at a time. A low cost solar hut for drying bananas has also been developed (Fig. 3). The solar hut is 2 m wide, 6 m long, 2 m high, and can dry 150 bunches of bananas at a time. To dry 300 bunches of bananas, two solar huts are needed and an investment cost of 6000 baht is required (3000 baht/one solar hut) which is only 12% of the investment cost of the modified KMITT solar dryer of the same capacity. The transparent plastic covers of the solar huts, however, have to be replaced at least once a year.

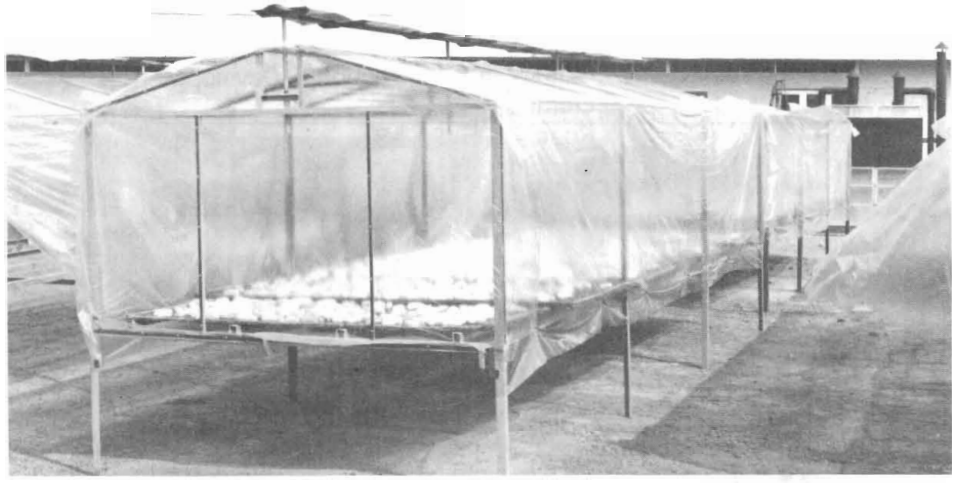

Fig. 3 Field testing of solar huts for drying bananas at Kaset Patana Factory, Phitsanulok Province, in 1986. Capacity: 150 bunches of bananas.

In 1986, five modified KMITT solar dryers and 40 solar huts were constructed at Amphoe Bang Krathum to be used for batch drying of 5000 bunches of bananas. Bananas are initially dried for a few days in the solar huts and then transferred to be dried within one day in the modified KMITT solar dryers which have higher drying temperatures and efficiencies. These dryers can dry 30 000 bunches of bananas monthly which can be considered suitable for industrial application.

Successful drying of bananas using the new solar dryers was achieved from November 1986 to February 1987 in Phitsanulok Province. But problems similar to those which occurred during testing of the first solar dryer developed by KMITT in rainy and in winter seasons are still unsolved. Further research and improvement of the dryers are being considered.

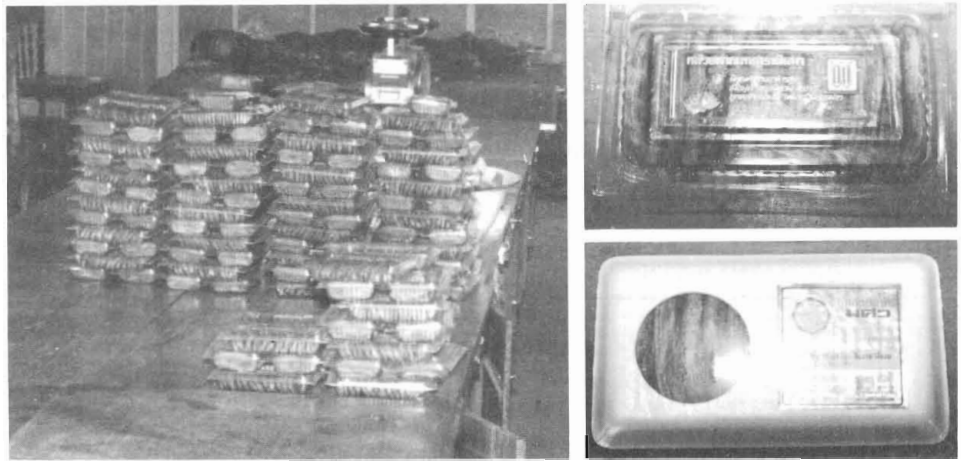

Fig. 4. Dried bananas – final product for the market.

The solar dryers were also used for drying preserved-sweetened tamarinds and pineapples, and it was found that the dryers can be used satisfactorily throughout the year and that good quality products are obtained. Sweetening and preserving of sour tamarinds has increased the price of sour tamarinds from 5 baht per kilogram to 50 baht per kilogram. It is expected that solar drying applications will have a high potential in the fruit preserving industry in Thailand.

Contributed by: Wattanapong Rugswichien (Institute of Science and Technology, Sri Nakharinwirot University, Phitsanulok Campus) and Prida Wibulswas (Asian Institute of Technology, Energy Technology Division, Bangkok).

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2. Wibulswas P. and Niyomkarn C., "Development of Solar Air Heaters for a Cabinet-Type Solar Dryer", Proc. of UNESCO Regional Workshop on Solar Drying, Center for Non-Conventional Energy Development, Manila, December 1980.
3. Ratana Putranon, "A Study on Natural Convection Cabinet Drying", A USAID-NEA Report, Renewable Non-Conventional Energy Project No. 493-0304, National Energy Administration of Thailand, Bangkok 1984.
4. Wattanapong Rugswichien, et al., "Quality of Dried Banana from Large Solar Dryers", A report, Institute of Science and Technology, Sri Nakharinwirot University, Phitsanulok Campus, 1986.

Photovoltaic Powered Reverse Osmosis Seawater Desalination System — Japan

A photovoltaic (PV) powered reverse osmosis seawater desalination system has been developed by Hitachi Zosen (Tokyo, Japan) for installation on isolated islands and in remote areas where the power supply situation is usually poor. Hitachi Zosen has installed a pilot plant in Okinawa (Japan) where the available sunshine is favorable, and looks forward to commercializing the system after one year of operation in a combined demonstration and feasibility study. The experimental scheme was started in February 1982 with the study of the site. The construction was completed in December 1982 and the test-run was commenced in January 1983.

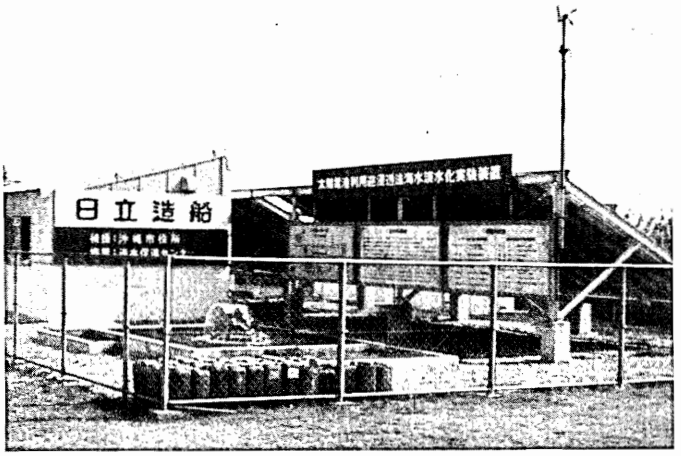

Fig. 1 General view of the photovoltaic powered reverse osmosis seawater desalination pilot plant in Okinawa, Japan.

The plant is normally operated without attendants and with the charging of chemicals and collection of data being performed once a week.

The location of the construction site is Awase district of Okinawa City, of latitude 26° 30′, east longitude 127°50′.

The annual mean rainfall is 2118 mm, and the temperature is 13~33 °C, indicating that its climatic condition is nearly that of a subtropical area.

A complete view of the pilot plant and the photovoltaic array are shown in Figs. 1 and 2 respectively.

The system flow diagram is presented in Fig. 3 and the system specifications of the pilot plant are outlined in Table 1.

The power source used to drive the high pressure pump, which is the essential equipment in the reverse osmosis desalination plant, is a PV power system designed to operate continuously for 7 hours during daylight.

The PV module is of silicon single crystal type comprising 152 sets of modules, 19 series × 8 parallel, having a maximum output of 5320 W taking into account the sunshine time in winter, a temperature rise of the cells in summer, and a charging efficiency of the storage battery, etc.

Cont. P. 4

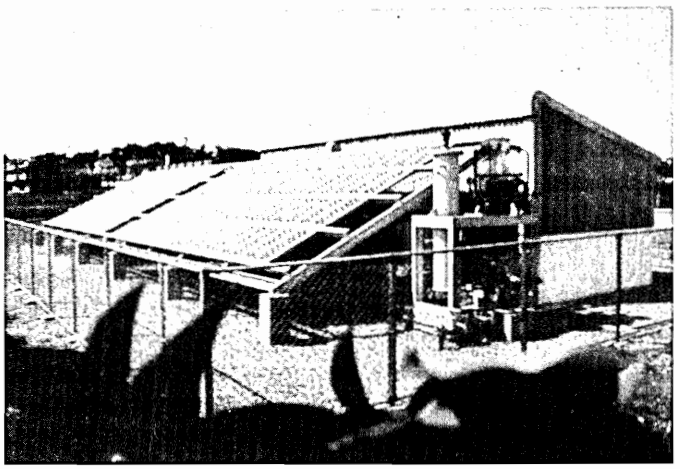

Fig. 2 Photovoltaic array of the pilot plant in Okinawa, Japan.

Photovoltaic Powered Reverse Osmosis Seawater Desalination System — Japan

From P. 3

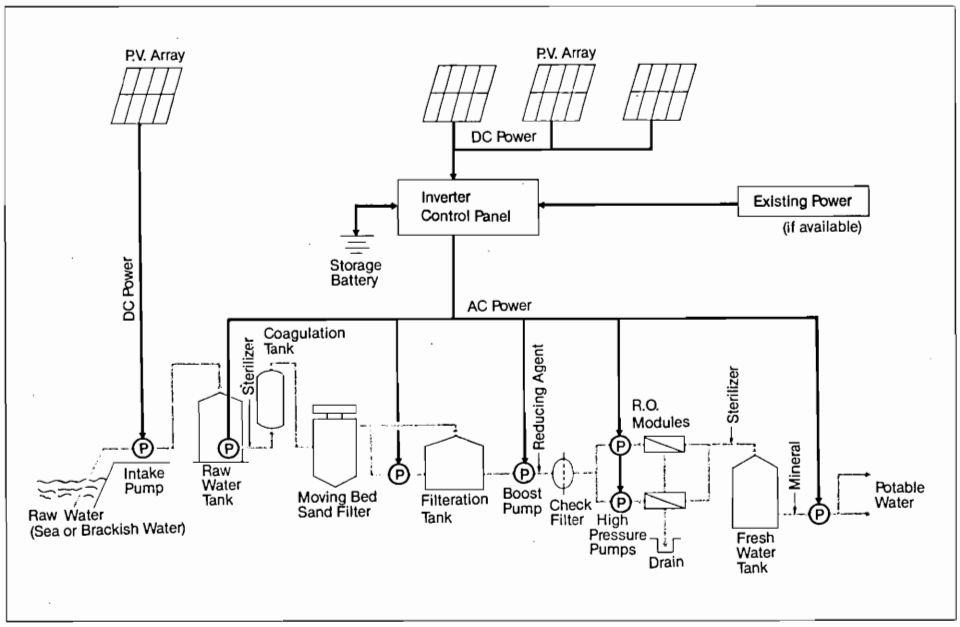

Fig. 3 System flow diagram of PV powered reverse osmosis desalination system.

A DC/AC inverter is of 3.5 kVA and VVVF thyristor type with an auto-starter which reduces the shock to the osmosis membrane. A storage battery is of CS-lead acid type having a capacity of 45Ah (discharge depth 50%) available for about 2 hours backing-up during a sudden change of weather, such as a momentary overcasting of clouds during the daytime, in order to ensure a stable power supply.

Table 1 Pilot plant outline

Construction site:	Awase, Okinawa City
Area:	Approx. 300 m^2
Building:	Single story steel frame building with slate roof
Capacity:	PV System: max. 5320W
	Desalination: 15 m^3/day
PV power generation system	
PV model:	Silicon single crystal type
	(S-270A, Sharp Corp. make)
	35Wp, Vop=16.6V, Iop=2.11A
Nos. of units:	152 sets (19 series X 8 parallel)
Capacity:	5320W (Maximum output)
DC/AC inverter:	VVVF thyristor type
	3.5kVA (incl. insulated transformer)
Storage battery:	CS-lead acid type (GS make)
	45AH, 126 cells
Load:	Induction motor for high pressure pump
	2.2kW AC 200V 3ϕ 60 Hz
Power system:	Linked to commercial power supply
Reverse osmosis seawater desalination system	
Capacity (product water):	15m^3/day
Desalination process:	Single stage R.O. process
Raw water:	Seawater (TDS 37000ppm)
Product water:	Potable water
Recovery rate:	35~40%
R.O. module type:	Spiral type (PEC-1000 TORAY make)
Pre-treatment:	Moving bed sand filter
High pressure pump:	Triple plunger type
Average power consumption:	5.8kWh

The PV array is of fixed type with PV modules arranged in 4 steps X 38 rows. The PV array was installed to face exactly southward with an inclination latitude of 26°30′ after computing the most effective use of the solar energy throughout the year. The power supply is a type linked to the commercial power supply by which automatic changeover to the commercial power is made whenever the solar energy is not available, such as at nighttime or on cloudy or rainy days, thus ensuring that the continuous operation of the desalination plant may be secured.

In the seawater desalination plant, seawater is first pumped up by the intake pump and supplied through the coagulation tank to the moving bed sand filter where the suspended solids are removed, then led to the reverse osmosis modules by the high pressure pump at the high pressure of 52 kg/cm^2 after passing through the check filter fed by the booster pump from the filtration tank.

Approximately 35 to 40% of the seawater supplied to the reverse osmosis modules will be desalinated by passing through the semi-permeable membrane and converted to potable water after adding minerals and sterilizing agents.

Since the plant is normally operated without attendants, protection systems are employed for detecting faults in charge and discharge voltages of the storage battery, the level of the electrolyte, and the liquid temperature in the PV power system. In the seawater desalination system a moving bed sand filter, which filters the seawater automatically and con-

tinuously, is controlled by the sequencer. Thus the whole plant is operated automatically except for charging chemicals.

A demonstration operation of the plant was started in January 1983. Since then the plant has been running continuously at an almost steady condition with just minor maintenance work and charging of chemicals once a week. In particular, the PV power system is operating satisfactorily even without the supply of water to the storage battery which had been anticipated. The following operation data of the PV power plant are continuously recorded by a pen-recorder for grasping the operating conditions: 1) solar irradiance quantity (mW/cm^2); 2) surface temperature of the PV module (°C); 3) storage battery voltage (V); 4) charge and discharge current of the storage battery (A); 5) DC/AC inverter output voltage (V); and 6) motor current for high pressure pump (A). A pilot cell has been installed for measuring the solar irradiance which recorded the conversion value of the generated current characteristic.

Further details on the PV powered reverse osmosis seawater desalination system and results of the field test are available from:

Hitachi Zosen Corporation
Tokyo Office
7th Floor, Palaceside Building, 1-1,
Hitotsubashi 1-chome,
Chiyoda-ku, Tokyo 100, Japan
Phone: 03-213-6611
Telex: SHIPYARD J22363, J24490
Telefax: 03-213-0914, 0905
Head Office
6-14, Edobori 1-chome, Nishi-ku,
Osaka 550, Japan
Phone: 06-443-8051
Telex: SHIPYARD J63376
Telefax: 06-448-5072, 5075

(Source: Design, Installation and Operating Experiences of a Photovoltaic Powered Reverse Osmosis Seawater Desalination System, Hitachi Zosen Cooporation, Tokyo, 1984, 8 p.)

International Workshop on Solar Energy, Manila, 1987

Introduction

An international workshop on solar energy was held in Manila between 9-15 February 1987. The event was sponsored by the German Ministry for Economic Cooperation (BMZ) through the German Agency for Technical Cooperation (GTZ) and by the Philippine National Oil Company — Energy Research and Development Center (PNOC-ERDC). Experts in this field from scientific, academic, private and public sectors participated in the workshop and visited some demonstration sites.

The discussions concentrated mainly on the state of the development of photovoltaics and solar thermal technologies and their possible applications. The elaborations regarding improvement of living conditions in rural areas, were concluded with a summary of recommendations addressed for consideration to the Philippine government agencies involved.

These recommendations may well serve as a guideline to other countries in the region.

Summary of Recommendations*

The participants reviewed the R&D activities of the project "Pilot Solar Power Plant and PV Field Laboratory" at Pulong Sampaloc, Bulacan, currently being jointly implemented by the PNOC-Energy Research and Development Center in cooperation with the Bureau of Energy Development of the Philippines and the Ministry for Economic Cooperation of the Federal Republic of Germany through the German Agency for Technical Cooperation. They identified the positive contributions of the project to its recipients and came up with the following recommendation:

— "It is essential and most favourable that present achievements be complemented by more intensive work supposed to provide relevant results on the economic and technical feasibility of said technology which will support future decisions and help design a concise development policy. All efforts should be made to make the results available at the earliest possible time."

Taking into consideration the discussions regarding papers presented and the project's available infrastructure and experience, the participants further recommended the following:

Photovoltaic (PV) Energy Systems

1. Photovoltaic technology for rural development is safe and sound.
2. Considering the technical, social, economic and market factors, activities related to PV applications such as: stand-alone lighting systems; battery charging stations; television for remote communities; and potable water pumping should be given priority.
3. Similar to most new technologies the initial capital investment for PV applications is rather high. Thus, it is recommended that in cases where specific applications are economically feasible, the following measures be undertaken:
   — Financing pilot schemes at appropriate places such as in remote villages lacking in electric network but with resources and market potential, so as to assist the dissemination of this technology; and
   — Extension of credit/financing and tax incentives such as exemptions from import duties for components not locally available for the use of PV systems.
4. The following R&D activities/needs are also established so

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Asian Network on Solar Energy

Just after the 7th International Solar Energy Congress held from January 16-21, 1978 in New Delhi, the Asian Working Group on Solar Energy was formed to promote solar energy based activities in the area. UNESCO, in cooperation with the Department of Science and Technology, (the then Nodal Agency for Solar Energy Activities in the country), Government of India, the Solar Energy Society of India, and the Regional Centre for Energy, Heat and Mass Transfer organised the first meeting of the Working Group from January 23-25, 1978 in New Delhi. The group recognised that there was much potential to improve national capabilities of countries in Asia through regional cooperation. In order to achieve the goal through regional cooperation it was recommended that a Regional Network on Solar Energy in Asia be established with its Headquarters in the Department of Science & Technology (the then Nodal Agency for Solar Energy Activities in the country), India and that Nodal Agencies identified in various member countries be associated with the Network.

The importance of regional cooperation in the field of energy was also stressed during the 13th Conference of the World Energy Congress held from October 5-11, 1986 in Cannes, France. This renewed call from energy experts round the Globe has necessitated an early action to develop such systems that will promote regional cooperation. One of these obviously is the revival of the Asian Solar Energy Network under UNESCO sponsorship.

Aims and Objectives

Problems of the developing world have been identified as deforestation, low agricultural productivity, lack of finance, especially foreign exchange and lack of energy resources leading to malnutrition, poverty and hunger. This has further been aggravated by limited reserves of fossil fuels which have been used as a source of energy for several hundreds of years. The objectives of the Network are, therefore to:

i) Initiate institutional cooperation to exchange experiences in the formulation of R&D projects, and to train manpower, etc;

ii) Promote general awareness and extension of activities in rural, sub-urban and urban areas to make use of locally available renewable energy sources so that the dependence on the outside world is reduced;

(iii) Create new and strengthen existing infrastructural and manpower development systems;

(ix) Share mutual experience gained by each member country on various renewable energy technologies that have been developed in the region or elsewhere and utilized by the member countries and/or others;

(v) Disseminate the knowledge

International Workshop on Solar Energy, Manila, 1987

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that support can be provided:
- Optimization of small inverter systems for lighting;
- Identification of suitable pump designs for specific applications; and
- Maximum use of local components for PV systems.

5. It is highly recommended that activities in the field of telecommunications also be carried out as early as possible, since test and operation of the Pulong Sampaloc Solar Power Plant have proved that PV can compete with present diesel engine equipment particularly in very remote and isolated applications, e.g., relay stations.

Solar Thermal Systems

1. Considering this technology's state of development, ERDC, in cooperation with other institutions, should be tasked to develop specifications and quality standards for solar water heaters. The government should then assign an agency to implement and regulate the use of solar water heaters considering the standards for the protection of the consuming public.
2. Applied R&D on the domestic applications of solar water heaters should continue with emphasis on producing low-cost units.
3. Applied R&D on potential applications of solar water heaters in industry should also be intensified after the successful development of small and low-cost domestic collector systems.
4. There is a need to reassess the use of solar energy in drying, preservation and storage of agricultural products suitable to the Philippine situation.

Technical Cooperation

1. Support from bilateral and multilateral agencies for funding, e.g. the Federal Republic of Germany, should be continued to propel further the development of the technology and the promotion work that has already gained positive results.
2. Considering the effective exchange of ideas and experiences among the workshop participants, it is felt that continuing cooperation among the institutions involved in solar energy activities should be institutionalized and supported to facilitate further developmental work in the field.

(*published with the permission of PNOC-ERDC, Manila, Philippines. Information submitted by J. van Winden, Div. of Energy Technology, Asian Institute of Technology, Bangkok, Thailand).

gained by various member countries or others in the world in the utilization of renewable energy in general and solar energy in particular;

(vi) Establish a national coordinating agency in each of the States of the region and select participating institutions;

(vii) Support/convene national seminars, workshops etc. by national coordinating agencies;

(viii) Convene regional seminars, meetings and workshops in cooperation with national coordinating agencies;

(ix) Strengthen and establish specialised training programmes and develop linkages between institutions and industry;

(x) Provide support for undertaking joint research programmes and schemes relevant to national and regional needs;

(xi) Arrange exchange of faculty members, energy experts and other research persons in the region;

(xii) Promote exchange of students and award of fellowships financed by national Government-funds or funds-in-trusts;

(xiii) Investigate sources for future funding; and

(xiv) Promote exploitation of research results beyond the laboratory stage within the region.

The Second Working Group Meeting of the Network was held from January 19-21, 1987 at India International Centre, New Delhi. The Meeting was organised by the Global Energy Centre and sponsored by the Government of India and UNESCO.

On the basis of the recommendations of this Meeting the Global Energy Centre will try to formulate projects and identify the level of funding required for them; wherever possible sources of funding will also be identified.

For further details contact: the Secretary, Global Energy Centre, Block No. B-4 (9th floor), CGO Complex, Lodi Road, New Delhi-110003 (INDIA).

Use of Windmills in Salt Production in Thailand

Thailand is probably the only country in Southeast Asia that has been using large numbers of windmills for water lifting. The plains of the Chao Phraya delta have been often described, along with the Plateau of Lassithi in Greece, as the home of the thousand windmills. There are two types of locally constructed windmills, a slow-speed sail-wing type and a high-speed wooden-rotor type. The former is used for brine pumping in salt farms and the latter is used for water lifting in rice irrigation and also for brine pumping in some areas.

As part of the research project on Technical and Economical Assessment of the Use of Windmills in Thailand, the King Mongkut's Institute of Technology Thonburi (KMITT) undertook a study to assess the use of windmills in salt production, a popular application in Thailand. The research project was funded by the National Energy Administration (NEA). Salt production fields in Samut Sakhon and Samut Songkhram area were selected for conducting a field survey. This field survey covered 143 square kilometers of the most concentrated area of salt production which is about 80% of all salt production fields in Thailand.

The specific objectives of the above project were:

(i) to study the use of windmills in salt farms in Samut Songkhram and Samut Sakhon, classify them in terms of type, size and population of windmills and wooden-paddle pumps;

(ii) to assess the amount of energy which has been produced by the windmills;

(iii) to estimate the petroleum cost and engine cost if the windmills were replaced by small deisel engines.

Salt Production Process

The salt farming season in Thailand begins in October and ends in May, which covers the dry period of winter and summer since sun drying is the major process of evaporation. Each salt farm covers an area of 0.048 to 0.064 km^2, and is divided into 3 parts. The first part, covering 40-45% of the farm, is a concentrating pond or a brine reservoir. Sea-water is pumped to this reservoir by a large windmill, called the "Outer Windmill", standing at the sea shore as shown in Fig. 1 and Fig. 2. The second part, covering 45 to 50% of the area of the

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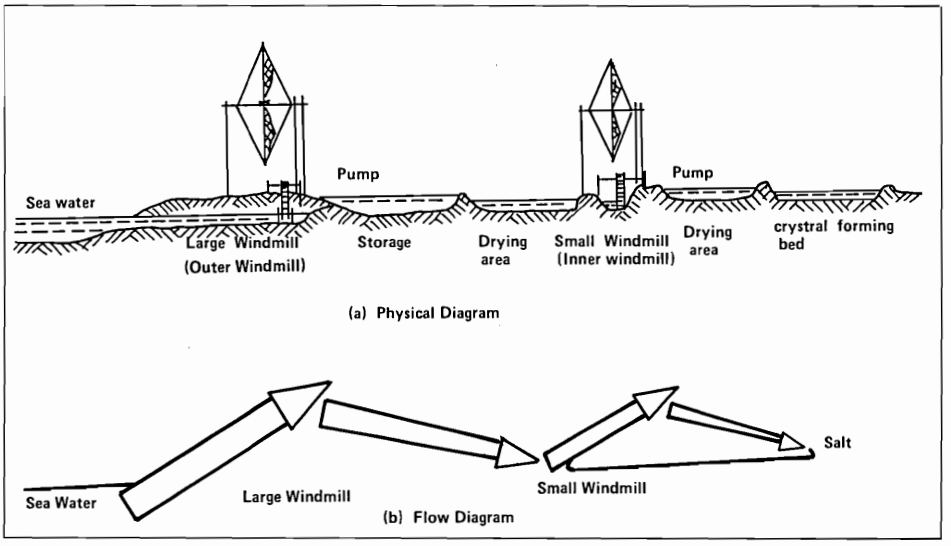


Fig. 1 Salt production diagram.

Wind Power Generation Looks Ahead in India

A wind energy programme directed towards harnessing the wind energy potential for various applications in the country was initiated in 1986. Five demonstration wind farm projects of aggregate capacity 3.3 MW were established initially at Mandvi and Okha in Gujarat; Tuticorin in Tamil Nadu; Devgarh in Maharashtra; and Puri in Orissa. The capacity of the Mandvi project is 1.1 MW; the expansion of the other four 550 kW projects to 1.1 MW each is in progress. By the end of the current year, the installed capacity from wind farm projects will be 5.5 MW. The current status of the wind farm projects in the country is shown in Table I. This phase of the demonstration programme was based predominantly on 55 kW unit size wind machines. The next phase of the demonstration programme will be based on machines of unit size up to 150 kW. An installed capacity of at least 3 MW is expected to be added next year.

The planning and implementation of the Mandvi project were done by a joint sector company in Gujarat. The conception, development and planning of the other four projects were done by the Department of Non-Conventional Energy Sources (DNES), Ministry of Energy, Government of India, and executed by respective electricity boards and renewable energy agencies. A notable feature of these projects was the very short gestation period from planning to commissioning — all the projects were commissioned within a very short span of about six months. Over

Table – I
Status of wind farm projects in India

Location	Aggregate Capacity (kW)	Manufacturer/ Unit size (kW)	Date of Commissioning	Executing Agency
Commissioned and operational				
Mandvi, Gujarat	1075	Micon 2 X 110 Micon 14 X 55 Windane 3 X 22 Windane 1 X 18.5	16-1-86	Gujarat Wind Farms Ltd.
Tuticorin, Tamil Nadu	550	WindMatic 10 X 55	18-1-86	TNEB
Okha, Gujarat	550	Vestas 10 X 55	8-3-86	GEB
Puri, Orissa	550	WindMatic 10 X 55	1-5-86	OREDA
Devgarh, Maharashtra	550	Vestas 10 X 55	23-5-86	MSEB
Tuticorin, Tamil Nadu	330	Vestas 6 X 55	21-11-86	TNEB
Installation in progress				
Tuticorin, Tamil Nadu	220	Vestas 4 X 55		TNEB
Okha, Gujarat	550	WindMatic 10 X 55		GEB
Puri, Orissa	550	Bonus 10 X 55		OREDA
Degarh, Maharashtra	550	Bonus 10 X 55		MSEB

Use of Windmills in Salt Production in Thailand

From P. 7

farm, is a flat area for drying where much of the water is evaporated. A small windmill, which is called the "Inner Windmill", lifts brine to this second part. The remaining 5 to 10% of the farm is an area where salt crystrals are formed. Therefore, it is necessary to compact the earth in advance. Before the farmers collect the salt crystrals they channel the saturated brine layer on the top surface of the salt crystals into

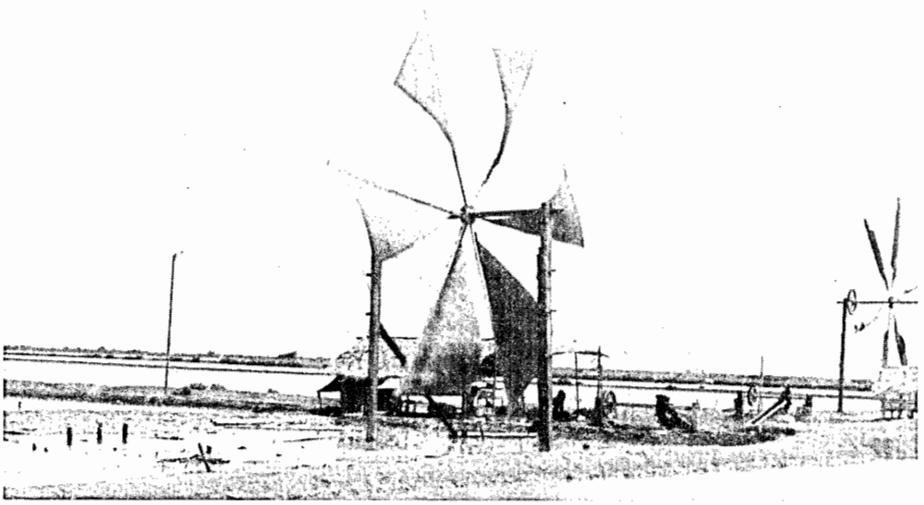


Fig. 2 Thai sail-wing windmills.

4 million units of electricity have already been generated and fed to the respective state grids. A month-wise comparative statement of energy generation during 1986 in each of the projects is given in Table II.

One of the major objectives of the demonstration programme is to create the conditions for demand for such machines to grow so that an indigenous industry could develop. Several foreign companies are entering into agreements with well-known manufacturing companies in India for indigenous manufacture of wind generators, which is expected to be realised soon. Various incentives are already available to industry for production and utilisation of non-conventional energy systems, which are also applicable to wind generators.

The capital cost and cost of power generation from wind farms are comparable to those of thermal power stations, depending upon the site. A typical calculation for the Okha project is given in Table III.

Under a Danish International Development Agency (DANIDA) financed experimental project, six wind turbines of unit size 100 kW will be received during 1987 for erection, one each in Gujarat, Maharashtra, Orissa and Madhya Pradesh, and two in Tamil Nadu. Also under DANIDA financing, a pilot wind farm project of about 1.5 MW capacity will be taken up during the year in Gujarat or Tamil Nadu; simultaneously work will commence on the siting and planning of a major wind farm project of over 10 MW capacity.

Demonstration projects are also being undertaken for stand-alone wind electric generator systems of capacities up to 25 kW in remote inaccessible areas not served by the electrical grid, and for wind battery chargers of capacity up to 5 kW. States/Union Territories are being encouraged to take up additional demonstration wind power projects. A list of some individual wind electric projects in various States/UTs is given in Table IV.

The future of wind energy applications in India seems to be bright in view of the encourage-

Cont. P. 10

Table – II
Comparative wind farm performance: 1986 (in kWh)

Month	Mandvi (16-1-86) 1.1 MW	Tuticorin (18-1-86) 550 kW	Okha (8-3-86) 550 kW	Puri (1-5-86) 550 kW	Devgarh (23-5-86) 550 kW
January	14 760	42 345	–	–	–
February	57 958	53 271	–	–	–
March	77 777	54 285	66 210	–	–
April	168 700	30 855	101 540	–	–
May	238 980	40 159	166 830	55 258	43 540
June	213 500	105 387	107 590	62 212	102 640
July	347 340	137 490	130 940	14 956	58 940
August	280 390	96 333	112 007	32 016	69 410
September	168 580	90 254	43 673	19 793	12 960
October	91 780	24 621	25 880	5 992	6 720
November	35 780	39 092	31 140	2 728	10 840
December	41 200	85 737	79 400	8 432	–
Total	1 736 745	799 832	865 210	201 387*	305 050**
Total Generation:				3 908 224 kWh	

* 10th machine commissioned in December

** 10 machines operational May – June; 5 operational July – November (none/only one operational for about 5 weeks in July – August); 8 machines operational December.

a small ditch and mix with the new coming brine to the second part.

Formerly, each salt farm required two windmills, a large one and a small one, but during the last decade, more and more brine reservoirs have been converted into shrimp farms. Since shrimp farms need large amount of sea-water at high tide, small diesel engines coupled to wooden paddle pumps, or in an industrial scale, large diesel engines coupled to axial flow pumps, are used to pump water into the shrimp farm. The water from the shrimp farm is supplied afterwards to salt farms.

Conclusions

The field survey revealed that all the windmills are sail-wing type and most of them are made from bamboo-mat while only a few are made from cloth. There are two sizes of windmill, the bigger size has a diameter of 10.5 m. and make up 21% of the total of 667 windmills, while the rest are the smaller size and have a diameter of 7.7 m. All windmill pumps are wooden-paddle pumps which have an average lift head of 0.7 m. The bigger size windmills are now declining in number due to the conversion of the brine reservoirs into shrimp farms.

The survey results showed that the farmers can save 0.16 million baht for the cost of petroleum in this area each year, however if the engine cost is included in the analysis, the overall cost that the farmers can save is 2.2 million baht.

(Extracted from the article "A study of Windmills Used in Salt Farms in Samut Sakhon and Samut Songkhram" by Woranut Koetsinchai and Sunee Suwontragul, presented at the Regional Seminar on Alternative Energy Applications in Agriculture, Chiang Mai, Thailand, 27-29 October 1986)

Wind Power Generation Looks Ahead in India

From P. 9

Table – III
Cost of power generation for the 550 kW Okha Project

	(Rs. in lakhs)
Cost of equipment	60.92
Cost of execution	20.99
Total project cost	81.51
Interest @ 8.67%	7.07
O&M costs @ 3%	2.45
Depreciation costs, taking life of equipment as 20 years	3.05
Total annual costs	12.57
Annual electricity generation (kWh), based on trend of actual generation in 10 months	1 100 000
Cost per unit (Rs/kWh)	1.14

One US$ = 13 Rs. approximately as on 16-2-87.

Table – IV
Individual wind electric systems installed in States/Union Territories

S. No.	State	Type	Capacity	Agency	Status
1.	Delhi,				
	Kanganheri	WBC	8.5 kW	DEDA	Operational
	Bakoli	WBC	10.0 kW	DEDA	– do –
	Palam Gaon	WBC	10.0 kW	DEDA	– do –
2.	Goa	WEG	55.0 kW	Goa Power Dept.	– do –
3.	Gujarat,				
	Veeraval	WEG	40.0 kW	GEDA GEB JK Syn	– do –
			55.0 kW	GEDA GEB RRB	– do –
			100.0 kW	GEDA GEB Thermax	Planned
	Okha	WEG	2 X 20 kW	DNES GEDA	Under installation
	Tuna	WEG	500.0 kW	DNES GEDA GEB	– do –
4.	Lakshwadeep,				
	Kavaratti	Stand-alone WEG	20.0 kW	Elec. Dept.	– do –
5.	Madhya	WEG	50.0 kW	MPEB MPUVN	Operational
	Pradesh	WEG	55.0 kW	MPEB	Planned
6.	Mizoram	Stand-alone WEG	2 X 20 kW	Elec. Dept. DNES	Under installation
7.	Andhra				
	Pradesh	WEG	5 X 100 kW	NEDCAP DNES	Planned

ment given by the Government of India to promote this clean energy.

(Details of the different wind projects were supplied by DNES; Contributed by Dr. A. Jagadeesh, President, Society of Science for the People, Nellore-524 002 A.P. INDIA).

First VAWT Machine on Line in Wales, UK

Almost two years after it was originally due on line, the vertical axis prototype machine of Britain's Vertical Axis Wind Turbines Ltd. (VAWT) is at last operating. The official commissioning ceremony was carried out in the last days of November at Carmarthen Bay in South Wales.

The delay in the machine's construction resulted from problems at the rotor construction stage and the 25 metre diameter rotor finally produced is, according to some industry observers, considerably heavier than the three tonne average weight of rotors used on horizontal axis machines of similar rated output (130 kW). VAWT's commercial machines, such as the one now being manufactured for installation on the British Scilly Isles, will be considerably lighter than the Carmarthen Bay machine, the company claims.

It has taken more than three years for VAWT to build the prototype. Planning permission to build the machine on land owned by the Central Electricity Generating Board at the Carmarthen Bay power station and the £3.5 million ($5 million) research, development and demonstration grant from Britain's Department of Energy, which financed the development, were obtained in 1983 and VAWT expected construction to be complete by late 1984.

Since the design is ultimately destined for operation in multi-megawatt sizes offshore, VAWT says, it paid closer-than-normal attention to the materials used in the machine and that this attention to detail resulted in the construction delay. The main structures for the blades, the main and actuator struts and the crossarm were all eventually fabricated in commercial grade steel while a more specialised steel was selected for the highly-loaded components to avoid the possibility of stress

Airfoil Changes Boost Darrieus Production — Canada

Canadian vertical axis wind turbine (VAWT) manufacturer Indal Technologies has concluded a study which indicates that the performance of a Darrieus machine can be substantially improved without increasing its generator size by the use of specially tailored airfoils developed by Sandia National Laboratories.

The study analyzed the effect of modifying Indal's Model 6400, a 500-kW turbine, by tailoring its airfoils without increasing its peak output of 520 kW. Several types of airfoil and of chord taper were studied in different assumed wind conditions.

In a paper delivered to the European Wind Energy Conference, results of two rotor modifications were reviewed.

The first (#1) used an SNLA 1850 airfoil to within 9.4 meters (31 feet) of the blade midpoint and a NACA 0018 elsewhere, with a chord of 0.762 meters (30 inches). The second (#2) used an SNLA 180 airfoil to the same point and a chord varying between 0.914 meters (36 inches) to 1.32 meters (52 inches).

For an assumed average wind speed of 6.2 m/s (14 mph) with a Weibull distribution (k=3), the #1 airfoil increased annual energy output by 44%, while #2 increased it by 54%.

At a higher assumed average wind speed, 8 m/s (18 mph), the differences were smaller, with #1 showing a 27% increase and #2 a boost of 33%.

Both rotor modifications were also subjected to cost and fatigue analysis. With rotor costs assumed proportionate to rotor mass, drive train and electrical system costs held constant, and transportation and installation costs excluded, both rotors #1 and #2 produced projected cost of energy reductions ranging from 14% to 25%.

For further information, contact David Malcolm, Indal Technologies, 3570 Hawkestone Road, Mississauga, Ontario L5L 2VS, Canada, phone 416-275-5300, telex 069-6142.

(Source: Wind Energy Weekly, Vol. 5, No. 233, December 1986).

Italian Firm Builds Innovative VAWT

The Italian company TEMA, a subsidiary of the national oil company ENI, has manufactured and installed an H-type innovative vertical-axis wind turbine in northern Sardinia.

The machine, which is located at a TEMA industrial plant a few miles from the government test center at Alta Nurra, is rated at 40 kW and has a rotor diameter of 14 meters (46 feet).

Its design incorporates both the variable rotor geometry concept of the UK's Professor Musgrove and an innovative variable-speed, constant-frequency (VSCF) generator.

The sides of the machine's H-shaped rotor divide in the center and are allowed to tilt outward from the center to reduce the rotor's area in high wind speeds.

The generator design uses a stator which is not fixed, but which can rotate either in the same direction as the generator rotor or in the opposite direction as appropriate to maintain a constant frequency at varying rotor speeds. If the wind speed is higher than 8 m/s (18 mph), the stator rotates in the same direction as the generator rotor.

For further information, contact Roberto Carli, TEMA SPA, Via Medici del Vascello, 26, Milano, Italy.

(Source: Wind Energy Weekly, Vol. 5, No. 234, December 1986)

cracking.

The machine will now be tested for two years but in the meantime, VAWT is activating a sales campaign for the design. The company has already installed a 14 metre, 40 kW rated output machine for TEMA SPA of Italy at Porto Torres on Sardinia in June last year and is in the process of completing a 17 metre, 130 kW version to be installed on the British Scilly Isles in early 1987.

The Scilly Isles machine is being fabricated by Davidson & Co. of Belfast with financial support from the UK Department of Trade and Industry and from the European Commission.

(Source: Windpower Monthly, January 1987).

AIT FACSIMILE NO.

Facsimile Service is now available on the campus of the Asian Institute of Technology (AIT).

The telephone number of the AIT facsimile is 5290374. This number is sufficient for normal use in the Bangkok area. For upcountry long-distance use (e.g. from Chiengmai or Phuket) the area code for Bangkok "2" should be dialed first. For an international call — the country code "66" should also be added.

AIT Facsimile (66-2)-5290374.

CRRERIS

Energy Planning in Papua New Guinea

The Papua New Guinea (PNG) energy policy supports the government's key objectives of job creation and self sufficiency. The energy policy seeks to promote productivity and growth through economic efficiency in the use of energy in both the commercial and non-commercial sectors. It is aimed at minimising the expected cost of meeting present and future energy requirements while maximising the net national benefit of developing domestic energy resources.

These objectives imply that (i) energy prices should cover the full cost of energy production, including a rate of return which reflects the value of capital to the economy; (ii) government should intervene selectively to supplement the price system where markets fail to work properly, due to inefficient prices, lack of public awareness, or some other cause; (iii) a systematic and cost effective approach to energy in the non-commercial sector is required, where a lack of functioning markets and market prices make application of standard economic and financial criteria difficult.

These overall objectives have been elaborated into a number of operational criteria which apply to the assessment of specific policies, projects, and programmes, as described below:

Pricing Policy

Sound energy prices are recognised as the single most powerful tool for ensuring that producers and consumers, making decisions in their own interest, will use energy in a way which imposes lowest costs on the economy. "Sound energy pricing" simply means that consumers pay the full cost of the energy which they consume. For domestic sources of energy, consumers should pay the full cost of production, including a rate of return reflecting the full value of capital employed in the energy sector. For imported energy, consumers should pay the world price plus any local distribution costs.

In general, actual energy prices in PNG reflect market prices quite closely, such that no energy form is generally subsidised by the State (although cross-subsidisation with individual sectors — particularly electricity — is a notable phenomenon).

Where price signals fail to operative effectively, either through unavoidably inefficient pricing in one sector or another or, more likely, a lack of training or public awareness of available technologies or the techniques of efficient utilisation, intervention in the market by government is justifiable. This may take a variety of forms, including specialised training programmes, regulation, direct or indirect subsidies, special tax provisions, etc.

Non-price Policy

Several specific criteria apply to developments in the energy sector, particularly with respect to the evaluation of new projects:

Commercial Energy Sources

1. Least Cost: all new energy projects should be comparatively evaluated to ensure that the least cost option for provision of energy is selected.
2. Conservation/management: where all other factors (technical reliability, economic viability, etc.) are the same, projects and policies promoting more efficient energy use are preferred to increased supply.
3. Security: all other things being equal, domestic energy supply is preferred to imported energy.
4. Renewable: all other things being equal, development of renewable resources is preferred to development of depletable resources.
5. Reliability: except for demonstration projects, all energy supply options will involve technology of proven reliability.
6. Social acceptability: Supply options must be socially acceptable in the context of PNG values, and make adequate provision for protection of public health and the natural environment.

Non-Commercial Energy Sources

Development and supply of energy resources to many rural projects and households will often not provide commercial returns on investment. However, these non-commercial activities, which include expanding and improving the supply of energy to rural communities, could provide longer term social benefits and the foundation of a future economic base. Such projects may require subsidies and so will compete with other social and economic demands on available public funds.

Energy supply to underdeveloped areas should be introduced in conjunction with other private and public investments aimed at integrated social and economic development in order to establish a local economic base that will support a higher standard of living. Selection of non-commercial projects on conventional financial or economic criteria will be difficult or impossible. A systematic approach to the evaluation of benefits is vital to ensure that projects are related appropriately to their costs and that they are ranked correctly.

Energy Programmes

In parallel with the policy requirements above, there has been intensive investigation into available energy resources and conversion technologies. A wide ranging programme was outlined in 1979.

Outstanding successes have been achieved in agriculture through substitution of petroleum with wood and crop residues for crop

drying and steam raising, and in public sector power supply through a shift from thermal to hydro generation.

Other successes include a continuing programme to promote energy conservation in government buildings and training of national plant supervisors working in public institutions. Some 7000 solar water heaters were installed in government houses in 1982/83. A further government programme to construct minihydros in remote villages was begun in 1985 and is likely to grow into a substantial rural electrification programme within 2-3 years.

Other initiatives to substitute imported petroleum with indigenous renewables have been sharply curtailed or dropped. The specific reasons for this vary in each sector, but in general relate to poor technical performance of the new technology, high cost, and difficult marketability.

Woodfuel-based Programmes (pyrolysis, charcoal)

Wood utilisation for petroleum substitution by industry has been hampered by difficulty in collecting and delivering the wood to potential users. There are few access roads into forested areas, and at present no means to ship wood wastes to where they are needed. Moreover, small experimental wood pyrolysis units have failed to perform satisfactorily.

The strategy for wood utilisation has shifted from substitution within existing industries towards supply at the margin, that is, wood-fired energy systems are now being planned for wood-abundant areas, in parallel with the development of wood-based industries.

Fuel Ethanol

The only ethanol facility in operation at present is at the Ramu Sugar factory, which produces ethanol in limited quantities for the fuel market in Morobe Province, using molasses (a waste by-product) for feedstock. In 1986, Ramu's sugar cane harvest was seriously reduced by a previously unknown cane disease. Ethanol production has accordingly been interrupted temporarily, pending cultivation of a new disease-resistant strain. Ramu plans eventually to increase ethanol production capacity which may lead to expansion of the ethanol market throughout the New Guinea highlands region.

Biogas

Experimental biogas plants, both using municipal sewerage and crop residues (coffee husks) have failed altogether to perform technically and have been abandoned.

Photovoltaic Cells (PVCs)

PVCs have proved to be expensive and unreliable for remote villages. The humid tropical conditions of PNG have shortened the life of installed arrays from the expected 20 years to less than six months in some cases. PVC applications have not achieved any significant penetration into the energy market to date, although they are beginning to be used in telecommunications and may be developed for refrigeration of medical supplies in remote areas.

New Priorities

In light of this experience, the Department of Minerals and Energy has ceased investing time and energy in untried technologies. Energy planners are satisfied that sufficient technology, proven in PNG, already exists to meet the country's energy requirements in the years ahead. New energy projects are now likely to be evaluated against the following criteria:—

1. proven technical reliability;
2. demonstrable social or economic

Cont. P. 14

CALL FOR PAPERS

RENEWABLE ENERGY REVIEW JOURNAL

The **Renewable Energy Review Journal** has now been published without a break for eight years. It is well established as a source of expository articles on renewable energy at an intermediate academic level. Our editorial policy has been to select for publication from among the many manuscripts submitted to us those that are technically sound at an appropriate academic level, and are on topics within the scope of RERIC's subject areas while being also of general interest. Obviously we cannot accept manuscripts that are of poor technical quality or are poorly written; at the same time we reject manuscripts that contain nothing more than an analysis (and perhaps some experimental test results) of a narrow topic typical of the kind treated in student project work. The articles we like best are those that cover an area of knowledge that can be applied or adapted to a range of problems — the sort of topics that appear in lecture notes for student courses or in state-of-the-art reviews in workshops devoted to current areas of development.

We therefore invite readers to look through their research reports and lecture notes for topics of potentially wide interest and send them to us in a form suitable for publishing as a journal article. The required format is given in the "Notes for Authors" on the inside of the back cover of each issue of the Journal. Our editors can help less experienced authors, or authors whose native language is not English, to put their contributions into an acceptable style provided that the amount of work involved is not large; we can "touch up" material, but we cannot rewrite blocks of text. We hope by this means to promote a lively exchange of knowledge of renewable energy and related topics among our members to allow the expertise developed by individuals to find wider recognition than would be possible by limited personal contacts.

For further details contact:
Renewable Energy Resources Information Center
Asian Institute of Technology
P.O. Box 2754
Bangkok 10501
Thailand

ASEAN – Working Group on Non-Conventional Energy Research (WGNCER) – Thailand

Energy Conservation in Tobacco Curing

Tobacco is an important cash crop of northern Thailand and an important export product of the country. The total production in 1985 amounted to about 66 500 tonnes, of which 64% (valued at US$1.6M) was for export. Approximately two-thirds of Thailand's tobacco production is Virginia flue-cured variety of neutral filler type, with low nicotine and high sugar content, which brings a low price in world markets. Over 90% of Thailand's present flue-curing facilities are of traditional natural convection barns with fire-tubes and opened-firewood furnaces. Firewood is the most common energy source. These traditional flue-cured barns and their curing practices are very energy inefficient. With the problems of firewood scarcity and associated deforestation, appropriate energy conservation measures for Thailand's flue-cured tobacco industry are urgently needed.

Cured tobacco leaves.

In 1984, the Department of Mechanical Engineering of Chiang Mai University, embarked on an ASEAN-Australia Research Project EC15(T) -- Energy Conservation in Tobacco Curing for Northern Thailand. The project goal was to reduce the firewood consumption of the existing traditional flue-cured barns through appropriate energy conservation measures. This will in turn reduce the energy cost of the tobacco curing operation and alleviate deforestation problems in Thailand.

This two-year project commenced in October 1984, with the specific objective of improving the overall curing efficiency of Thailand's existing traditional flue-cured barns, with minimum modification and investment. The activities carried out and the results achieved are as follows:

Stage 1 – Energy Auditing (October 1984 – March 1985)

In this first stage, the project commenced with an overview study of northern Thailand's tobacco curing industry in general. Thereafter, an energy auditing study of a typical conventional flue-cured tobacco barn, operating under normal conditions, was carried out. It was found that the major areas of heat losses for both the wood-fired and lignite-fired traditional barns were ventilation loss via barn openings, conduction loss via barn structure (wall and roof), stack loss through exhaust gas, and furnace losses due to heat radiation and excess air. From these, possible energy conservation measures were identified and tentative methods for each conservation measure were chosen and evaluated by computer simulation techniques in Stage 2.

Stage 2 – Computer Simulation and Evaluation (April – September 1985)

In the second stage of the project, all the identified energy conservation measures (from Stage 1) were simulated on a computer and evaluated. The overall objective was to optimize energy conservation measures by improving curing efficiency and minimizing fuel cost, with marginal investment. The following energy conservation measures were considered: (1) reduction of heat loss through the barn's structure by insulating with appropriate insulation materials at the optimum economic thickness; (2) reduction of ventilated loss through optimum control of the barn's openings to achieve ideal ventilation air flow rates; (3) reduction of furnace losses by reducing radiation heat loss and excess air through the front of the furnace; and (4) reduction of exhaust gas loss through

Energy Planning in Papua New Guinea

From P. 13

benefit to the country and affected area;

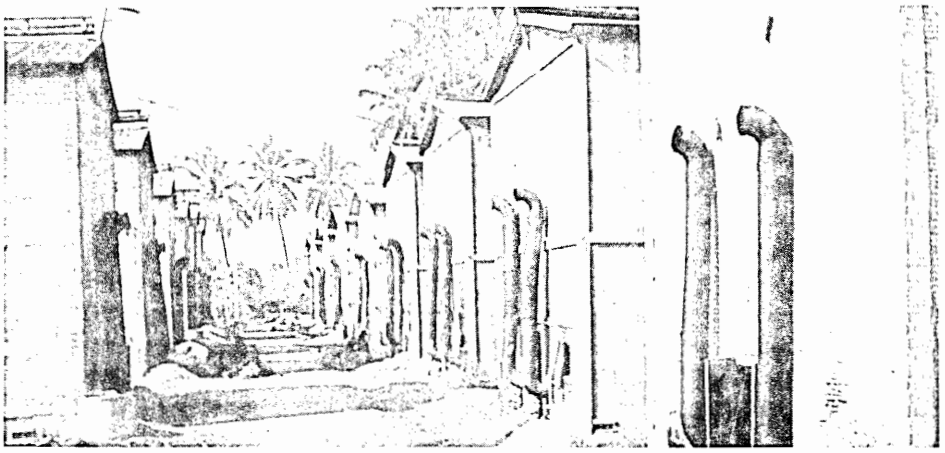
3. increased utilisation of PNG's most abundant primary resources, hydro and wood.

In particular, import substitution is no longer a useful criterion in itself. In line with the government's priority for economic growth and employment, the goal of energy planning has shifted from petroleum replacement *per se* to reducing the cost of production and investment throughout the economy.

Extracted from "Energy Policy and Development in Papua New Guinea" by C. Cheatham, Department of Minerals and Energy, Papua New Guinea. Presented to the Asian Forum on Energy Policy, Bangkok, October 1986. The complete report is available from the Manager, Energy Information Service, CSIRO, PO Box 89, East Melbourne, Victoria, 3002, Australia.

modification and rearrangement of the heat exchanger pipes, the fire-tubes, and the exhaust pipes.

Measures (1) and (3) were adopted for field testing and implementation. The decision to adopt was based not only on their technical and economic justification, as provided by the computer simulation study, but also on their practicability and suitability to the standard practices of the local tobacco curing industry. The first energy conservation measure adopted, insulation of the barn's structure with plain fiberglass sheets of 16 mm optimum thickness and thermal resistance of 0.254 m^2K/W, was expected to recover about 40% of the conduction loss or save about 6% of the total firewood consumption of a conventional barn. The second measure adopted, reduction of furnace loss with simple front covers, was expected to save about 8% of the total firewood consumption. Thus, the two combined energy conservation measures were expected to conserve about 14% of total firewood energy consumed by the conventional flue-cured tobacco barns.



Traditional tobacco curing barns.

Stage 3 – Modification, Testing and Evaluation (October 1985-March 1986)

In the third stage of the project, two traditional flue-cured tobacco barns were modified to suit the two adopted computer simulated energy conservation measures. Seven test runs, five with firewood fuel and two with lignite fuel, were conducted in parallel with a standard reference barn. The results proved the technical and economic viability of incorporating fiberglass insulation and front furnace control measures to the traditional flue-cured tobacco barns. Both measures achieved a combined energy saving value of 22%, with an equal 11% for each measure. The economic potentials for both measures were ideal, with low initial investment and short pay-back period of less than one year for the furnace control option. The test results of the standard reference barn, also, provided comprehensive standard energy consumption and thermal curing efficiency references for future work.

Stage 4 – Dissemination, Assessment and Recommendation (April-September 1986)

In the final stage of Phase I of the project, a training workshop on 'Energy Conservation in Tobacco Curing', was organized to disseminate the proven technology. The workshop participants included tobacco farmers, tobacco station curing operators, exporters, and representatives from various government agencies. The two-day training workshop concentrated on technical and practical aspects, with on site demonstration of the modified barns, and product demonstration by suppliers of the energy conservation materials. The workshop proved to be an important launching platform for the dissemination of energy conservation technology to the local tobacco curing industry. The returned workshop-evaluation forms strongly indicated that all of the tobacco farmers and station's owners, who attended the workshop, are interested in incorporating one or both disseminated energy conservation measures into their traditional fluecuring tobacco barns. The technology is being further transferred through other disseminating agencies, such as Thai Tobacco Monopoly (TTM), National Energy Authority (NEA), and Tobacco Producers Association of Thailand (TPAT).

From the results of testing, it is evident that if the 22% energy saving measures were to be incorporated into northern Thailand's traditional flue-cured tobacco barns, firewood consumption and deforestation by the tobacco curing industry would be substantially reduced. However, a potential energy saving of 50% is possible with an energy efficient forced-draught 'bulk' curing system. The Energy Research Team of Chiang Mai University recommends that further study on energy conservation in tobacco curing should be conducted to achieve the final goal of introducing an appropriate forced-draught bulk curing system to the flue-cured tobacco industry in Thailand. The team proposes to tackle this task and to continue the study in the upcoming Phase II of the ASEAN-Australia's Energy Conservation Programme.

Further details on the project are available in "Energy Conservation in Tobacco Curing for Northern Thailand," by Boon-Long, P.; Hirun, A.; Rerkkriangkrai, P; Siratanapanta, T.; Sitthiphong, N; Sucharitakul, T., and Therdtoon, P. (Department of Mechanical Engineering, Chiang Mai University, Chiangmai 50002, Thailand). Final Report of Project T2, EC15(T) – Tobacco Curing submitted to ASEAN Working Group on Non-Conventional Energy Research and ASEAN-Australia Energy Cooperation Programme, sponsored by the Government of Australia.

TRAINING COURSES

Course on Energy Usage in Rural Industries of Developing Countries

July 1987, Australia (26 days)

The course is organized by the University of NSW and Biomass Energy Services and Technology (a private energy consultancy).

Course Outline

- o Energy assessment for rural industries.
- o Planning and management of appropriate interventions.
- o Evaluation of existing technologies used in food and agriculture, building, ceramics and metal processing and manufacturing industries.
- o Designing and testing new technology or modifying existing technology.
- o Integration of fuel production and energy conservation.
- o Monitoring, evaluating and training in rural energy programmes.

Participants

The course is intended for senior project personnel from government and non-government organisations concerned with energy sources and usage in rural industries.

General Information

Course Fee: US$3000

This includes bed and breakfast in University College accommodation, all course materials and tuition for the duration of the course.

Travel to and from Australia and to Sydney are not included. Incidental expenses and meals other than breakfast are not included. Three meals per day are available (except week-ends) for an additional US$80.

English Proficiency

Course participants must be proficient in English, if they are to gain maximum benefits from the course.

Further enquiries and all correspondence concerning the course should be directed to:

Dr. Bill Lawson,
School of Architecture,
University of NSW,
P.O. Box 1,
Kensington, N.S.W. 2033,
AUSTRALIA

Training Course on Energy Management in Small and Medium Scale Industries

September 14 — October 16 1987

The course is organized by the Technology and Development Group of University of Twente (Enschede, The Netherlands) and the Research Institute for Management Science (Delft, The Netherlands).

Course Objectives

To enhance the management capabilities for small and medium scale industries in developing countries with respect to:

- — the analysis of the role of energy in production processes
- — the efficient use of energy in small and medium scale industries
- — the formulation of policy options and strategies for energy in small and medium scale industries.

Target Groups of Trainees

- — managing staff involved in energy planning and management in their industries
- — policy makers from government organisations, industrial associations and institutes involved in industrial development and energy
- — consultants who relate to the themes of the course.

Course Programme

Lectures, discussions, case studies, exercises and excursions with respect to the following subjects:

- — technology options in production processes
- — energy utilisation and need assessment
- — energy control and conservation techniques
- — energy planning and supply options
- — energy auditing
- — economic aspects of energy
- — management dimensions
- — policy aspects of energy in small and medium scale industries.

The course assumes that participants have a basic understanding of science and economics. Case studies and experiences of the participants play an important part.

The language of the course is English.

Course fees D.Fl. 10.000,— incl. training materials & excursions (D.Fl. 7.500 for local sponsors). Estimated costs for living expenses (5 weeks): D.Fl. 3.500,—

Deadline for application — 1 June 1987.

For more details contact:

The Course Administrator
Technology & Development Group
University of Twente
P.O. Box 217
7500 AE ENSCHEDE, The Netherlands
Tel. (0)53-893539/893534
Telex 44200 thtes nl

Postgraduate Programme on Energy and Environmental Technology in Architecture

The postgraduate teaching and research programme on Energy and Environmental Technology at the Architectural Association School of Architecture in the UK is concerned with the critical study of the

relationship between technology, architecture and urban form; with building performance and the quality of the environment; the application of scientific principles and techniques in building design; and with the evolution of a regionalist architecture, response to the particularities of climate, site and cultural context. The practical objective of designing with climate is the starting point for these studies and a vehicle for a fresh exploration of fundamental issues in architecture.

The programme offers postgraduate courses leading to the AA Graduate Diploma, and research options toward MPhil and PhD degrees. The taught course, first established as a postgraduate area of study twelve years ago, has been developed in response to the global discourse on energy, technology and environment, and to the long tradition in the study of climatic design and the technology of architecture within the AA school. The course draws upon a growing network of international research and expertise in the areas of passive solar design, passive cooling and energy conservation in buildings, as well as the more traditional areas of building science and environmental technology. The contents of lecture courses are reviewed annually to take into account this experience and the incoming students' regional backgrounds.

The course is especially designed for architects, but graduates from other environmental disciplines with a background in design, building technology or in urban planning are eligible to apply.

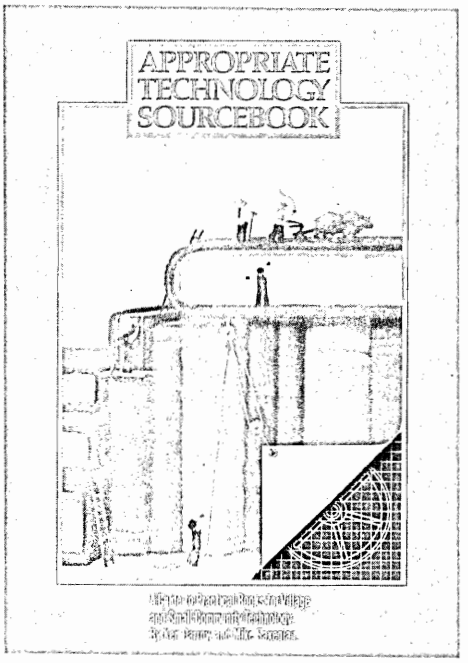
Those interested in the above program can get further details from:

The Director
Energy Studies Programme
Architectural Association School of Architecture
34-36 Bedford Squere
London WC1B 3ES
U.K.

Appropriate Technology Sourcebook

A guide to practical books for village and small community technology

(By Ken Darrow and Mike Saxenian. Revised and enlarged edition, September 1986. Volunteers in Asia, Stanford, CA, U.S.A. ISBN. 0-917704-17-7 (paperback); ISBN. 0-917704-18-5 (hardbound)).



This publication is the latest edition of the guide to practical books on village and small community technology. Over 50 000 copies of previous editions have been used in more than 130 countries, to find a wide range of published technical information that can be used by individuals and small groups. In the new edition, 1150 publications from international and U.S. sources are reviewed, covering small water supply systems, renewable energy devices such as watermills and improved cookstoves, agricultural tools and implements, intensive gardening, workshop tools and equipment, crop preservation, housing, health care, forestry, aquaculture, nonformal education, small business management, transportation, small industries and other topics. Price and ordering information are provided for each publication. An extensive index is also included.

In addition to serving as a guide to references on small scale technology, this book can be used as an index to the *Appropriate Technology Microfiche Library*. The microfiche library has been designed to contain the best selected references available to small-scale and village-level technology, and includes over 1000 of the books and documents reviewed in the *A.T. Sourcebook*. The very low cost of the microfiche library makes it affordable for small organizations and individuals.

The microfiche library is compact, lightweight and portable. It contains more than 128,000 pages of text which is reproduced on 4″ × 6″ plastic "microfiche" cards. The full library collection is 1% of the weight and 5% of the cost of a comparable paper book library. Like a conventional paper library, the microfiche library is fully organized and indexed so that information is easy to find. A complete list of the 1000 books in the microfiche library and instructions for the use of the microfiche library are included in the sourcebook.

The regular price of the paperback edition of the *A.T. Sourcebook* is US$17.95. For local groups in developing countries, the price is US$9.00. Postage costs are US$2.00 for domestic U.S. addresses, and US$3.00 for foreign addresses. A hardbound edition with a sewn binding is available for US$26.95 plus postage ($14.00 plus postage to local groups in developing countries).

For more information, write to: Appropriate Technology Project, Microfiche Library, Volunteers in Asia, P.O. Box 4543, Stanford, California 94305, USA.

Solar Thermal Component and System Testing

Proceedings of the Fourth Asian School on Solar Energy Harnessing held at the Asian Institute of Technology, Bangkok, Thailand, 12-20 December 1985.

Since 1982, the Division of Energy Technology, Asian Institute of Technology (AIT), and the School of Energy and Materials, King Mongkut's Institute of Technology (KMIT) have organized the Asian School on Solar Energy Harnessing. Each year, a special theme of current interest in the field of solar energy development is chosen for the programme of lectures and practical development. In 1985, the Organizing Committee chose "Solar Component and System Testing" as the theme for the school. The school, which is funded by the French Agency for Energy Management (AFME), the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), the Canadian International Development Agency (CIDA), the International Center for Theoretical Physics (ICTP), and the United Nations Educational, Scientific and Cultural Organization (UNESCO), was held at Asian Institute of Technology, Bangkok, Thailand, from 12 to 20 December, 1985.

Due to the evolution of the solar equipment and systems, it is imperative that standard test methods of these components and systems be proposed, discussed, formulated and a consensus which should be acceptable to all those concerned be reached.

The objective of the Fourth Asian School on Solar Energy Harnessing was in effect, to make a start towards the discussion of testing methods and procedures of both thermal and photovoltaic components and systems which are acceptable in South-East Asia. The subjects presented and discussed during this event were designed to stimulate and catalyse people and agencies into actively, systematically and scientifically pursuing solar testing and in the preparation of national or regional standards.

These proceedings have been structured into the following groups,

- Solar radiation and astronomical aspects
- Basic solar collector science
- Collector testing procedures
- System testing procedures
- Practical aspects relating to hot water systems
- Representative paper presentations by participants.

A separate volume is being envisaged which will dwell exclusively on the photovoltaic aspects.

The Proceedings, edited by T.A. Reddy and Ph. Bouix (1986, vi+ 266 p.), is available from Renewable Energy Resources Information Center (RERIC), AIT, G.P.O. Box 2754, Bangkok 10501, Thailand, at US$25.00 per copy including air-mailing cost.

Biogas Community Plants Manual

by BORDA Biogas Team
(G. Eggeling; G. MacKensen; L. Sasse; B. Stephan)

This manual is intended to provide assistance in decision-making and planning concerned with the construction of community biogas plants.

Unlike the simple technology often sufficient for family biogas plants, community plants require more mature techniques and a fully functional management. For this reason, and since biogas plants are only economically viable when adapted to each individual situation, this manual includes construction plants which are not complete. In the technical section and the technical appendix, primary planning criteria and examples of proportion are illustrated. This should lead the engineer engaged to finding independent solutions that are suitable for local conditions.

The socio-economic framework, especially for cooperative plants, is a subject treated in the manual in detail. The chapter on social structure shows the importance of local on-the-spot surveys and the relation between regional and village structure. The integration of future consumers at the planning stage and the recognition of possible problems arising amongst local social groups are imperative prerequisites for a functioning of cooperatively operated biogas plants.

Biogas plants have to be economically profitable for the operators. Intangible effects, as well as monetary viewpoints, play a role here. For community plants these would be a safe, modern energy supply, hygiene aspects and cooperative plants as instruments for the formation of cooperatives. Subsidies to ease the burden of high investment costs are as a rule necessary to assure economic viability. These subsidies are justified on account of their positive macro-economic aspects on a long term basis. Ecology, the balance of foreign exchange and regional development are also important here. As far as communal plants are concerned hygiene stands in the foreground. These points are discussed in the chapter 'Economy and Finance'.

Each community biogas plant, especially a cooperative plant, depends on a management which functions. Technical, social and economic questions have also to be

taken into consideration. These three factors influence each other and are of equal importance, though technical performance does play a key role. In the appendix, detailed directions are given on this to assist technical management. In addition, more practically orientated information is stated in the appendix — for instance, questionnaire frames, calculation examples and tables.

The manual is published by BORDA (Bremen Overseas Research and Development Association, Bahnhofsplatz 13, D-2800 Bremen 1), in cooperation with GTZ (Deutsche Gesellschaft fur Technische Zusammenarbeit GmbH, Postfach 5180, 6236 Eschborn 1).

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- o *Saving Energy in Agriculture*, Advisory Booklet 18, National Energy Conservation Program, Australian Government Publishing Service, Canberra, 1984, 35 p. (ISBN 0-644-03317-7).
- o *Saving Energy in Commercial Buildings*, Advisory Booklet 16. National Energy Conservation Program, Australian Government Publishing Service, Canberra, 1985, vi+45 p. (ISBN 0-644-03884-5).
- o *Energy Conservation in Towns: The Swedish Concept*, B. Boos, Swedish Council for Building Research, Stockholm, Sweden, 1986, 95 p. (ISBN 91-540-4558-4).

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- o *Proceedings of the Regional Conference on Energy Physics and Physics Education*, Jakarta, Indonesia 20-30 August 1984, the Physics Department, Faculty of Science and Mathematics, University of Indonesia, Jakarta, 1985, x+346 p.
- o *Alternative Coal Combustion Systems*, K.C. Johnston and C.G. Martin, NZERDC Report No. 133, New Zealand Energy Research and Development Committee, Univ. of Auckland, Private Bag, Auckland, New Zealand, Ausugt 1986, 100 p.
- o *Energy Use in Transport, Data Report*, BECA Carter Hollings & Ferner, Auckland, NZERDC Report No. 131, New Zealand Energy Research and Development Committee, Univ. of Auckland, Private Bag, Auckland, New Zealand, June 1986, 32 p. +app.
- o *Integrated Energy Planning: A Manual*, Vol. I — Energy Data & Energy Demand; Vol. II — Energy Supply; Vol. III — Energy Policy, Asian and Pacific Development Centre, Kuala Lumpur, 1985.
  Available from:
  Asian and Pacific Development Centre (APDC)
  Pesiaran Duta
  P.O. Box 12224
  Kuala Lumpur, Malaysia.
- o *Four Futures: Energy Implications of Social and Economic Change*, J.F. Boshier, R.R. Alan, M.J. Ellis, J. Gallacher and P.H. Phillips, NZERDC No. 135, New Zealand Energy Research and Development Committee, Univ. of Auckland, Private Bag, Auckland, New Zealand, September 1986, 85 p.
- o *Energy — Related Issue in Early Economic, Literature-Summaries and Bibliography*, Juan Martinez-Alier, Energy Research Group, Ottawa, Canada, March 1986, 62 p.
- o *A Linear Programming Model of Electric Power Generation*, Eero Tamminen, Technical Research Centre of Finland (VTT), Espoo, Finland, 1986, 61 p. +App.
- o *Water-Pumping Devices: A Handbook for Users and Choosers*, Peter Fraenkel, Intermediate Technology Publications, London, UK, 1986, 176 p.

SOLAR ENERGY

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- o *Technical, Social and Economic Evaluation of Photovoltaic System for Rural Application: Computer Package Manual* (Draft), compiled and condensed by F. Lasnier & Tony Gan Ang, Energy Technology Division, Asian Institute of Technology, December 1986, 132 p.
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- o *Report of the 1986 Workshop of the European Cooperative Networks on Rural Energy on Solar Heating of Green Houses*, Thessaloniki, Greece, 28-30 April 1986, FAO, 16 p.+app.
- o *The Effects of State Support on Industry and on the Market for Solar Heating, Heat Pumps and Heat Storage*, Orjan Isacson,

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DIARY OF EVENTS

- April 28-30, 1987, London, UK.

Conference on Power Supplies, Photovoltaics and Batteries

For further details contact:
Miss Laura Christie,
ERA Technology Ltd,
Cleeve Road, Leatherhead,
Surrey KT22 7SA,
UK.
Tel: (+44) 372 374151,
Telex 264045.

- May 10-12, 1987, Dartmouth College, Hanover, NH, USA

International Workshop on Wind-Diesel Systems and on Performance Testing of Wind Systems

The American Wind Energy Association (AWEA) and the Canadian Wind Energy Association (CanWEA) are sponsoring the international technical workshop on wind-diesel systems and on performance testing of wind systems.

The performance testing portion of the event will be a forum for information exchange about experience with various testing methods including AWEA Standard 1.1-1985, 'Standard Performance Testing of Wind Energy Conversion Systems," while the wind-diesel session will aim to identify key issues remaining in the development of economic and reliable systems.

For further details contact:
Beth Turner
AWEA
1017 King Street
Alexandaria, VA 22314
USA.

- May 23 — June 14, 1987

International Course on Biomass Energy

This course is organized by KENGO Regional Wood Energy Programme in conjunction with Kenyatta University, Appropriate Technology Center.

The course is intended to expose the participants to a wide range of mature biomass energy technologies and to meet the training needs of technical staff working on biomass energy projects in Africa, Asia and Latin America. It will cover the practical aspects of the following:—

- o Stove Production: Small and large scale production of metal and ceramic components of energy saving cookstoves.
- o Briquetting: Utilisation of biomass waste — namely coir dust, saw dust, coffee husks and groundnut shells — for energy production by briquetting.
- o Bakery Ovens: Construction.
- o Charcoal Production.

Course Structure

The course will consist of 10% formal lectures and 80% practical training which will involve actual construction of relevant devices. The rest of the time will be spent in visiting production workshops and factories. Opportunities will be provided to participants to talk to various specialists and to concentrate on particular topics of their choice, other than stove production, the main focus of the course.

For further information contact:
Course Director
International Course on Biomass Energy
Kenya Energy Non-Governmental Organizations (KENGO)
P.O. Box 48197
Nairobi
Kenya
Tel: 749747/748281
Telex: 25048 Energy

- May 25-29, 1987, Dubrovnik, Yugoslavia.

Alternative Energy Sources

For details contact:
Inter-University Centre of Postgraduate Studies,
Frana Bulica 4,
YU-50000 Dubrovnik, Yugoslavia.
Telephone: (050) 28-666.

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- o *Anaerobic Digestion 1985*, Proceedings of the Fourth International Symposium on Anaerobic Digestion, Guangzhou, China, 11-15 November 1985, 1986, 720 p.

WIND ENERGY

- o *Report of the 1986 Workshop of the European Cooperative Networks on Rural Energy on Wind Energy Applications for Rural Areas*, Riso, Denmark, 14-16 May 1986, FAO, 14 p. +app.
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- o *Survey of the Experience in Particular with the Prototype of the CWD2000 Windmill at the Technical University Eindhoven from May 1983 until December 1985*, Ad.v.d Nat, CWD, Amersfoort, The Netherlands, November 1986, 27 p.
- o *Laboratory Measurements of a Pump with Floating Valve*, Frits Verheij and Henk Oldenkamp, CWD, Amersfoort, The Netherlands, December 1986, 20 p.

RERIC news

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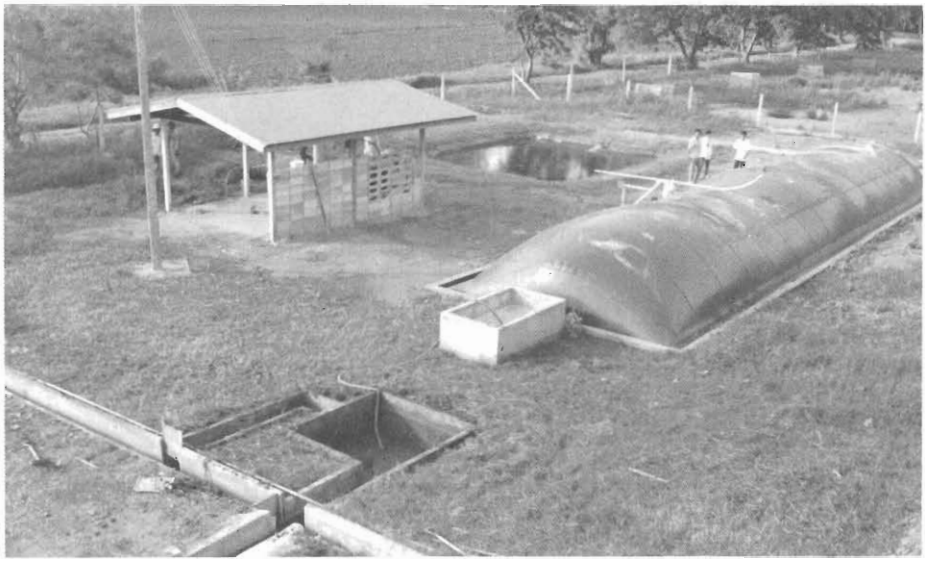


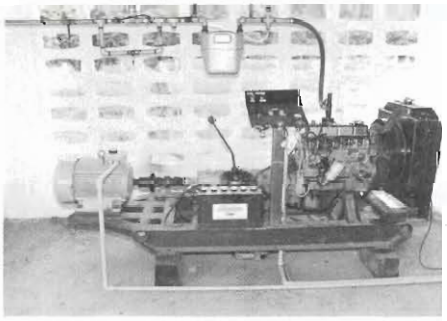


Fig. 1 Biogas plant at Tabkwang Research Station, Saraburi Province, Thailand

Fig. 2 The engine-generator-set

ELECTRICITY FROM PIG MANURE

A full-scale plug-flow biogas plant was constructed at Tabkwang Research Station of the Kasetsart University in Saraburi Province, Thailand. It is covered with Red Mud Plastic (RMP) film as gas holder and operates at a maximum gas pressure of 10 cm water column. At 15 days hydraulic retention time (HRT), manure of about 800 pigs including all flushing water can be digested.

This digester is the first pilot plant of this type that is being tested under practical conditions in Thailand. This is also true for the RMP film, for which the contractor gave a guarantee of 10 years.

Figure 1 presents the whole set-up consisting of the flushing canal and the manure collection tank in front, the plug-flow digester in the middle, the effluent holding tank in the background and the power shed on the left hand side.

The specific electricity production of the engine-generator-set is about 1.4 kWh per m^3 biogas (at ambient conditions) at 10 kW output. The electricity is mainly used to operate a 15 HP water pump, a 5 HP feed mill and a 20 HP hammer mill, which normally are not run at the same time. The elec-

Cont. P. 2

tool
wind and sun compendium
Development of wind and solar energy for water pumping
cwd

Energy Information Service, CSIRO
Incorporates news from the Energy Information Service, CSIRO and Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).
INNERTAP

Electricity from Pig Manure

From P. 1

tricity is also used for running some air-conditioners, a refrigerator and for lighting.

Construction

The digester cavity was dug two meters deep into a clay layer and two meters further down into lateritic soil. A ferrocement retaining wall of 3.5 cm thickness and a bottom concrete layer of 15 cm were built inside this cavity. A ring canal was constructed around the pit to fix the gas holder which is made of the RMP film. The gas holder was sealed by filling water into the canal.

The effluent holding tank is 4 m deep but the slope is 63° instead of 80° as in the digester. This is a long term stable slope. The cavity was simply lined with a PVC plastic film.

Table 1
Technical data on the full-scale biogas plant

DIGESTER	
Volume	: 170 m^3
Type	: Plug-flow (trapezoidal shape)
Dimensions	: Bottom length : 16 m, bottom width : 1.8 m; top length : 18 m, top width : 3.6 m; depth : 4 m; slope : 80 degrees
Retaining Wall	: Ferrocement (steel rods with 2 layers of hexagonal chicken wire), 3.5 cm plaster thickness
Inlet and Outlet Pipe	: Dia. 20 cm 45 degrees inclination
Ring Canal	: Cast steel reinforced concrete bottom, 15 cm thickness and 1.12 m width; stainless steel hooks every 75 cm; brick wall
Gas holder	: Material: Red Mud Plastic (RMP) film, 1.8 mm thickness; total length: 20 m; total width: 5 m; maximum height: 1.1 m (not expanded)
MANURE COLLECTION TANK	
Volume	: 3.1 m^3
EFFLUENT HOLDING TANK	
Volume	: 100 m^3
Depth	: 4 m
Lining	: PVC film, 0.25 mm thickness
Slope	: 63 degrees

Design parameters

The manure collection tank with a volume of about 3 m^3 is designed to trap the undestroyed faeces of about 800 pigs which normally float. Surplus liquid is allowed to drain off. The faeces are then mixed at a ratio of 1:2 with the liquid collected in the tank to obtain a proper concentration of between 4 and 8% TS. The HRT under this condition is about 60 days. In case the faeces are almost completely disintegrated by the flushing process, then all the diluted manure has to be collected during flushing time, and loaded into the digester, resulting in a low HRT of about 15 days which should be considered as the minimum. The HRT for digestion of the same amount of pig manure may therefore vary between 60 and 15 days. If the farm considers increasing the number of pigs, the flushing process should be improved so that the HRT will be about 15 days. Dilution and HRT also influence the daily gas produc-

Fig. 3 15 HP water pump.

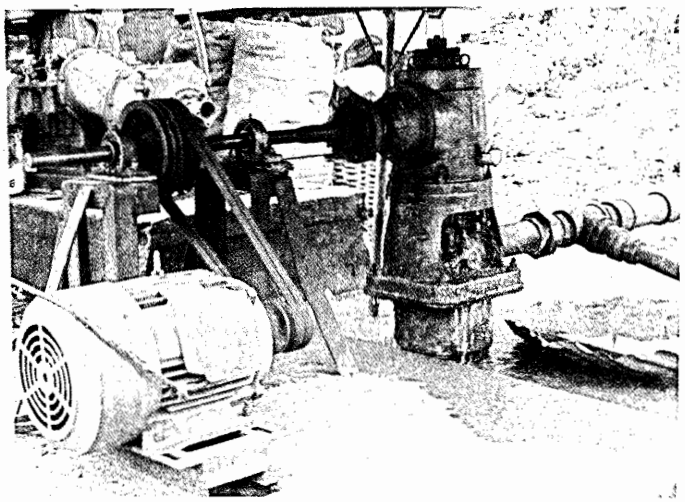
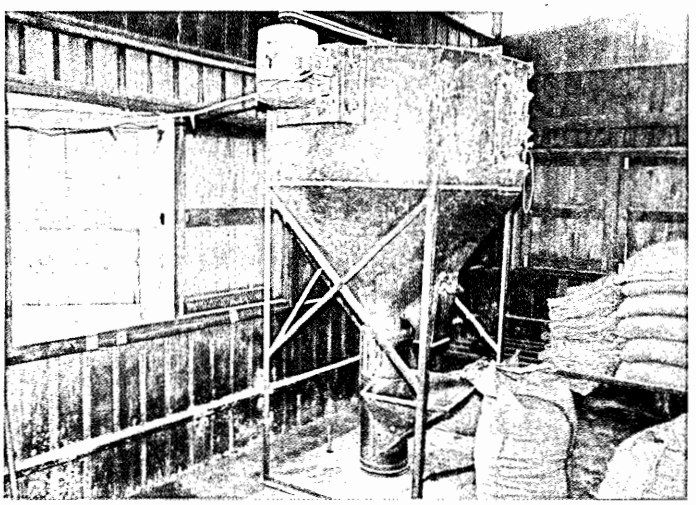


Fig. 4 5 HP feed mixer.



tion which is higher at a longer HRT.

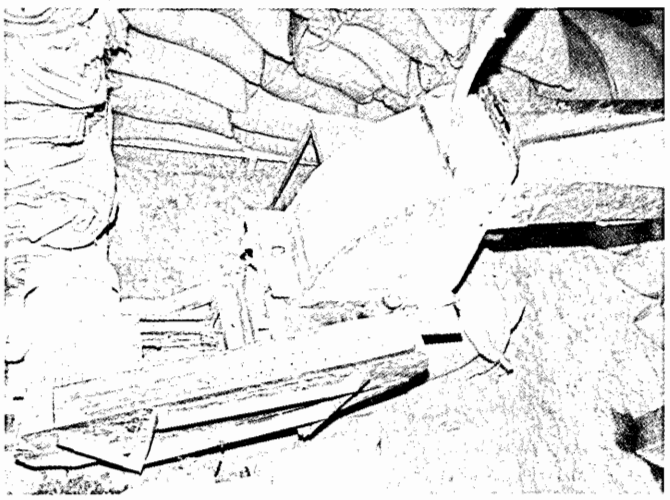
The engine-generator-set is designed to cover 30 to 50% of the pig farm's electricity demand and it should run 10-15 hours per day at 10 kW output. The farm has peak demands of about 30 to 50 kW. The rest will be purchased from the main grid. There are two more digesters of the fixed-dome type, each of 65 m^3 digester volume. They were constructed 3 years earlier by Kasetsart University and together produce about 25 m^3 gas per day. Part of this gas is piped over a distance of 320 m to a kitchen where it is used for cooking.

This plug–flow digester with engine-generator-set was designed by the Biogas Project Team at the Division of Energy Technology, Asian Institute of Technology (AIT). Construction was carried out with the active support of the staff and workers of the Tabkwang Research Station. The project is sponsored by GTZ, Federal Republic of Germany.

Table 2
Technical data on the engine-generator-set

ENGINE	
Model	: Nissan 784 H 20, 4 cylinder gasoline engine
Total displacement	: 1982 cm^3 (Bore = 87.2 mm, stroke = 83 mm)
Designed Compression Ratio	: 8.2 :1
Power Output	: 91 HP at 4800 rpm
Max Torque	: 160 Nm at 3200 rpm
Weight	: 157 kg
Cooling System	: New truck radiator
Engine Protection Devices	: Max. temperature, min. oil pressure (new)
GENERATOR	
Type	: Inductive synchronous generator (new)
Rated Max. Output	: 15 kW; 3-phase, 380 V, 30 Amp.
CONTROL PANEL	
Model of operation	: Manual and automatic control operations
Measuring instruments	: Amp., Volt, and Hour meters
Equipment protection Devices	: for short circuit, overload current, reverse current, unbalanced phase and over and under voltage

Fig. 5 20 HP hammer mill.



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Use of Biogas and Fermentation Residues in India

Biogas

The majority of biogas plants constructed in India are fed on cattle dung. The biogas generated from this consists of about 60% methane and 40% carbon dioxide which has a calorific value of 4713 Kcal. Some 90 to 95% of the biogas produced in India is used for domestic cooking and lighting to replace the burning of firewood, agricultural residues and dung cakes, and kerosene, respectively.

Indian biogas burners (biogas stoves) have a 60% burning (thermal) efficiency, therefore, the effective heat generated by biogas fuel amounts to 2828 Kcal. However, biogas lamps used for lighting burn with an efficiency of only 5 to 10%.

Although dual fuel diesel-biogas internal combustion engines have been developed in India, their use is not common. Biogas consumption is 15 ft^3/HP per hour and replaces 80% of the diesel fuel. A 5 HP dual fuel engine requires 75 ft^3 (approximately 2 m^3) biogas per hour, which is beyond the capacity of most family size plants. Dual fuel engines linked to community biogas plants are either used for running small generator sets in the 3.5 to 10 KVA range, or for direct pumping of water or powering agro-industrial machines.

A public corporate body, namely, Bharat Heavy Electricals Ltd. has recently developed an engine pump set which operates solely on biogas. It is a 4 stroke single cycle, spark-ignited engine coupled with a centrifugal pump having an engine shaft output of 3 HP and consumes 2.62 m^3 biogas per hour.

Digested Residues

The digested residues from biogas plants using cattle manure

Cont. P. 4

Biogas in Asia and the Pacific

The interest in the use of organic materials considered as wastes was heightened by world concern over environmental pollution, deforestation and the fuelwood crisis, and the need to dispose of wastes more efficiently. However, national biogas developments have met with varying degrees of success. If biogas is to secure a firm position in a country's energy mix: its viability and reliability must be demonstrated in order to build up user confidence and attract other potential users.

A Regional Expert Consultation on Biogas-Network was organized by the FAO Regional Office for Asia and the Pacific at Bangkok, Thailand, from 28 October to 1 November 1986 in order to promote inter-country cooperation on biogas through the network of national institutions, to facilitate the exchange of information and to stimulate applied research work. With regard to this it was hoped that the Consultation's deliberations and recommendations would form a strong basis for continued biogas development to benefit the rural masses of the Asia Pacific Region.

The primary objective of the

Report of the Regional Expert Consultation on Biogas-Network held at FAO Regional Office for Asia and the Pacific, Bangkok, Thailand, 28 October – 1 November 1986.

Consultation was to enable selected experts in biogas technology to:

a. Exchange experiences on the use of biogas as a fuel and the use of the organic residue of biogas fermentation as organic fertilizer, animal feed, and in aquaculture.

b. Exchange information on types of family, commercial and community biogas plants presently in use or in development under different environmental conditions, inclusive of information on design, construction materials, feedstocks and fermentation techniques.

c. Compare training and extension strategies formulated to popularize biogas and organic residue utilization among rural communities.

d. Discuss the need for and means of assessing the socio-economic viability of biogas.

e. Review problems and constraints to biogas development and identify areas for inter-country and FAO cooperation in implementing research, development, training and extension programmes to overcome such problems and constraints.

National experts from the following 13 countries participated in the meeting: Burma, China, Democratic People's Republic of Korea, India, Indonesia, Malaysia, Nepal, Pakistan, Philippines, Republic of Korea, Sri Lanka, Thailand and Western Samoa (representing Pacific Island Countries). In addition, representatives from ESCAP, the Asian Institute of Technology, the DPRK Trade Commission in Thailand, and relevant Royal Thai Government agencies attended as observers.

This report contains an overview of biogas development in Asia and the Pacific compiled from country reports of participating countries.

The report is available from:
FAO Regional Office
for Asia and the Pacific
Maliwan Mansion
Phra Atit Road
Bangkok, Thailand.

Use of Biogas and Fermentation Residues in India

From P. 3

as a feedstock is a rich manure containing 1.5% N, 0.4% P_2O_5, and 2.2% K_2O, plus trace elements and humus. The composition of the residues of other organic matter however, depends on the nature of the feedstock. In general 30 to 50% of the organic matter fed into both main types of Indian biogas plants (KVIC and Janata models designed for 50 days hydraulic retention time and operating under normal conditions) is decomposed. The residue, therefore, contains 50 to 70% of the organic matter fed into the digester. Under anaerobic conditions both types of biogas plant convert only 10 to 20% of the total carbon into cellular matter as against 40 to 50% for aerobic composting. This has the effect of reducing the problems of smells and insect development because of the smaller quantity of bacterial matter present in the residue.

Biogas residues are stabilized by retaining most of the carbon which would otherwise be converted into cellular mass. Nitrogen, which is the most important plant nutrient, is practically retained in the residue after anaerobic fermentation in organic or ammonia nitrogen form. The nitrogen contained in fresh slurry is easily mixed with the soil and is practically fully available without much loss as would happen if it were exposed to the sun and weather prior to application. Fresh slurry, therefore, is best applied by mixing it with irrigation water. An alternative method, perhaps more acceptable to Indian farmers, is to use the slurry in accelerating fermentation of agricultural wastes in compost pits.

Field experiments conducted during 1982-1985 at Tamilnadu Agricultural University, Coimbatore, showed yield increases due to the application of slurry in wet condition of 6.5% in rice, 8.9% in maize, 15.2% in wheat and 15.7% in cotton as compared with farm-

Briquettes from Water Hyacinth

The troubles associated with the spread of water hyacinth (*Eichhornia crassipes*) have stimulated research into using this noxious plant as a raw material in industry, as a feed, and also as a new source of energy.

Since 1982, Mrs. Prangtip Kittiladdaporn, Chairperson of Saharatkij International Import-Export Co., Ltd., has studied the briquetting of lignite mixed with agricultural wastes or weeds. Using lignite as solid fuel has some inconveniences however. For example, it is difficult to ignite and has a strong smell during combustion due to its high sulphur content (3%). Fortunately, in late 1985 some success in reducing the sulphur content in lignite was achieved.

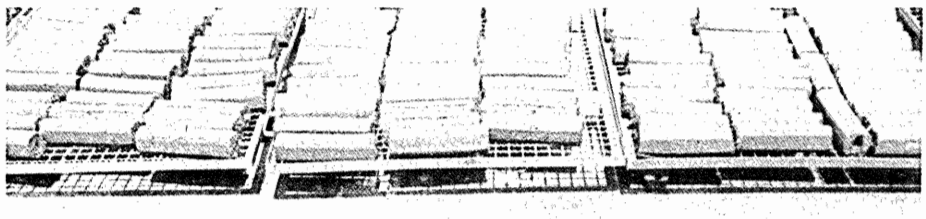
The briquettes are produced by mixing ground lignite, chopped dried water hyacinth and binder in the ratio of 6:3:1. The binder is composed of 4% glue, 2-3% resin and 2-3% synthetic compound made from tapioca. The briquettes are then formed by extruding under high pressure and then dried in an oven or by the sun.

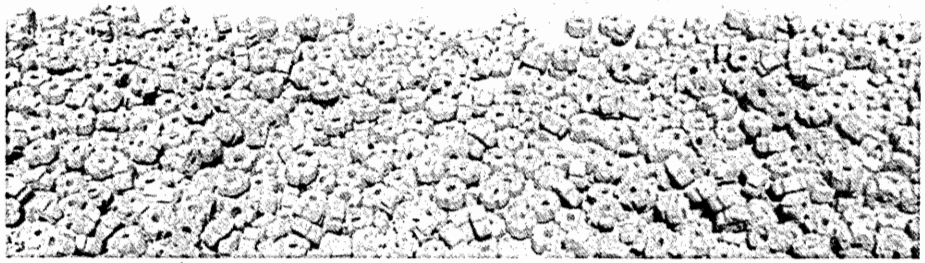
The briquettes thus obtained contain only 0.8-1.2% sulphur. Their heating value was found to be about 5,700 Kcal/kg. After burning 30-40% ash was left. Testing was carried out by heating 800 gm of water with 800 gm of these briquettes. It took only 1.5 minutes to boil the water while using wood charcoal took 6 minutes.

The manufacturing cost is 2.69 Baht/kg. (≈ US$0.20/kg) which is 30% less than wood charcoal. The briquettes are strong and retain their shape for a longer period and also while burning. They are now commercially available in Thailand for domestic and industrial utilization. It is envisaged that the company will be able to find export markets for the briquettes sometime in the future.

For further information, contact Saharatkij International Import-Export Co., Ltd., 173 Vipa Vadee Rungsit Road, Soi Chokchairuammitr, Bangkok 10900. Tel. 277-0932.

Chopping of fresh water hyacinth.





Water hyacinth briquettes are being dried by sun drying.

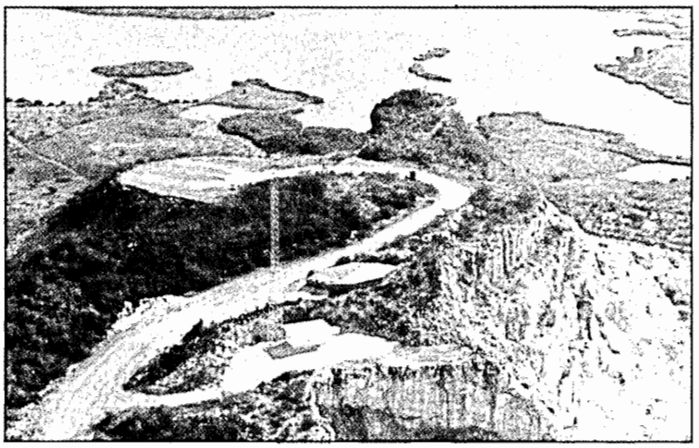
yard manure treatment.

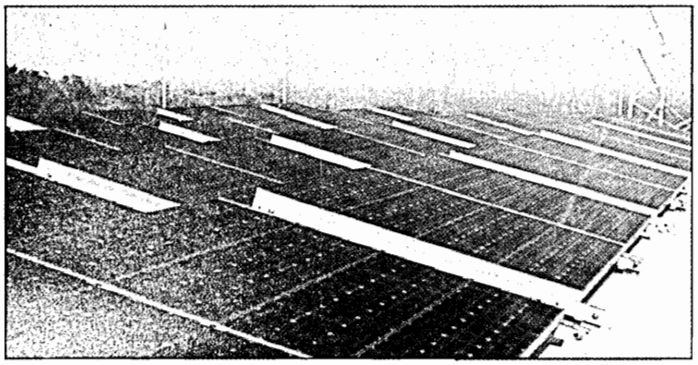
The economic viability of a biogas plant also depends upon the optimum use of slurry. With this in mind field demonstrations of different methods for storage and application of biogas slurry in combination with chemical fertilizers are organized under the National Project for Biogas Development sometimes in combination with Users Training Courses to draw farmer's attention to the economic benefits from biogas plants in terms of increased agricultural production.

Certain progressive farmers in West Bengal have used biogas slurry for fish culture since 1976. The Central Inland Fisheries Research Institute, Barrackpore has recommended an ideal feed containing equal quantities of mustard oil seed cake, bran and biogas slurry for Singhi, an air breathing cat fish. A yield of 1000 kg of Singhi fish per hectare can be obtained in about 105 days from a diet of slurry and bran mixture of 2:1 ratio.

(Extracted from *Biogas in Asia and the Pacific,* Report of the Regional Expert Consultation on Biogas-Network, Bangkok, Thailand, 28 October – 1 November 1986. Food and Agriculture Organization of the United Nations, Regional Office for Asia and the Pacific (RAPA), Bangkok, 1987).

FM Station Tuned to Solar Electricity—Curacao's Radio Hoyer





Solar electricity provides 100% of power for Radio Hoyer's FM transmission.

Located on top of Tafelberg, the highest hill in eastern Curacao, is Radio Hoyer's FM transmitting tower. What makes the Radio Hoyer FM project especially unique is the power source for the transmission system — 100% solar electricity. "The two commercial FM radio stations that broadcast from this site are the world's first that are fully solar powered," according to Ekke J. Huisman, Marketing Director of Industrial Electronics (Antilles) N.V., an ARCO Solar distributor located in Curacao. Curacao is one of a string of small islands in the Caribbean that make up the Netherlands Antilles.

Radio Hoyer N.V. is a locally owned, 32-year-old company which operates two AM stations (Hoyer I and II), one each for Dutch and Papiamento programming. On March 10, 1984, Radio Hoyer began transmission over the new FM frequencies simultaneously with the AM stations' daytime programming. In the evening, transmissions are split to broadcast two separate FM programms, so that four different Hoyer stations are on the air at one time.

The effective radiated power of each of the two FM stations is 5 kilowatts (horizontal and vertical). With the highly directional antenna system, a transmitter power output of only 300 watts is required for each station.

The photovoltaic (solar electric) system consists of 128 ARCO Solar M53 photovoltaic (PV) modules mounted on an elongated octagon-shaped base. Divided into sixteen panels of eight modules each, the PV array charges a 24-volt battery bank with 72-hour reserve capacity, which allows operation at night and during periods of insufficient sunshine. The two 300 watt FM transmitters and associated equipment operate directly from the 24-volt DC supply.

The station is controlled by a microcomputer designed by Industrial Electronics (Antilles). The computer handles telemetry and control functions and provides accurate battery charging.

A further innovation was the use of large aluminum heat sinks mounted through the building walls to dissipate the heat produced by the power amplifiers. This eliminates the need for conventional air conditioning.

According to Mr. Huisman, the Radio Hoyer FM stations have been in operation for over two years, and the results prove that solar electricity can be used on an economic basis with a very high degree of reliability.

(Source: *ARCO Solar News,* Vol. 6, No. 1 (Summer, 1986), pp. 4-5).

New Photovoltaic Devices Lepcon and Lumeloid

Lepcon and Lumeloid are the two photovoltaic devices which are expected to lower the price of PV power to unheard of levels, according to Gerard Aitken, Chairman of the Board of Phototherm Inc.

Lepcon (light to electricity power conversion) employs an array of submicron size antennas deposited on a glass substrate to pick up sunlight and convert it into high frequency alternating current. A miniature circuit then converts the AC power to DC power so it can be stored in batteries. Regarding degradation problems, it was claimed by Aitken that it lasts forever.

The other photovoltaic device more recently patented is Lumeloid. It is basically a plastic film, much like a polarizing film. In it there is a donor acceptor complex of molecules that directly converts light to electricity with an efficiency in the order of 80%. Some reports claim that this Lumeloid will reduce the cost of PV power from five dollars to one cent per watt. But Lumeloid is restricted in its potential applications by a current lifetime of one year. Aitken, however, expressed confidence that his scientific staff will come up with a way to improve the lifetime of Lumeloid, making it a potential

force in other PV markets.

Patents on these two photovoltaic devices, Lepcon and Lumeloid, have been granted to Dr. Alvin Marks, chief scientist of Phototherm Inc. (Dept. ASE, 14 Columbia Drive Extension, Amhest, NH 03031, USA).

Extracted from "Selling Lepcons and Lumeloids" by Larry N. Stoiaken, *Alternative Sources of Energy*, No. 90, April 1987.

Trends and Developments in Photovoltaic Systems

Current research and development work on photovoltaic systems in most of the leading countries in this field has as its objective the reduction of the manufacturing costs per unit of power for the solar cell panel. It relates to all stages of the manufacturing process, i.e. everything from the production of the basic material to the encapsulation of the solar cells.

To achieve the objective current R&D works include the following:

Simplified processing of silicon

Very pure silicon for semi-conductors (at least 99.999% Si) is obtained by the decomposition of trichlorosilane ($SiHCl_3$) at a temperature of approx. 1100 °C with the aid of an inert gas (e.g. argon). Prior to this, the Si-halogenides undergo several complex chemical purification processes. This method is energy-intensive and very expensive.

Experience has shown that a somewhat lower degree of purity is sufficient for the manufacture of solar cells than that required for semi-conductor purposes (solar-grade Si). Thus, attempts are currently under way to achieve a significant reduction in manufacturing costs through simplification of the purification procedure and improvement of the overall process.

Reduction of production costs for monocrystalline Silicon

Up to now, the monocrystals for semiconductors have been produced either by zone-melting the metallic Si in a vacuum or by drawing monocrystals out of molten silicon. These processes require a great deal of highly sophisticated equipment and are very energy-intensive. A large number of new processes are currently being tested; of these, the conversion of polycrystalline silicon strips by means of heating and re-crystallization into monocrystals seems most promising (Motorola).

The utilization of polycrystalline silicon

The manufacture of polycrystalline silicon is a less complicated process than the production of monocrystals. The lower efficiency of the cells (8-18%) must be compensated for by reduced costs. Polycrystalline silicon is produced by casting. The bar is subsequently sliced into very thin chips (20-30μ) which are affixed to a supporting plate (graphite).

The utilization of amorphous silicon

At present, solar cell production methods utilizing amorphous silicon are still in the development stage. So far, efficiencies of approximately 5-6% have been achieved in laboratory tests. These values cannot yet be realized in commercial-scale production. Amorphous silicon can be obtained by means of the direct decomposition of hydrosilicon in a luminous discharge and is affixed to a supporting plate (glass, plastic, metal) through a process of evaporation.

Other basic materials

Cadmium sulphide (CdS) is of particular interest in this connection. Solar cells made of a compound of CdS/Cu_2S have a theoretical efficiency of 16%. Since CdS has good light-absorption properties, thicknesses of 8-10 μ are sufficient. The CdS cell can be produced on a suitable supporting plate (glass) by a process of evaporation. The cell is then briefly dipped in copper chloride in order to apply the Cu_2S layer and subsequently encapsulated. Efficiencies of up to 6.7% can be achieved with cells of this type. In addition, continuous processes for the production of the cells in strip form are currently being tested.

Utilization of the cadmium technology is restricted by the high toxicity and limited availability of this element.

Less expensive methods of encapsulation

Current research efforts are directed at finding less expensive materials which are suitable for use in encapsulating solar cells. The plastics which are currently in use are more or less hygroscopic; thus, after a certain time, the material becomes opaque and this leads to a limitation of its light transmissivity. While glass does not have these drawbacks, a further reduction in production costs is feasible only to a very limited degree.

(Extracted from *Solar Energy-Status Report*, German Appropriate Technology Exchange (Deutsches Zentrum fur Entwicklungstechnologien), Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) GmbH, Eschborn, 1986.

Wind Turbine Marketing Strategy of Yamaha, Japan

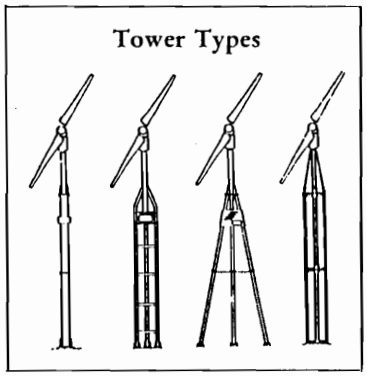
Yamaha Motor Co. Ltd. is marketing a mini wind turbine for use as an eye-catching centrepiece in shopping centres, playgrounds, parks and other areas open to the public.

Not only will the public come to regard wind turbines as machines of aesthetic beauty; but they will also learn that the structure has utility, explains the world's largest manufacturer of motorcycles.

Since August 1981, Yamaha has been a member of the Japanese Sunshine Project, a long term study of wind energy sponsored by the Ministry of International Trade and Industry (MITI). The project, managed by the New Energy Development Organization (NEDO), aims to develop wind energy as a viable source of alternative power for use in Japan.

In March 1982, Yamaha delivered a prototype wind energy generator to MITI's Industrial Research Institute and a year later the company produced a hybrid wind/solar generator. The prototype was erected at Yamaha's plant in Shizuoka Prefecture, south of Tokyo. A number of similar hybrid generators are now found across Japan, including one at Niigata University.

More recently, Yamaha was commissioned by NEDO to develop a 100 kW generator for commercial use. The five year project is still in its early developmental stage and Yamaha researchers are reluctant to discuss the state of their studies.



However, Yamaha has used the expertise it gained from participation in the Sunshine Project to develop a line of small scale, wind generators which are now available on a commercial basis. The Yamaha WT600D was developed two years ago and is now undergoing full scale marketing as an attention-getting device for use in public areas. Yamaha is promoting the machine as a "monument" designed to attract people to areas where it is on display. Its dual function as a structure of use and beauty is seen as an important promotional feature.

The WT600D has a variety of tower configurations, depending on the user requirements and local conditions. Four models are available, including tubular and latticed towers. It has a tilt down collapsible tower which can be lowered to the ground for easy access during maintenance checks. This allows the structure to be lowered should bad weather, such as the strong typhoons experienced in Japan, threaten the stability of the ten metre tower.

The device has six metre glass-fibre reinforced polyester blades, a pitch control system developed by Yamaha and a mechanical governer to control rpm and ensure a stable energy supply. An azimuthal control allows a 360 degree free yaw so that the turbine can swing into the wind from any quarter. The self-starting DC generator has a rated output of 1 kW at 1,800 rpm and the WT600D is considered to have a low cut-in speed and a wide range of wind speeds in which it can operate. Power generation starts at 3.5 m/s and rated output is achieved at 6 m/s.

Like the device itself, plans for the WT600D remain small scale. Yamaha has a sales target of about 40 units and already a number of machines have been exported. The system is being marketed for 4.3 million yen (US$31,000).

(Source: *Windpower Monthly,* June 1987).

Recent Wind Activities in the Netherlands

Bouma Windenergie of Heerhugowaard, Holland has received an order from the Egyptian Ministry of Defense to deliver five wind turbines and five diesel sets, rated at 200 kW each. The system was scheduled to be operational in January 1987. Bouma is delivering a modified 20 meter unit, with the rotor diameter increased to 25 meters so as to increase the output at locations with average wind speeds of less than 5.5 m/s. Dynaf of Alkmaar, Holland is supplying the diesel engines. ECN of Petten, Holland consulted on the design of the project, which may be expanded to include 20 more wind-diesel sets if the first phase is judged successful.

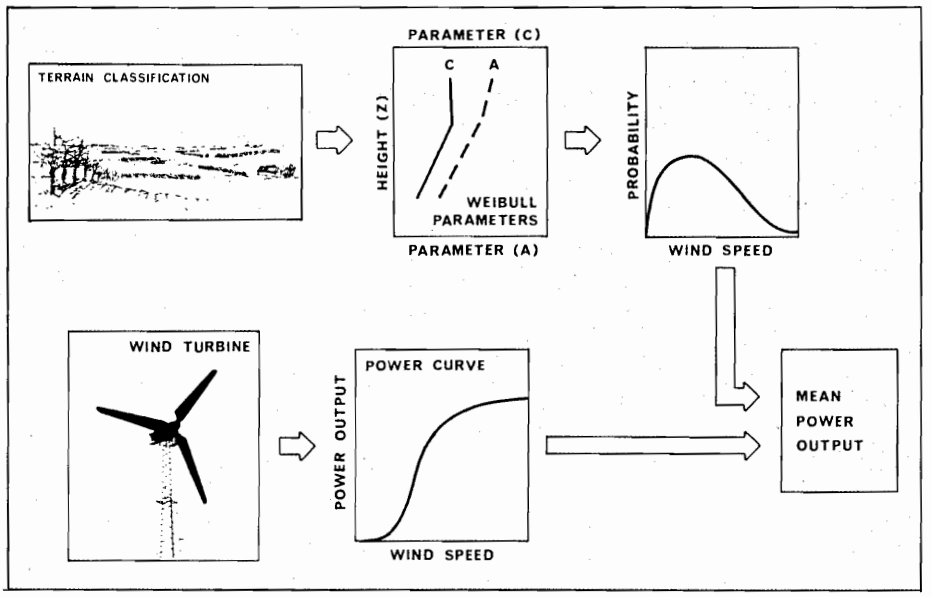
Bouma has also received a provisional order from PEN, the Dutch provincial utility, to deliver eighteen 20 meter wind turbines for a wind generating facility to be installed near Den Helder. Construction was scheduled to begin in September 1986, but was delayed due to objections raised by the Helicopter Division of KLM and NAM, the Dutch oil company. The latter expressed concern that, in an accident, a rotor on a wind turbine could damage their storage drums and distribution lines.

Government Programs

The completion of a pilot wind-farm — to be financed by the Dutch Ministry of Economic Affairs and the cooperating utility, SEP — at

Interactive Personal Computer Programme for Wind Turbine Siting

The Department of Meteorology and Wind Energy at Riso National Laboratory has recently made available to the public a computer programme designed for the calculation of wind conditions on specific sites. The programme has been developed by the same group of people that worked out the Danish Wind Atlas and currently is finalizing the European Wind Atlas.



Sketch of procedures in calculating the mean energy production from a given wind turbine at a specific site.

Purpose

Wind turbine siting calls for models and calculation procedures to describe the wind profile near the ground, the effect of different surface roughness conditions, sheltering effects due to nearby buildings and flow modification due to specific terrain characteristics. The computer programme thus provides the user with a valuable basis for the calculation of the output produced by a specific type of wind turbine on any specific location.

Interactive PC-programme

The work with the Danish and the European Wind Atlases has promoted the development of both new calculation methods and the adaption of existing methods related to the special wind energy requirements. Due to the introduction of the easy-to-use interactive PC-programme, these methods are now available for both professionals and non-professionals working with wind energy.

The programme is very user-friendly, using screen menus with keywords that interactively guide the user. The programme constitutes a complete analysis and application package. Using the transformation methods based on the methods used in the Danish and the European Wind Atlases, the wind-climatological data available can be transformed into regional "wind-atlases".

Such data can be the users' own data or general climatological data. Thus, the programme can directly be used with data from the Danish and the European Wind Atlases and corresponding data collections for other countries — including the U.S.A.

For detailed siting, the programme allows the user to specify any number of complications in the form of terrain inhomogeneities,

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Sexbieruum in the province of Friesland, has also been delayed. The supplier of the 18 wind turbines, TCR (formerly Polenko) has declared bankruptcy. The towers and steel blades were already completed for the project. The Holec company is taking over construction of the drive trains for the project, which is now expected to be operational by mid-1987.

To date, numerous projects within the framework of the government's "Integral Plan for Windenergy" (IPW) have been submitted to the Dutch government for funding, including some 40 different types of wind turbines (about 10 of which are of non-Dutch manufacture). However, none of these turbines has been certified by the ECN yet. Many of the Dutch-designed units are still in the design stage. The Dutch government is now requesting that all wind turbine manufacturers submit data concerning their progress in designing, building, and testing their products. If a design is considered satisfactory, the maximum government subsidy granted will be Dfl 700 per installed kilowatt of capacity, although according to the rules, this subsidy was only applicable in 1986, for certified designs.

The provincial utility, Yssel Centrale at Zwolle has announced a plan to install a wind project outside the dike of the NO-polder. The proposed project would consist of 25 turbines made by HMZ. Since HMZ is a Belgium-based enterprise, some of the Dutch manufacturers have raised objections to the plan. However, the blades for the HMZ turbines are supplied by Stork Ventilatoren of Holland.

(Source: *Alternative Sources of Energy*, January 1987).

Energy Banking Finally Underway in India

Tamil Nadu in southern India is the first Indian state to put the country's much discussed energy banking plans into effect.

The state utility, Tamil Nadu Electricity Board (TNEB), is perennially dogged by power shortages in spite of allotting a hefty percentage of the annual state budget for the production of power. With the declaration of the terms of the energy banking system a much needed boost has been given to the wind power industry in India.

According to TNEB, consumers with their own generating capacity of 500 kW and above will be entitled to bank the energy they generate with the utility; this energy can then be withdrawn in times of power cuts. The banking period will always be a 12 month period, running from October 1 to September 30 of the following year.

Under this scheme, energy generated by the consumer will be quantified and credited to his account during what is somewhat pessimistically termed "non-power cut periods." In return the consumer will receive an uninterrupted power supply during power cuts, limited to the number of units he generates.

Meters will be installed at the consumer's cost to determine the total energy generated, and the percentage generated during peak hours. Power units generated by power plants owned by non-continuous process industry during peak hours will not be considered for banking. This restriction does not apply to continuous process industries which are bound by law to receive an uninterrupted power supply.

All energy banked by power-generating consumers will be stored in a hydro electric reservoir and correspondingly less water will be drawn for power. When there is a surplus in the reservoir, the units banked by consumers will be wiped out, until reserve drop to the required levels in proportion to the energy stored by respective consumers on that date. Two per cent of the total energy banked will be

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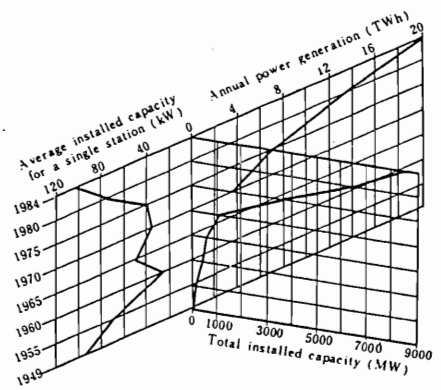
Small Hydropower Development in China

Edited by Scientific and Technical Information Institute and Development of Rural Electrification, Ministry of Water Resources and Electric Power.

In December 1983, the State Council approved and released the "Report on Vigorous Development of Small Hydropower Generation to Build Pilot Counties with Chinese Characteristics of Rural Electrification", submitted by the Ministry of Water Resources and Electric Power. Subsequently, 100 counties were selected for pioneering rural electrification on a trial basis and good results were achieved through the construction of small hydropower stations.

By 1984, the total number of small hydropower stations completed in China had reached over 74,000 with a total installed capacity of 9,060 MW, capable of producing 20.8 TWh of electrical energy annually. All these constitute a good foundation for rural electrification. Presently in China, 1,574 counties have set up small hydropower stations and among them 770 counties rely mainly on these small hydropower stations for their electricity. Many counties have also established their own rural power grids mainly fed by small hydropower. Electrical energy from this source is principally used on county- and village-run industries, irrigation and drainage, household lighting, processing of farm and sideline products, etc. In a number of counties, seasonal electrical energy has been utilized for tea processing plants, tobacco curing, smelting iron alloy, etc. Electricity services are also available to 300,000 farmer households for operating electric kitchenwares.



Status of small hydropower development in China.

The main tasks of rural electrification in the coming years will be, first of all, to provide electricity to all those farmers who have no electricity at their service, and at the same time, to supply more electrical energy to the original farmer customers. This will help to promote the modernization of agriculture through rural electrification.

The publication "Small Hydropower Development in China" is a useful information source for overseas readers. It contains information on small hydropower resources, layout of small hydropower stations with some technical data, development, planning, economic and policy aspects of small hydropower in China.

The publication was published in 1986 by China Water Resources and Electric Power Press, 6 Sanlihe Road, Beijing, China.

Energy Information Service, CSIRO

The *Energy Information Service* is the new name for CRRERIS (Commonwealth Regional Renewable Energy Resources Information Service). Our interests are in energy management, energy conservation, pricing, supply and the renewables. The Energy Information Service is based at CSIRO (Commonwealth Scientific and Industrial Research Organisation) in Melbourne, Australia.

Major activities are publication of the *Renewable Energy Index*, the *Renewable Energy Directory* and occasional special reports; enquiry answering services and training. These are provided free to developing member countries, under funding arrangements with the Australian Development Assistance Bureau and the Industrial Development Unit of the Commonwealth Secretariat, through the Commonwealth Fund for Technical Co-operation.

Revenue-based services for industry, developed countries, and other users supplement the development funding.

The names and addresses of Contact Points in member countries are listed below. You should write to the Contact Point in your country to obtain Energy Information Service publications and other requirements. From other countries write to Mr. A. Carter, Manager, Energy Information Service, CSIRO, P.O. Box 89, East Melbourne, Victoria, Australia 3002.

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Ministry of Lands, Energy and Mineral Resources
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Global Energy Centre,
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Ministry of Works and Energy
P.O. Box 498, Betio, TARAWA,
KIRIBATI

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Australian Education Programs for Renewable Energy Industry

An Australia-wide program of technical training in energy management and renewable energies is being implemented. The objective is to provide training in the occupational skills required for design, installation and maintenance of renewable energy systems. This will augment the promotion and use of non-conventional energy systems, provide employment and help develop renewable energy industries.

Who is it for?

The courses are intended for students aiming to acquire a recognised qualification as tradespeople, technicians and supervisors. These include plumbers, electricians, salespersons, technical support staff, engineering/construction managers and consultants. A Certificate course prepares students for employment requiring a range of skills up to that needed by a tradesperson. For an Advanced Certificate there is a course of study satisfying the needs of a trade technician or a trade supervisor. The Associate Diploma course covers specialist skills leading to employment in higher technical and paraprofessional fields.

Course Content

Seven major study areas have been identified:

General awareness
Solar water heating
Stand alone power systems
Energy efficient buildings
Energy management
Solar heating
Biomass

Essential units of study for each area will be drawn from plumbing, electrical, electronics, mechanical, building, architecture, applied science and rural disciplines.

Detailed resource material has been developed, including study outlines, reference texts, related government and industry contracts.

Major occupational skills to be studied include:

Design/sizing
Installation
Supervision
Maintenance
Testing
Commissioning
Monitoring
Economic analysis
Use of codes and standards
Customer relations
Pricing
Marketing
Industrial relations
Business management

The new courses supplement existing trade and technical training as far as possible. Selected units of study can also be offered to specific client groups.

Who runs the courses?

The courses are being provided by Australian Colleges of Technical and Further Education (TAFE). Course development is the responsibility of TAFE in Queensland and the first study programmes are being offered in Queensland and Victoria.

Interactive Personal Computer Programme for Wind Turbine Siting

From P. 9

sheltering obstacles and the terrain height differences around the site considered.

Wind turbine siting

The programme offers the necessary tools for detailed siting of wind turbines. The calculations supply information on the mean wind speed, on the mean energy which is expected to be generated and on the so-called Weibull distribution. Furthermore, the following pieces of information on 12 different wind direction sectors are supplied: frequency, available turbulence intensity, wind decrease due to shelter, and the influence of different topographical features.

Model for complex terrain

The programme contains a sophisticated flow model which can handle flow over hills and more complex terrain. The user enters the height description directly from a map by tracing height contour lines. The user then specifies his particular point of interest within the area in question and the programme calculates the speed-up or retardation of wind speed and the computed wind statistics.

Purchase and further information

The programme is sold on floppy disks and can be used directly on IBM personal computers and IBM compatible machines. The disk also contains the basic data from the Danish Wind Atlas and will be extended with corresponding data from the European Wind Atlas later on. The price of the programme, the users' manual and a two year subscription including two updatings is DKK 9,875 (US$ 1,400). The programme is distributed by Centec Business Consultants at the address given below who also will be ready to supply further information and more detailed material.

Centec Business Consultants
7, Falkoner Alle
P.O. Box 95
DK-2000 Frederiksberg
Denmark.

(Source: Wind Data Computer Programme, Sales Brochure, Department of Meteorology and Wind Energy, Riso National Laboratory, Denmark.)

The Australian Council on Tertiary Awards as well as numerous educators, government and industry representatives have contributed to the project. The Energy Information Service is involved in its role as a national source of energy management and renewable energy information.

Further information

Details on the project and course content should be sought from:
Mr. T. Knobel,
Convener, Application of Renewable Energy Technologies,
Division of Technical and Further Education,
Department of Education,
P.O. Bag 3,
South Brisbane, Queensland 4101
Australia.

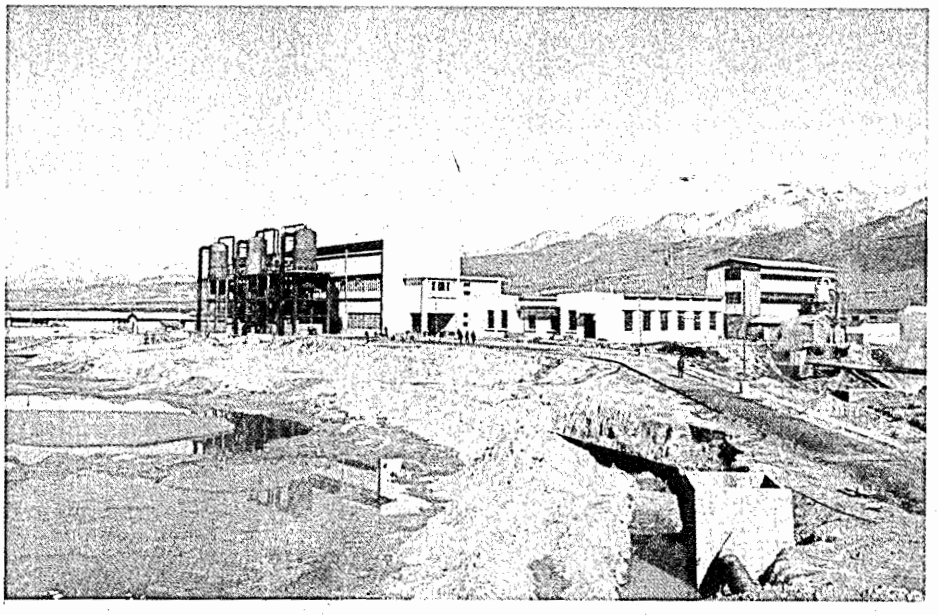
For implementation of the courses contact
Mr Knobel or:
Mr. P. Featherstone
Preston College of TAFE
St Georges Road
Preston, Victoria 3072
Australia

The Preston College of TAFE adapted some of the material for a special Remote Area Power Technology Course, held in May 1987. This course for technicians and technologists from developing countries was sponsored by the Commonwealth Science Council.

The objective of the course was to give participants the necessary background to be able to carry out viability assessment, installation and maintenance of projects upon their return home. Attendees to the course originated from India, Fiji, Malaysia, Papua New Guinea, Tonga, Solomon Islands, Tuvalu and Bangladesh. Main topics covered during the course included: photovoltaics for lighting and communications; microhydro and wind power systems; hybrid power systems; solar water heating; and battery technology.

(Prepared by Andrew Carter, Manager, Energy Information Service, with advice from Mr. T. Knobel and Mr. P. Featherstone).

Geothermal Power Plants in China



Yangbajing Geothermal Power Plant in Tibet, capacity 10 MW.

Geothermal power resources are comparatively abundant in China. More than two thousand hot spring outcrops and other geothermal sites have been discovered. These can generally be classified into two categories according to the state of geothermal fluids, i.e. wet steam or medium and low temperature hot water. Wet steam resources exist mainly in Tibet, Yunnan and Taiwan, while medium and low temperature hot water resources spread over the whole country, and are particularly abundant in Guangdong, Fujian, Jiangxi, Hunan provinces and Liaodong Peninsula. But exploitation and utilization of geothermal resources are still in the initial stage.

A pilot geothermal power plant, currently the largest geothermal power plant in China, has been built at Yangbajing in Tibet, utilizing 145°C wet steam. In 1985, three 3 000 kW and one 1 000 kW generation sets were installed, with a total capacity of 10 MW. New technologies such as double flash cycle system and mixed pressure turbines were incorporated in its design. The plant supplies electricity to the city of Lhasa. In the meantime, the plant will provide opportunities for carrying out research and experimental works in the fields of corrosion and scaling prevention of equipment, reinjection techniques, utilization of exhaust hot water, etc.

Experimental hot water type geothermal power plants have been built also in Hebei, Guangdong, Liaoning and Hunan provinces, utilizing hot water at a temperature of about 100°C. Some of them employ flash cycles, and others employ binary cycles.

(Source: *Electric Power Industry in China 1984-1985*, Scientific and Technical Information Institute, China Ministry of Water Resources and Electric Power, Beijing, 1986, pp. 36-37).

AT Source—A Quarterly Periodical on Appropriate Technology

AT Source, formerly *Vraagbaak*, is an independant periodical, dedicated to spreading information on appropriate technology for improving the position of under-privileged people in Third World countries. It contains practical information about agricultural, technical and health related topics, including their social implications. *AT Source* finds its readers mainly among development aid workers in a small-scale setting.

In 1987 *AT Source* celebrates her 15th anniversary. Therefore it was decided to publish a special issue. This jubilee issue, published both in English and French, contains 10 articles which have been selected from the volumes which appeared in Dutch in the period 1972 till 1984. These articles were translated and rearranged to meet present-day requirements.

Subjects covered are: energy from water, infant nourishment, natural crop protection without pesticides and preservation of timber.

The editorial board consists of representatives of AGROMISA, ATOL, CICAT, CMP, TOOL, TWO and WOT. An important activity of these organisations is to provide answers to specific technical and social questions, sent by people working in the field.

For further details please contact the following organizations:
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  Belgium
- TOOL
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  1018 AD Amsterdam
  The Netherlands

ASEAN Energy Demand Trends and Structural Change

By Ang Beng Wah
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Heng Mui Keng Terrace, Pasir Panjang
Singapore 0511

Energy demand is one of the most difficult energy areas to study in developing countries because of the paucity of good data. It is, therefore, not surprising that current understanding of energy use in developing countries is fairly limited compared to that for the industrialized world. Yet knowledge of the structure and the mechanisms of change in energy use is crucial to energy planning and policy formulation. In particular, it assists planners and policy makers in assessing future energy requirements, fuel substitution, and policies for energy production, use and conservation.

As a contribution to energy demand studies in developing countries, this book deals with how energy has been used in five ASEAN countries, namely, Indonesia, Malaysia, the Philippines, Singapore and Thailand. It concentrates on four major aspects of energy use: trends in commercial energy consumption, energy demand and economic growth, non-commercial energy use, and energy consumption by end-use. The analysis is based on energy data collected from sources which are highly scattered and uncoordinated. One main objective is to provide a description of the changes in the structure of energy demand that accompany the growth of these economies and to analyse their interactions. Another objective is to make inter-country comparisons to identify systematic differences in energy use. By accounting energy demand in a harmonized manner, this book is able to provide a consistent picture of the mechanisms of change in energy use in these countries.

This publication entitled *ASEAN Energy Demand: Trends and Structural Change* (1986, 156 p., ISBN 9971-988-43-7 (hard cover), ISBN 9971-988-56-9 (soft cover)) is available from the Institute of Southeast Asian Studies at US$12.00 (soft cover) and US$20.00 (hard cover).

Energy Banking Finally Underway in India

From P. 10

taken by TNEB as banker's commission.

According to the terms of this proposal, consumers with the ability to generate their own electricity will be able to sell surplus power banked with TNEB to any other consumers through TNEB's grid. Two per cent of this energy sold will be taken as banker's commission in addition to the previous commission referred to above.

If the energy banked is not used before September 30 of the following banking period, it will be treated as lapsed and no claim on it can be made. It is worth noting that financial transactions between private generators and the state utility are not a part of this ingenuously devised scheme.

Tamil Nadu hosts a 550 kW windfarm at Tuticorin which was paid for by the Central Government. The ten, 55 kW machines cost Rps. 7.5 million (US$600,000). On top of this came installation costs, including purchase of the site, which worked out at Rps. 2.7 million (US$216,000) and were borne by the TNEB utility.

Sources at TNEB point out that a 1 MW thermal project recently commissioned in the state, cost a total of Rps. 10 million (US$-800,000) — exactly half that of a

windfarm of equal capacity. In their estimation, based on the present turbines' efficiency factor, wind power would be economically viable if it could be bought at Rps. 2/kWh (US$0.16). This is exactly double the highest rate they presently charge the consumer.

However, TNEB does have plans to set up wind turbines on sites which have higher proven wind speeds than Tuticorin, using higher capacity machines. A step which could well result in a dramatic reduction of Tamil Nadu's wind generated kilowatt hour tariff.

(Source: *Windpower Monthly*, May 1987).

Publications Received

- *Rural Energy Information System (REIS), Rural Energy Research Projects, Collaborating Scientists, Institutions and Countries 1983-1985*, CNRE/REIS Report No. 1, Food and Agriculture Organization of the United Nations, 152 p.+Appendix, 1985.
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- *Annual Report 1985-86*, Pakistan Council of Scientific and Industrial Research, Karachi, Pakistan, xi+95 p., 1986.
- *Annual Report 1985*, Ceylon Electricity Board, Sri Lanka, 86 p.
- *User Evaluation of Photovoltaic Powered Vaccine Refrigerator/Freezer Systems*, A.F. Ratajczak, National Aeronautics and Space Administration, Lewis Research Center, USA, March 1987, 72 p.
  Available from:
  National Technical Information Service
  U.S. Department of Commerce
  5285 Port Royal Road
  Springfield, VA 22161
  U.S.A.
- * *Common Accounting Procedures for Assessing Biomass Resources in Developing Countries*, Proceedings of Working Groups Workshop, London, U.K., 14-18 April 1986, CSC Technical Publication Series No. 195, 67 p., July 1986.
- * *Caribbean Energy Information System, An Assessment of the Resources and Needs of the Participating Countries: A Mission Report*, H. Lowe, M. Whyte, and C. Jackson, CSC Technical Publication Series No. 219, vi+93 p., May 1987.
- * *Biomass Resources Assessment, A Survey of Sierra Leone's Energy Potential from Agricultural and Forestry Wastes: Phase II, Economic Value and Supply Potential of Rice Residues in Sierra Leone*, J.G.M. Massaquoi, CSC Technical Publication Series No. 220, xiv+66 p., October 1986.

* These publications are available from:
Commonwealth Science Council
Marlborough House
Pall Mall
London SE1Y 5HX
United Kingdom

Diary of Events

- August 10 — September 18, 1987, Department of Engineering, University of Reading, Reading, U.K.

Short Training Course on the Design, Construction and Testing of Wind-pumps

The course covers all aspects of wind-pump selection design, construction and testing. It has been planned to provide both theoretical and practical training to engineers and agriculturists concerned with the setting up of wind-pumping projects in rural areas. The Reading University team has worked in this field for more than 12 years and has both design experience and field experience in a number of countries.

Course contents include: Resource analysis; Wind data analysis; Basic hydrology; Human resource; Water requirement; Systems components design; Rotor; Transmission; Pump; Tower; Control; Storage; System interaction; Pump/rotor matching; Optimizing starting; Water source matching; and Wind availability.

Computer Aided Design (CAD) software will assist the participants to optimize the design performance. No previous knowledge of computing is necessary. The language of the course is English.

The course is intended for engineers and agriculturists of graduate or equivalent level.

Course fee will be £1,000. In addition, participants will require a subsistence allowance to cover accommodation plus living expenses in the UK for six weeks plus return travel to UK.

Further details can be obtained from:
Ms. J. Clancy, Department of Engineering, P.O. Box 225, University of Reading, Reading RG6 2AY, UK.

- August 17-18, 1987, Portland, OR, USA

Small Scale Hydropower Development: Planning, Feasibility and Design

For details contact:
Jan Becker
Professional Development and Conference Service
University of Minnesota
315 Pillsbury Dr. SE., Minneapolis
MN 55455, USA
Tel: (612) 626-1358

- September 1-4, 1987, Copenhagen, Denmark

International Symposium on Energy Savings — Focusing on Electricity Savings

For details contact:
Danske Elvaerkers Forening
Rosenorns Alle 9
DK-1970 Frederiksberg C.
Denmark

- **September 4-5, 1987, Sukhadia University, Udaipur, India**

Fourth Convention & Symposium of the Bio-Energy Society of India

The Fourth Convention and Symposium of the Bio-Energy Society of India is being organized by the Rajasthan Local Chapter of the Society with the focal theme "Bioenergy for Arid Regions". The technical sessions will cover the following broad areas:

(1) Production and Availability of Biomass
  (i) Bioenergy Scenario and Assessment Techniques
  (ii) Fuelwood Production and Improvement
  (iii) Petrocrops
(2) Conversion and Utilization of Biomass
  (i) Solid Fuels
  (ii) Liquid Fuels
  (iii) Gasification
  (iv) Biogas
  (v) Hydrogen Energy
  (vi) Single Cell Protein/Microbial Products
  (vii) Waste Recycling for Rural Development
  (viii) Power Generation
(3) Special Topics
  (i) Bioenergy for Arid Regions
  (ii) Bioenergy
  (iii) Bioenergy Information
  (iv) Bioenergy Extension

Those interested in contributing papers may contact:

Dr. O.P. Vimal
Hon. Secretary
Bio-Energy Society of India
c/o Department of Non-Conventional Energy Sources
Block No. 14, CGO Complex
Lodi Road
New Delhi-110 003

For arrangements regarding stay, etc. at Udaipur, queries may be addressed to:

Prof. A.N. Mathur
Renewable Energy Scheme
College of Technology & Agricultural Engineering
Sukhadia University
Udaipur-313 001 (Rajasthan)
India

- **September 7-11, 1987, Bangkok, Thailand**

Workshop on Socio-Economic Constraints to Diffusion of New and Renewable Sources Energy Technologies-Utilization of Agricultural Residues

For details contact:

ESCAP
UN Building
Rajdamnern Avenue
Bangkok 10100, Thailand

- **September 14-25, 1987, Miramare-Trieste, Italy.**

Workshop on Economic, Modelling, Planning and Management of Energy

For details contact:

International Centre for Theoretical Physics
Workshop on Economics, Modelling, Planning and Management of Energy
P.O. Box 586
I-34100 Trieste
Italy
Tel: (040) 22401.
Telex: 460392 ICTP I.

- **September 27-30, 1987, Calgary, Alberta, Canada**

Canadian Wind Energy Conference and Exhibition '87

Featuring

- o Small wind turbine workshop
- o Day tour of southern Alberta wind energy installations
- o Annual general meeting of the Canadian Wind Energy Association

Conference Topics

- o The commercial market
- o Project financing
- o Utilities and regulatory issues
- o International affairs
- o Technology developments
- o Mechanical and pumping applications
- o Case studies
- o Hybrid systems
- o Government programs and policies

Who Should Attend

- o Wind energy distributors and manufacturers
- o Ranchers and farmers
- o School and hospital administrators
- o Municipalities
- o Utilities
- o Government

Exhibition

Leading companies and organizations active in renewable energy will be exhibiting their latest information, products and services.

For more information contact:

Conference Coordinator
Nancy Phillips
Passmore Associates International
209-135 York Street
Ottawa, Ontario K1N 5T4, Canada
Tel: (613) 234-3602

- **October 13-15, 1987, Leeuwarden, the Netherlands**

Windpower Europe '87 (International Exhibition and Conference on Windfarm Technology and other Wind Energy Applications)

The International Conference

The conference will be held under the auspices of the European Wind Energy Association (EWEA) and organized in cooperation with the Netherlands Wind Energy Association (NEWIN) and is co-sponsored by the Dutch Ministry of Economic Affairs. Main subjects are: the integration of windfarms into the public power systems/pure technical aspects/legal, financial, environmental and organizational aspects. Excursion(s), film sessions and a social programme will also be organized.

Conference Information:

Holland Organizing Centre
16 Lange Voorhout
2514 EE The Hague/Holland
Tel.: ++31 70 657850
Telex: 33111 hoc nl
Cables: Hocland – The Hague

The International Exhibition

Many companies and institutions from Italy, Belgium, the United Kingdom, Denmark, France, Holland and West Germany have already decided to exhibit at Windpower Europe '87.

Exhibition Information:

Expoconsult
P.O. Box 200
NL 3600 AE Maarssen/Holland
Tel. ++ 31 3465 73777
Telex: 47945 expo nl
Telefax: ++31 3465 73811.

- **November 15-18, 1987, Hyatt Regency Technical Institute, Denver, CO, USA**

Eighth SERI Photovoltaics Advanced Research and Development Project Review Meeting

The Eighth SERI Photovoltaics Advanced Research and Development Project Review Meeting will be sponsored by the Solar Energy Research Institute under contract to the U.S. Department of Energy.

For further information please contact:

Roland Hulstrom
Solar Energy Research Institute
Conference Co-ordination Section
1617 Cole Boulevard
Golden, CO 80401-3393, USA
Tel: (303) 231-1158

RERIC news

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Thermophilic Anaerobic Contact Digestion of Palm Oil Mill Effluent—Pilot Plant Study in Malaysia

The palm oil industry is one of the major agro-based industries in Malaysia whose production accounts for more than 90% of the world export. The industry, however, also generates enormous quantities of liquid waste with high organic load causing serious pollution problems. In view of the high level of organics, anaerobic pretreatment is usually practiced prior to aerobic breakdown. Most of the anaerobic digesters installed at the mills in Malaysia are currently operated under mesophilic conditions. The inherently high temperature of the effluent suggests that thermophilic digestion would bring about a much more effective system.

△ *Palm oil fruits.*
◁ *Thermophilic anaerobic contact digester, pilot plant.*

In cooperation with the Palm Oil Research Institute of Malaysia, the Standards and Industrial Research Institute of Malaysia (SIRIM) has conducted a pilot plant study on thermophilic anaerobic contact digestion of palm oil mill effluent (POME) to determine the efficiency and viability of such a system.

The anaerobic contact digestion system is basically a completely mixed reactor with provision for sludge recycle, to achieve very high bacterial retention time at low hydraulic retention.

The flow diagram of the pilot plant is shown in Fig. 1.

Raw POME transported by a 2-tonne vacuum truck is charged into a 5 m^3 storage tank after being passed through a 2 mm mesh screen basket for the removal of coarse solids in the effluent. A pump feeds POME

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wind and sun compendium
Development of wind and solar energy for water pumping
tool
cwd

Energy Information Service, CSIRO
Incorporates news from the Energy Information Service, CSIRO and Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).
INNERTAP

Thermophilic Anaerobic Contact Digestion of Palm Oil Mill Effluent – Pilot Plant Study in Malaysia

From P. 1

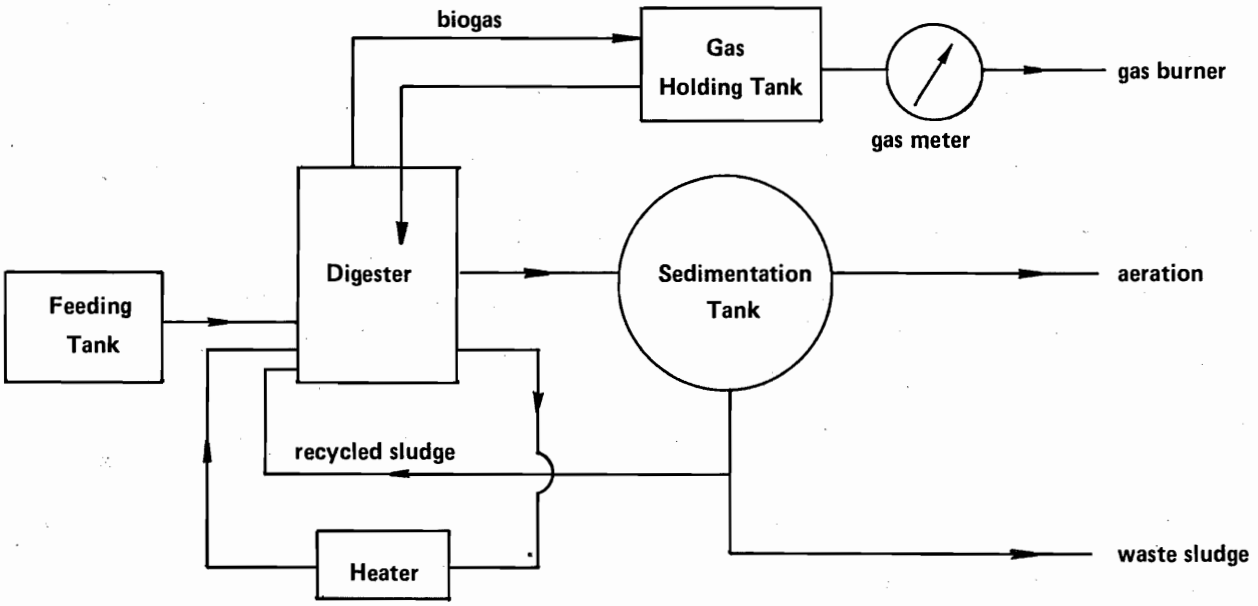


Fig. 1 Flow diagram of the pilot plant

continuously into a 10 m^3 digestion tank.

In the digestion tank, organic matter in POME is digested under anaerobic condition and then sent to a 3 m^3 sedimentation tank whereby the supernatant separates from the concentrated digested sludge. The sludge is recycled into the digester and excess sludge is diverted into the sludge tank.

An indirect heating system using an electric heater is adopted to heat the digested liquor. Agitation and mixing in the digestion tank are achieved by sparking the recirculated biogas.

BOD of the POME used in this study was in the range of 10250-43750 mg/l. Various organic loadings were tried over a temperature range of 45 to 55°C.

Experimental results revealed that at higher temperatures, higher loadings with shorter hydraulic retention time could be tolerated. However, there was no significant difference in gas yield between 45°C and 50°C. Maximum tolerable loading achieved at 45°C digestion temperature was 4.8 kg TS/m^3. day with hydraulic retention time of 6.25 days while that at 50°C was 7.7 kg TS/m^3. day with hydraulic retention time of 4.7 days. Gas yield of between 0.9 to 1.5 m^3 per kg of total solids utilized was achieved with loading of 3 to 5 kg TS/m^3. day. Total volatile solids reduction efficiency was in the range of 72-76%.

Thermophilic anaerobic contact digestion process has been demonstrated to be cost-effective and efficient in biogas production due to the low hydraulic retention time achieved with good gas yields.

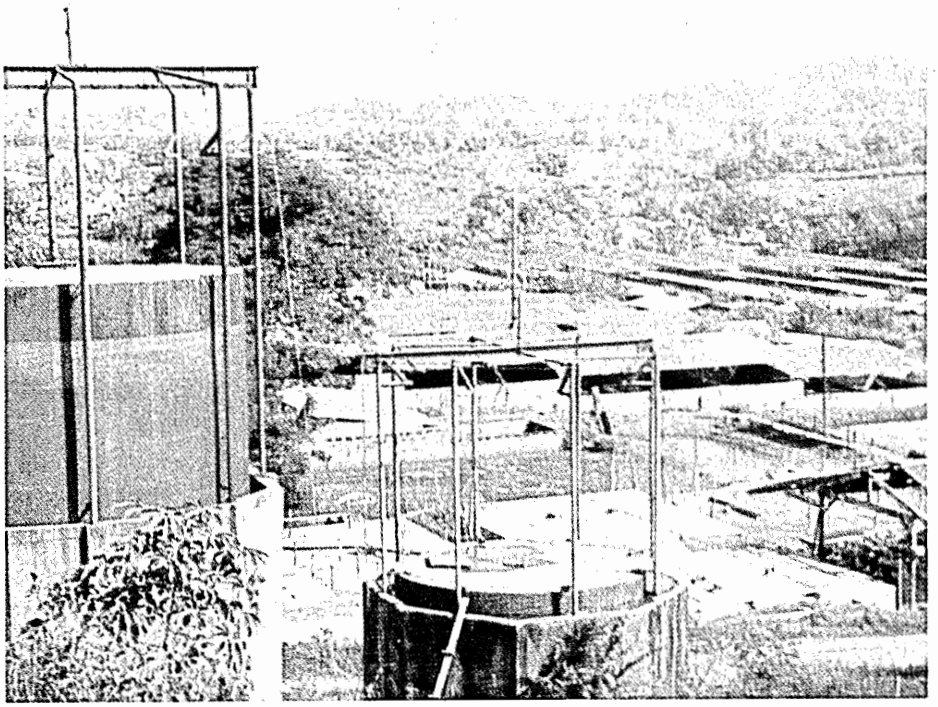
References

1) *Thermophilic Anaerobic Contact Digestion of Palm Oil Mill Effluent*, A. Ibrahim, B.G. Yeoh, S.C. Cheah, A.N.Ma, S. Ahmad, T.Y. Chew, R. Raj, and M.J.A. Wahid, Paper presented at IAWPRC 12th Biennial International Conference on Water Pollution Control, 17-20 September 1984, Amsterdam.

2) *Biogas from Thermophilic Anaerobic Contact Digestion of Palm Oil Mill Effluent*, T.Y. Chew, B.G. Yeoh, R.Raj, S.C. Cheah, A.N. Ma, S. Ahmad, A. Ibrahim and M.J.A. Wahid, Proceedings of the 2nd ASEAN Workshop on Biogas Technology Applied to the Management and Utilization of Food Waste Materials, 8-13 October 1984, Kuala Terengganu, Malaysia, ASEAN Working Group on Food Waste Materials, Malaysia, 1984, pp. 245-265.

3) *Palm Oil Mill Effluent as a Source of Bioenergy*, T.Y. Chew and B.G. Yeoh, Proceedings of National Symposium on Oil Palm By-products for Agrobased Industries, Kuala Lumpur, 5-6 November 1985, Palm Oil Research Institute of Malaysia, pp. 155-168.

Waste-Recycling Biogas Generator for Farm Self-Sufficiency



A panoramic view of one of the biogas units at Maya Farms, in which can be seen the biogas digesters, gasholders and a sludge-conditioning system.

When Maya Farms, a 36-ha integrated livestock-meat processing enterprise located in the outskirts of Metro Manila, Philippines, was established in 1972, its farm waste was disposed of through a conventional lagoon method. Subsequent expansion programmes posed a pollution problem and it was decided to develop a biogas system attuned to local conditions and the specific needs of a major agro-industrial venture (waste disposal, pollution control and fertilizer production). A prototype incorporating features of different existing models, as well as revolutionary concepts, was eventually constructed.

The installation is fed with a slurry comprising manure and waste water which ferments for 20-30 days. The fermented residue exits from the biogas plant in the form of sludge; the solids are collected for use as organic fertilizer and feed material while the sludge liquid goes through a series of sludge-conditioning lagoons to ensure that it is safe for discharge into public waters. The biogas system is now the core of a total waste recycling process which handles not only the total production of manure and waste water but also all the waste products from the slaughterhouses. The biogas operation at Maya Farms currently produces 6,500 m^3 of biogas per day, generating power equivalent to 6,500 kWh of electricity. Biogas fires the burners for the cooking vats, scalding tanks and retorts in the processing plants, and runs the engines which serve as prime movers for various pumps, machines, refrigeration equipment and electricity generating plant.

The digestion process results in sludge with a high concentration of plant and animal nutrients which, when processed, gives a practically odourless, innocuous, humus-like material. The coarse solids are pelletized and used as fertilizer. The fine solids are dried, ground and recycled as feed material in the feedmill. At present, the biogas system at Maya Farms processes daily over 75 tonnes of manure and 1,000 m^3 of wastewater from 50,000 hogs.

After the digestion process the remaining fluid flows through the sludge-conditioning lagoons. Ducks are raised to feed on the scum that forms over the surface of the lagoons together with leftover feed from animal pens. The conditioned liquid passes through a fish pond where it stimulates the growth of algae and plankton which serve as food for the fish. Fish life is also an indicator that the liquid is acceptable for use as fertilizer-irrigation water for the crop fields. This technology is now being disseminated free of charge to small farmers and social institutions, and on-farm training courses have been organized. It has now been decided to use the biogas system as the basis of an integrated farming system aimed at raising the agricultural income of small farmers with limited land resources. A pilot farm using this system is now run by a volunteer family which owns a 1-ha crop field and a 0.2-ha lot for the farmhouse.

Work is also being done to reduce the cost of the biogas plant through design simplification and through the use of alternative construction materials. It is further planned to establish demonstration projects in selected rural communities to propagate the concept.

Source: "A waste-recycling biogas generator for farm self-sufficiency" by F.D. Maramba, in "Spirit of Enterprise, the 1987 Rolex Awards", Montres Rolex S.A., Geneva, 1987. (ISBN 0 7476 0003 1).

Rice Hull Fuelled Power Plant

The Economic Development Foundation (EDF), Philippines, has collaborated with the Bureau of Energy Development (BED) in developing a power generating set fuelled by rice husk suitable for small-scale rice mills in rural areas.

A fluidized-bed combustion system for generating producer gas, originally developed by Ahlstrom of Finland and DUVANT of France, has been adopted. By gasifying biomass materials, the diesel plant is operated to generate electricity through a coupled AC generator. The developed unit consists of a 30kW, 220V, 60HZ power generator set and a gasifier unit.

The use of rice husk as fuel in this plant involves three steps:

- gasification to produce producer gas;
- mechanical power generation in an internal combustion engine; and
- conversion of mechanical power to electric power.

Basically, the process involves feeding dry rice husk into the fluidized-bed reactor where it burns at sub-stoichiometric air fuel ratio to produce carbon monoxide and hydrogen (producer gas). The resulting hot producer gas then passes through a cyclone dust separator and scrubber to remove ash and tar successively. The fluidized-bed reactor is operated at about 1000°C using fine silica sand as the fluidizing-bed. The power plant is fitted to a 6-cylinder diesel engine which consumes the low BTU gas. At 1800 rpm, the engine produces 75 BHP. The gasifier unit consumes about 120 lbs of rice husk per hour and 1 gallon of water per minute for gas cooling and cleaning. The diesel unit also requires pilot fuel at 1-2 L per hr to ignite the gas. The entire plant can be easily fabricated with the locally available materials and fabrication shop facilities. The project cost is estimated at approximately US$-7000 (gasifier system and shed) excluding diesel generating set.

For further details contact: Economic Development Foundation, 7th Floor, Combank Building, 6764 Ayala Avenue, Makati, Metro Manila, Philippines.

Source: Technonet Asia Technology Digest, Jan-Apr 1987.

Nomad Solar Kiln

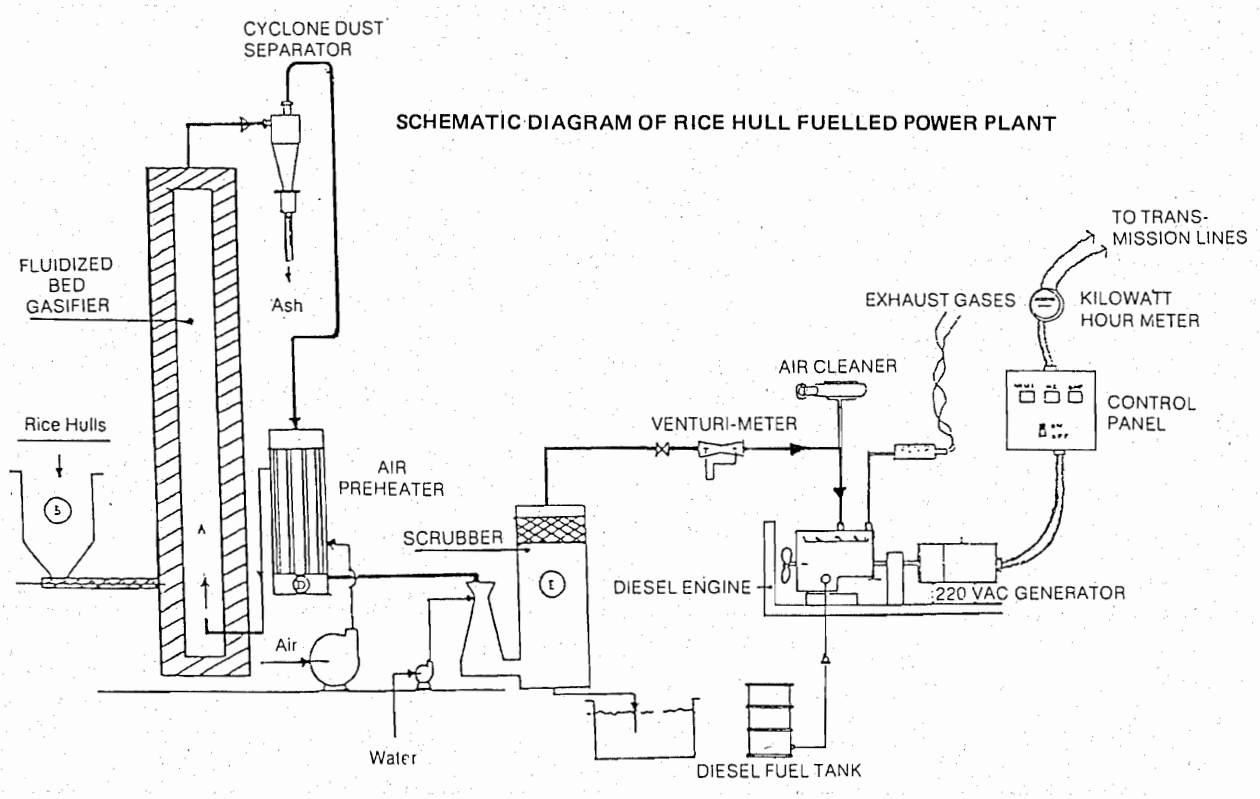
"Nomad Solar Kiln", a solar kiln specifically designed for use in small-scale saw-mills and furniture production centres, is manufactured and commercialized by Cambridge Glasshouse Company Limited, a subsidiary of British Alcan Aluminium plc. This solar kiln was designed based on an original idea from Oxford Forestry Institute with support from the Intermediate Technology Development Group.

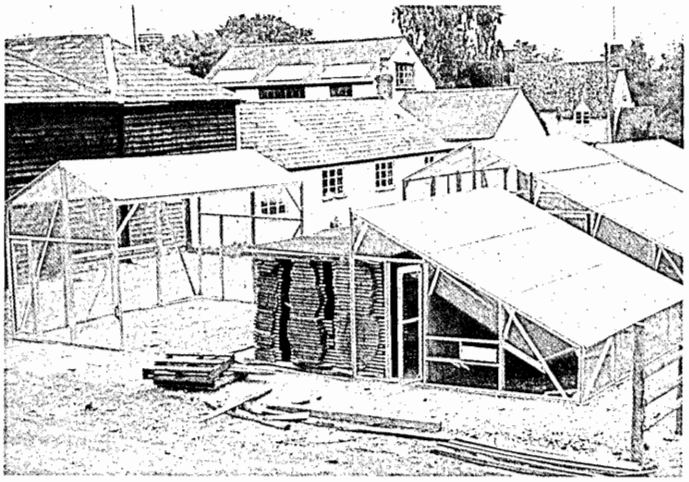
The Nomad Solar Kiln is already being used successfully in Sri Lanka, Malawi, Guyana and Great Britain.

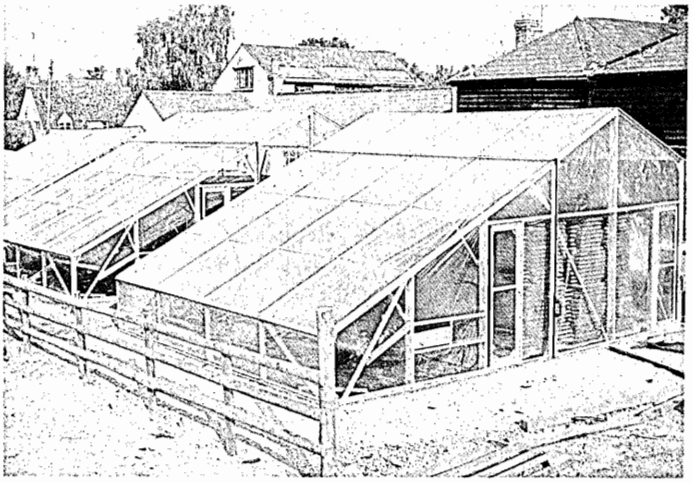
The design was nominated for the International Inventors Award and is featured amongst some of the best 100 innovations.

Completely Portable Design

The "Nomad Solar Kiln" is a portable solar kiln with a 7 m^3 capacity. The kiln is joined in two halves, the front half houses the fan motors and switchgear for air circulation and the back half covers







the timber stack. Both halves have lifting handles and can be easily moved. The two halves clamp together with simply operated "anti-luce" fittings.

The kiln can easily be lifted by as few as four people and placed around an air dried timber stack in a yard, or any level site. This avoids having to move the stack, which without heavy equipment is a long and laborious job.

Construction of the Nomad Solar Kiln

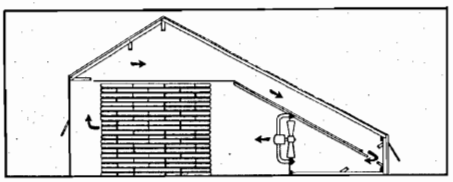
The kiln consists of a sturdy aluminium framework, covered with a polyester glazing film called "Melinex" 071™. The Melinex is attached to the framework by the patented Cambridge "Double X" fixing system for Melinex. This material allows excellent daylight transmission and shows good retention of heat built up in the kiln. Solar heat is absorbed by a false ceiling of sheets of corrugated aluminium or galvanised iron painted matt black and covering an area of 26.8 m^2 (288 ft^2). A fan baffle is also required made from two sheets of plywood in a standard 4-6 mm size. To save on transport costs these weighty and widely available items are not included in the solar kiln kit, however an individual tool kit and comprehensive assembly instructions are included.

The actual dimensions of the kiln are:

Side	– 16' 4 7/8"	(5000mm) nom
Front	– 20' 0"	(6096mm) nom
Low side	– 2' 6"	(762mm) nom
Ridge	– 10' 0"	(3048mm) nom
High side	– 7' 7 3/4"	(2331mm) nom
Door leaf size	– 1' 9 1/4"	(540mm) wide x 5' 5 1/8" (1665mm) high

How the Kiln Works

Short wave radiation passes through the Melinex and is converted to long wave radiation as it reaches the black absorber. It is trapped by the Melinex ensuring transference to the timber stack in the air flow from the fans. Small quantities of air are vented through exhaust vents and fresh air is allowed through inlet vents, removing the moisture produced by water evaporating from the timber. Some of the water removed from the timber condenses on the inside of the roof glazing at night and drips onto the floor, via the absorber panels which protect the timber from getting wet, acting in a similar way to a dehumidifier.



Temperatures during the day rise to a maximum of about 55°C (130°F). This enables drying to 6-8% moisture content in the tropics. Even in the rainy season a moisture content of 10-12% can be achieved.

The rate of drying depends on species and permeability of the wood, the original moisture content of the timber, its thickness and the climate at the time of drying.

Running and Operating Costs

According to the company, the only electricity used is for running the fans. The solar kilns would normally be in operation for 10 hours a day using a maximum of 7.5 kW per day. 240 volt, 50 cycles mains or portable generator power supply can be used.

Labour is needed for stacking and placing the kiln in position. The person supervising the drying operation will need to spend ½ -1 hour a day measuring the moisture content of the wood. However the work is less skilled than it would be in a conventional kiln.

The "Nomad Solar Kiln" has proved to be lower in drying costs per cubic metre sawn than any conventional kiln in all the tropical trials. In both Sri Lanka and Guyana it has proved to be less than two thirds of the cost of conventional kiln drying and to have a low capital input cost.

Further details on the Nomad Solar Kiln can be obtained from:

Cambridge Glasshouse Co. Ltd.
Comberton CAMBRIDGE CB3 7BY
England
Tel: 0223 26 2395.
Telex: 818788.
Facsimile: 0223 26 2713

"Suntrac" Solar Hot Water Systems

Solar Tracking Systems (Australia), a division of Bisley (Qld) Pty. Ltd., has just introduced the all-new TRI-SLIM 320 solar hot water system (Fig. 1) to the Australian market and is now in the process of introducing it abroad. The tracking system sets this solar water heater apart from the others because it tracks the sun from sunrise to sunset by means of a non-electric tracking mechanism, ensuring a continuous supply of hot water. Its water tank is made from corrosion resistant marine grade 444 stainless steel and, most important, the unit has an aesthetically pleasing low roof profile.

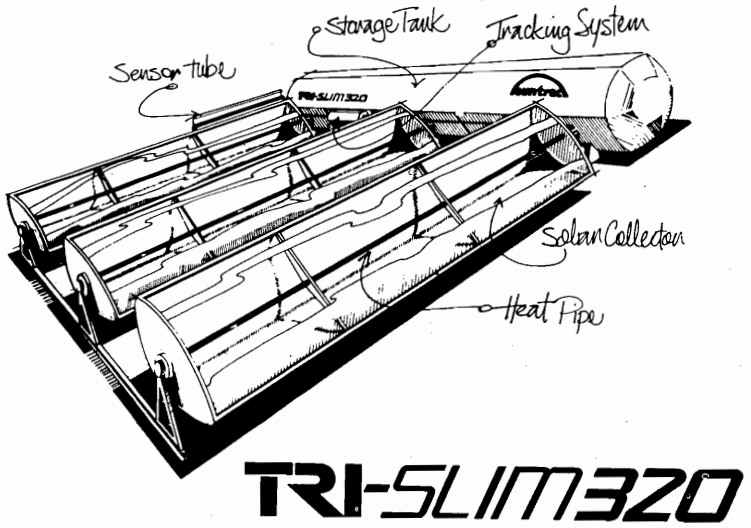


Fig. 1 Suntrac Tri-Slim 320.

Tracking Mechanism

The line focussing parabolic SUNTRAC TRI-SLIM 320 collectors focus 3.9 square metres of the sun's radiation onto the full length of the heat pipes in a manner similar to a magnifying glass. The heat pipes collect this concentrated energy and efficiently transfer it directly into the storage tank.

The heat differential tracking system permits the collectors to follow the sun from sunrise to sunset with accuracy. The tracking system has no electric motors, gears, electronics or solar cells. The principle of operation involved is the use of air expansion and contraction caused by temperature changes. This action in turn triggers water valves connected to a diaphragm. The two air-tight sensor tubes A and B (Fig. 2) are enclosed in a clear plastic tube. They are connected to an air diaphragm C which has a lever to activate the two water valves D and E.

At dawn, the sun's energy heats expansion tube A while expansion tube B remains shaded. The expansion of the air in the tube A moves the diaphragm C to open the right hand water valve D. This allows mains water pressure to enter the water operated ram and set the collectors on focus to the early morning sun. It is by this early morning action that springs on the collectors are tensioned as they turn to the east. When the collectors face the sun directly, both tubes A and B are 50 percent shaded. This equalises the pressure at the diaphragm, closing both valves. As the sun moves to the west it warms the left sensor tube B which moves the diaphragm C to open the left hand water valve E. This allows water to escape from the ram and adjusts the collectors to track the sun until both expansion tubes are equally shaded.

During the day the mechanism steadily tracks the sun. The differential pressure on the diaphragm created by the sun's movement causes a steady transfer of water out of the ram. This continuing process keeps the collectors square on the sun until it sets. The actual tracking power throughout the day has been provided by springs from sunrise to sunset.

Even the early morning and late afternoon sunlight can, in appropriate conditions, be concentrated to temperatures exceeding 100°C, thus adding valuable heat energy to the tank.

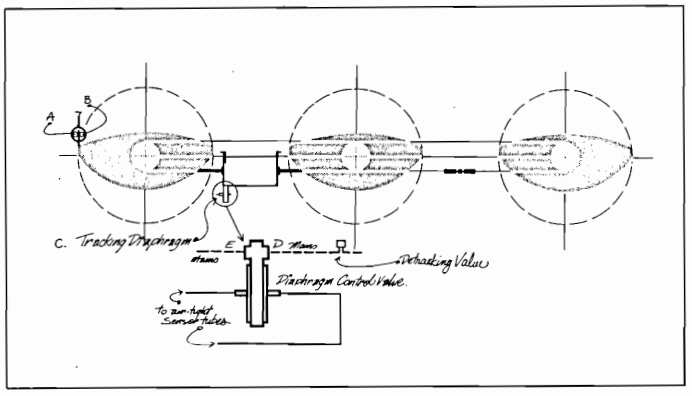


Fig. 2 Tracking mechanism.

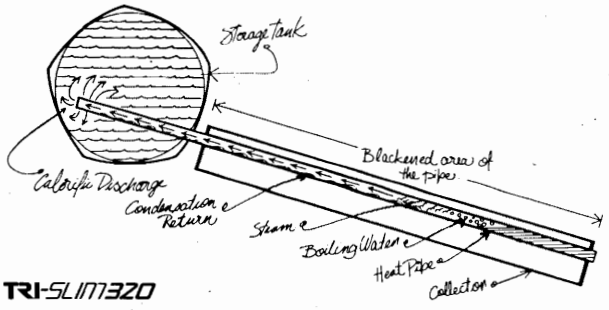


Fig. 3 Heat pipe-principle of operation.

Highlights of the Polycrystalline Thin Film Program Meeting

Lakewood, Colorado, July 20-22, 1987

According to Dr. Harin Ullal, Program Chairman, about 90 people attended the meeting (an all-time high) including 10 foreign representatives from Canada, England, India, Japan and West Germany. Mr. Robert H. (Bud) Annan, Director DOE PV Energy Technology Division gave the keynote address, and gave his impressions on his recent visits to the polycrystalline thin film solar cell industry. Dr. Harold M. (Hub) Hubbard, Director, SERI was the featured lunch time speaker.

The following are the technical highlights of the meeting:

Photon Energy reported on their near one square foot monolithically series-connected thin film CdS/CdTe module, which had an output of 4.3 W that was measured outdoors at SERI. For small area, cell efficiency of 9.7% with high voltage (0.788 V) and good FF (0.68) was reported.

Ametek reported on their novel n-i-p structure (n-CdS/i-CdTe/p-ZnTe). Monolithically series — connected submodule (51 cm^2) had an active area efficiency of 9.3% and a total area efficiency of 6.1%. Further improvements in the module design should reduce the area losses to less than 15%. For small area cells, they have observed V_{oc} = .828 V and FF = 0.75. These are the highest reported V_{oc} and FF for thin film CdTe solar cells.

Southern Methodist University (SMU) reported on their newly developed cell structure, Glass/TC/CdZnS/CdTe/HgTe/Ag with an efficiency of 10.84% for 1 cm^2 thin film solar cell, with HgTe as the new ohmic contact. CdZnS has a bandgap of 2.85 eV, resistivity = 1 ohm-cm with a Zn content of 35%. SMU has also fabricated a highly conductive (10^{-4} ohm-cm) and transparent ZnO made by low temperature MOCVD.

Boeing Electronics Company (BECO) presented data that showed that the uniformity in the current and voltage is + 1% across their high efficiency 9.6% monolithically series-connected 4 cells (91 cm^2) $CuInSe_2$ submodule.

ARCO Solar presented results for their stand-alone $CuInSe_2$ module (9.1%, 835 cm^2) and power output of 7.6 W. For solar cell, J_{sc} of 41.1 mA/cm^2 was reported for cells over 10% efficient.

Institute of Energy Conversion (IEC) proposed an 'n-i-p' model for $CuInSe_2$ devices, emphasizing that a near intrinsic layer may exist near the CdS interface.

International Solar Electric Technology (ISET) has developed the E-beam evaporation method for depositing Mo on glass for $CuInSe_2$ devices. This technique is significantly faster than the conventional sputtering method. ISET also reported on achieving 10.4% on small area $CuInSe_2$ solar cell by electrodeposition and selenization.

SERI in-house researchers presented many stimulating talks on $CuInSe_2$ fundamentals, including a new absorption coefficient (near 5×10^4/cm rather than 10^5/cm), low temperature device measurements, photoemission spectroscopy indicating In_{Cu} as a critical defect influencing doping and oxidation-reduction behavior. Electron and Ion Beam Effects in the analysis of $CuInSe_2$ were also reported. SERI also presented innovative one-step co-electrodeposition of $CuInSe_2$ and early "live" cell results.

Several new ideas for fabricating "top cells" for cascade (tandem) structures were presented by Georgia Tech, ISET, JPL and Poly Solar using CdTe based alloys with band gap of about 1.7 eV.

There were also two interesting and productive panel discussions on CdTe and $CuInSe_2$.

The meeting was sponsored by U.S. Department of Energy and Solar Energy Research Institute.

For more technical information contact:
Dr. Harin Ullal
Solar Energy Research Institute
1617 Cole Boulevard
Golden, Colorado 80401
U.S.A.
Tel. (303) 231 1841

Heat Pipe Technology

The heat pipe technology has been applied to give the SUNTRAC TRI-SLIM 320 another distinct advantage. Heat pipes (Fig. 3) at the axis point of the parabolic collectors work in a similar manner to a one way valve, allowing the energy collected to be rapidly and efficiently transferred to the storage tank. When there is no energy to be gained from the sun, the heat transferring vapour condenses at the bottom of the tube. This leaves a vacuum over the length of the pipe so that there is a negligible loss of heat from the storage tank.

A significant benefit of the heat pipe system is that it can withstand moderate freezing conditions. As the actual liquid in the tube only occupies a small portion of the pipe, this allows room for ice to expand without causing damage or breakage. No special precautions are therefore required in frost-prone areas. Where temperatures below 0°C are experienced for extended periods in winter, a low-cost freeze protection kit is required.

For further information please contact: Con Galtos, Bisley (QLD) Pty. Ltd., 15th Floor, 141 Queen Street, Brisbane Queensland 4000, Australia.
Telephone +617 229 3744
Telex AA 43830
Fax +617 221 9759

Energy Research at the University of New South Wales, Australia

A wide range of energy research has been undertaken at the University of New South Wales, Australia. Some of the projects on energy management, liquid fuels, solar energy, biomass energy and wind energy are outlined below:

Energy Management

There are several projects concerned with improving the efficiency of energy use in buildings, industry and transport.

A major project is under way in the Department of Electric Power Engineering to develop techniques for simulating the interaction of the supply industry and industrial consumers under advanced electricity tariffs based on the concepts established in an earlier project. A series of seminars with interest groups and potential end-users is an integral part of the project.

The Department of Fuel Technology has worked with the Energy Authority of NSW in studies on the efficient use of energy in industry, in particular, during 1986, in the brick and ceramic industry.

Projects applicable to buildings include computer simulation of the energy performance of buildings, particularly with reference to the impact of daylighting and window glazing. Solar beam lighting using prismatic panels continues to be evaluated, and a new project aims to develop a centralised daylighting system to light deep interiors and so conserve electricity.

The School of Mechanical Engineering has continued with basic studies and modelling of internal combustion engines and has a particular interest in the utilisation of gaseous fuels.

The Department of Chemical Engineering has received support for fundamental studies on methane distillation. This is a thermally driven membrane process which can utilise a wide variety of heat sources. It has promise for the removal of water from solutions e.g. in the concentration of fruit juices.

Liquid Fuels

The Department of Industrial Chemistry has active projects on the development of improved catalysts for methanol production and for upgrading coal liquids. The catalysts developed for methanol showed promise in plant trials conducted in North America. This work has led to further developments into catalysts to produce higher alcohols.

Alcohol fuels have been evaluated in blends with gasoline in the Internal Combustion Engine Laboratory in Mechanical Engineering. Several methods of alcohol introduction are being investigated to enable controlled alcohol proportions to be maintained. Problems of alcohol flow in a manifold are being studied. Octane numbers of blends have been evaluated, and further work along these lines is planned with unleaded gasolines. This laboratory is continuing work on diesel fuel substitution, particularly with gaseous fuels and turbocharging.

Solar Energy

Of a total of 19 projects in the solar energy fields in 1986, there were 10 projects in the area of conversion of solar energy to electricity. Four projects were related to solar architecture and energy conservation in buildings, with three others being reported separately under Energy Management. There were five projects in the area of solar thermal conversion.

Projects on direct conversion of solar energy to electricity are continuing in the Schools of Physics, Chemistry, and Electrical Engineering. Improvements in the efficiencies of photovoltaic cells have been achieved, and various approaches are being taken to the development of technology for the commercial production of economical, rugged, and efficient cells and cell modules. A project aimed at optimising equipment for solar electric pumping in remote areas has made further progress.

The long-term project in the School of Mechanical and Industrial Engineering which has gathered local data on solar climate is now directed at obtaining a useful condensed solar radiation data bank for Australia. The same group of researchers is involved in testing and evaluating solar water heaters.

In the School of Architecture, work continued on daylighting and solar energy utilisation in commercial buildings. Evaluation of thermal performance and energy consumption in a solar warmed school was completed. Test cells for comparative studies on thermal storage materials have been re-commissioned at a coastal location.

Biomass Energy

Within the Department of Biotechnology two major programs are continuing on the conversion of agricultural crops (cassava, sugar cane, cellulosic residues) into fuel ethanol. In one of the programs, high productivity fermentations are being developed using genetically manipulated strains of the bacterium *Zymomonas mobilis*. Additional NERDDP support has been provided for 1987 to complete a program of genetic improvement of strains of *Z. mobilis* to reduce the enzyme costs of pretreating starch and cellulosic substrates. Three patents have been granted in the USA and licence agreements negotiated with CSR Ltd. for Australia and Southeast Asia, and with Grain Processing Corporation for North America. Scale-up studies (100-1000 litres capacity) have been completed successfully in Australia on cassava hydrolysate and in America on corn starch. Data from

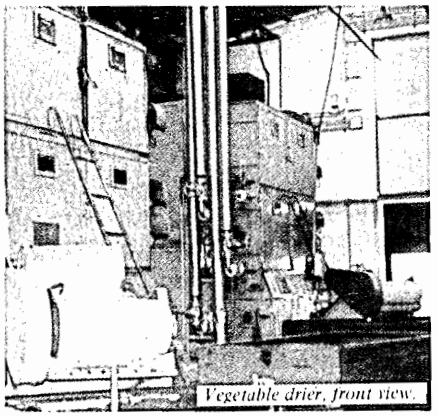
Waste Heat Recovery for Vegetable Drying

Since 1981, Deco Swiss Israel Dehydration Co. at Bror Hayil (South of Ashkelon) has installed four heat exchangers for recovery of waste heat of a vegetable drier. The investment was US$3100 with a grant of 30% of the investment from the Ministry of Energy and Infrastructure as an incentive for being an energy conservation demonstration project.

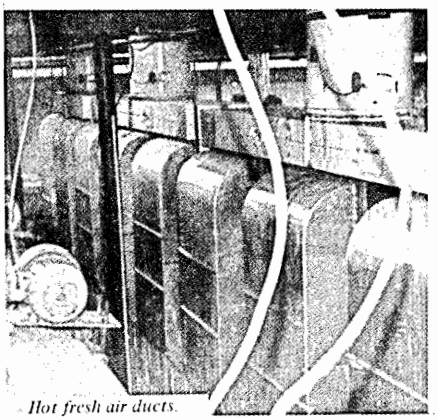
The unit, which is modular, is constructed out of corrugated aluminium foil installed for cross flow. The hot saturated air exhausted from the drier at 135°F is used for preheating of the drying air and raising its temperature by about 31°F. About 200 CFM of air flown through the unit will save 15-16 tons of fuel per year.

Upon completion of the system with 20 heat exchangers installed the saving will amount to an annual saving of 300 tons fuel oil.

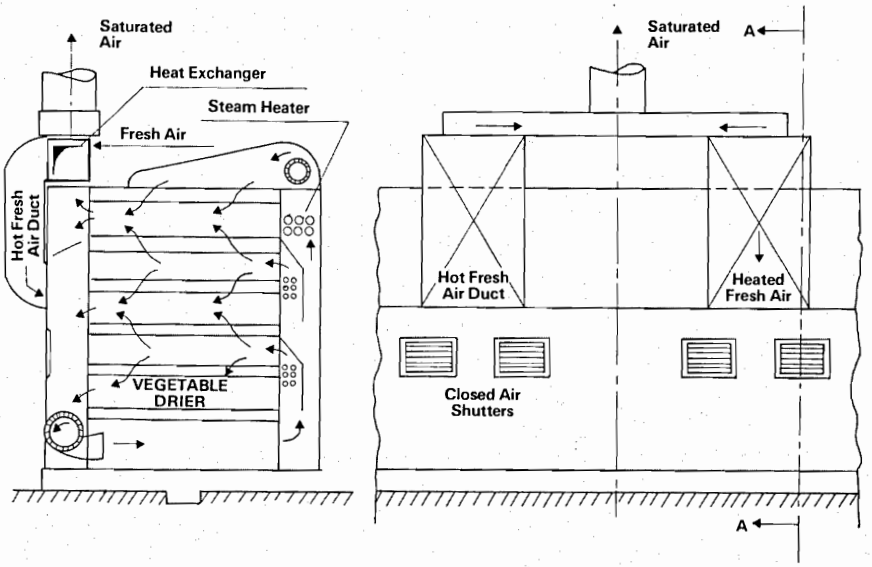
For further information contact: Energy Conservation Industry and Institutional Information Office, Tel Aviv, Ramat Aviv, University Street 26 a., Israel, Telephone (03) 414 271



Vegetable drier, front view.



Hot fresh air ducts.



these trials provide substantial evidence that the zymomonas process gives much higher rates, improved yields and simpler fermentations than those for traditional yeast processes.

A collaborative project on the production of sorbitol and gluconate from fructose and glucose mixtures using enzymes from *Z. mobilis* is being developed in association with the Department of Biochemistry at La Trobe University. Patent applications have been filed on this process through Unisearch Ltd. Some funding has been provided from the Lefebvre Scientific Foundation to develop a continuous process using ceramic membrane technology.

The second project is concerned with the microbial conversion of hemicellulose and cellulose to fermentable sugars using mutant strains of *Cellulomonas* and *Xanthomonas* species. The sugars can then either be upgraded to produce an enriched animal feed or converted to ethanol by yeast or *Zymomonas*. Using bagasse (a residue from sugar cane milling) as raw material, considerable progress has been made in developing alkali pretreatment and steam explosion techniques to render the substrate more amenable to microbial attack. Yields of 65g sugar/100g dry bagasse have been achieved. Currently, recombinant DNA techniques are being used in strain constructions to improve levels of enzyme production. Genes that encode beta-glucosidase, endogluconase and cellobiohydrolase have been cloned or obtained.

Within the Department of Chemical Engineering, research is continuing on distillation optimisation and the use of a liquid carrier impregnated microporous membrane for the separation of ethanol from aqueous solutions. In the Department of Mechanical Engineering, various alcohol fuel blends with gasoline are being studied for octane characteristics.

A project has been initiated in the Department of Fuel Technology on the kinetics of bagasse pyrolysis under the conditions experienced in a swirl burner being developed by the Sugar Research Institute. The pyrolysis process is expected to control the rate of ignition of the bagasse, and the

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Energy Conservation in a Small-Scale Production Engineering Facility

An energy conservation programme was undertaken for A & T Burt Mechanical Ltd., the main production factory in Christchurch, New Zealand. The company is at present a wholly owned subsidiary of the Steel & Tube Group.

Energy costs, for this light metal fabrication operation, which manufactures equipment for the heating and air-conditioning industry, constituted 5.4% of total production costs. This is considered a low energy operation when 'low energy' is defined as less than 7% of total production costs.

The programme was initiated and directed by the Energy Conservation Department of the Company over a 3 year period. At the completion of the programme, energy monitoring, reporting and controlling became integrated into the overall factory management system and continued.

The potential of improved energy efficiency was identified by improving the management of energy systems and by capital and maintenance expenditure. Significant energy savings were made in the first year by improved management and further savings were achieved in the next two years with investment in capital items and maintenance. In the third year of the programme annual energy consumption dropped to 46% of that used before the programme commencement. While implementation costs were significant at $39,500 over 3 years the annual saving achieved in the third year was $32,500.

The results clearly indicate that the programme was cost effective. The dramatic savings made in oil fuel consumption reflected the poor standard of maintenance of the heating plant before the programme commenced. The valuable savings in electricity were achieved almost entirely by the improved management of electricity consuming plant.

It is considered that this factory is typical of many industrial operations in the South Island of New Zealand where maintenance of plants not directly affecting production is lax and where a major component of energy consumption is for factory heating. If this is the case, the implementation of an energy conservation programme can have significant benefits.

Further details are available in "Energy Conservation in a Small Scale Production Engineering Facility", New Zealand Energy Research and Development Committee, Report No. 142, June 1987, by M.R. White, A & T Burt Mechanical Ltd., Christchurch, New Zealand.

Prefeasibility Study on Small-Scale Cogeneration Plants

Small-scale cogeneration systems producing electricity and heat have recently attracted attention in several countries. They are seen as being a technically feasible and economically viable alternative to meeting the energy demand of small communities particularly in sparsely populated areas. Several turbine and I.C.E. (Internal Combustion Engine) manufacturers have already started producing items and package offers of small cogeneration plants. Several feasibility studies have been undertaken by national and international organizations and others are currently underway.

A prefeasibility study on small-scale cogeneration plants (diesel and gas turbine) was conducted by the Technical Research Centre of Finland and was supported by the Ministry of Trade and Industry of Finland (KTM). Mr. Martti Korkeakoski, KTM, was in charge of the project and the research team consisted of Dr. Yehia ElMahgary, Kari Sipila and Hannu Pihala, all from the Electrical Engineering Laboratory.

The objectives of this prefeasibility study were to collect information on small-scale cogeneration plants available in the market and on their economic viability in producing electricity and heat on a small-scale and to consider some case studies in the field.

Technical aspects of small-scale cogeneration plants and parameters affecting their economy were studied. The economics of both SCP (Small Cogeneration Plants 1-20 MWe) and MCP (Mini Cogeneration Plants < 1 MWe) was estimated using tariffs and costs valid in Finland. Two typical case studies were also considered.

The result has demonstrated that both SCP (1-20 MWe) and MCP (< 1 MWe) are generally competitive in comparison with other conventional methods of producing electricity and heat. In the case of SCP the electricity tariff in force is the factor which has the most pronounced role in their economics. This is true also in the case of MCP, however, the district heat tariff and the type of fuel used in the boiler have similar pronounced effects as well. Upon escalation of oil prices the competitiveness of SCP and MCP using natural gas improves.

Although costs and tariffs valid in Finland were used in the present study, similar trends should be observed in any country with similar level of cogeneration costs and tariffs.

Further details on the study are available in the report entitled "Prefeasibility Study on Small-Scale Cogeneration Plants", by Yehia ElMahgary, Kari Sipila and Hannu Pihala, Technical Research Centre of Finland, Research Notes 718, 1987. The report is available from Valtion Teknillinen Tutkimuskeskus (VTT), Vuorimiehentie 5, 02150 Espoo, Finland.

Performance Review of the Global Wind Turbine Manufacturing Industry

Worldwide shipments of electric power-producing wind turbines increased from 4631 units (11 MW) in 1981 to 18,813 units (339 MW) in 1986. Most of this growth was in two areas: (1) Very small turbines, (40-150 W, less than 5 meter rotor diameter) used for remote battery charging, and (2) intermediate turbines (typically 50-150 kW with 10-22 meter rotor diameter) used on windfarms.

Small Wind Turbines

The market for very small turbines increased from 3701 units in 1981 to more than 15,000 units in 1986. Most of this growth was from small inexpensive battery chargers in developing countries. North American, European and a few Pacific area manufacturers traditionally supplied most of these units. Today, the most impressive growth is in developing country markets served by local manufacturers. For example, of the 12,000 units shipped in 1985, more than 7,500 were manufactured and used in China. Six years ago, only a few hundred units were manufactured there. Manufacturers in Indonesia, Morocco, Argentina, Brazil and others also serve local markets. Increased developing country manufacturing is reflected in unit size and price. In 1981, when the market was concentrated in North America and Europe, the average unit was 597 W and US$1764 (US$2,950/kW). In 1986, the average unit was 149 W and priced at US$353 (US$2,360/kW). The market for these small, inexpensive machines continues to grow.

According to the Wind Data Center (Great Falls, VA, USA), the world's top ten manufacturers of small electric power producing wind turbines, (by units shipped for turbines with a rotor diameter less than .5 meters) in 1986 consists of five Chinese companies, three from Europe, and two from the Americas. In order, the top ten are:

1. Shangdu Husbandry Machinery Works (China)
2. Fenxi Machinery Plant (China)
3. Kokair-Tecnia (Argentina)
4. Inner Mongolia Power Machinery (China)
5. Marlec Engineering Co., Ltd. (UK)
6. Beijing Combine General Plant (China)
7. Skenyang Sailplane Factory (China)
8. Thermax Corporation (US/Canada)
9. LMW Windenergy (Netherlands)
10. Bornay (Spain)

Larger Wind Turbines

The introduction and rapid expansion of intermediate turbines is the major event of the wind energy industry in the 1980s. In 1981, 336 intermediate machines (17 MW) were shipped worldwide, of which only 3 units were larger than 20 meters. In 1986, 3046 units (329 MW) were shipped, including 581 units (86 MW) larger than 20 meters. This market expansion reflects North American windfarm opportunities beginning in 1981, peaking at 526 MW in 1985 and declining to 266 MW in 1986 after the expiration of federal energy tax credits in 1985.

Europe is an expanding market for intermediate turbines for utility-grade windfarm applications and dispersed systems. In 1981, seven European countries/territories installed intermediate wind turbines. By 1986 there were 19. Shipments increased from 136 units (6 MW) in 1981 to 567 units (31 MW) in 1986.

For larger machines (10.1-40 meter rotor diameter), an entirely different group of manufacturers occupy the top ten. These manufacturers, listed in order of the total electric power producing capacity of their shipments are:

1. U.S. Windpower, Inc. (United States)
2. Nordtank A/S (Denmark)
3. Micon A/S (Denmark)
4. Bonus-Danregn Vindkraft A/S (Denmark)
5. Wincon A/S (Denmark)
6. Vestas Energy A/S (Denmark)
7. HMZ Belgium N.V. (Belgium)
8. Wind Matic International A/S (Denmark)
9. Danish Wind Technology A/S (Denmark)
10. Wind Energy Group, Ltd. (United Kingdom)

Source: News Releases from the Wind Data Center, STADIA, Inc., P.O. Box 442, Great Falls, VA 22066, U.S.A., Telephone (703) 759-6520.

Energy Research at the University of New South Wales, Australia

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project is intended to study the effects of various operating parameters (e.g. moisture content, particle size) on the pyrolysis process. The results of slow heating rate experiments are being analysed, and fast heating equipment is being commissioned.

Wind Energy

The Department of Electrical Power Engineering is engaged in an investigation of the interaction of wind generators with diesel based supply systems. The 150 kW wind generator installed by the Energy Authority of NSW at Malabar is a source of data for this project, and the School of Mechanical and Industrial Engineering is collaborating in the laboratory testing of appropriate diesel engines. Optimising the design of power supplies for remote areas, by modelling the operation of a combined wind/diesel/solar system, is a closely related activity.

Projects related to light wind performance and the simplification of control systems for wind generators operating over large speed ranges are continuing at the Australian Defence Force Academy.

(Extracted from "Energy Research, Development and Information Centre (ERDIC) Annual Report 1986", The University of New South Wales, Australia, 1986, 69 p.)

China's Interests in European Wind Turbine Manufacturers

Europe's wind energy links with China have been strengthened with the erection of a windfarm using Belgian turbines on the Chinese island of Pingtan in the province of Fujian not far from Taiwan.

Costing US$2 million, the farm — said to be China's biggest to date — consists of four 200 kW turbines made by the Belgian company HMZ. Each machine is a 22 m diameter, horizontal axis turbine mounted on a 22 m high tubular steel tower.

The project is a joint venture between the State Science and Technology Commission of China and the Belgian government.

Shi Pengfei, head of the liaison division of the Chinese Wind Energy Development Center was responsible for commissioning and installing the four WindMaster machines which are intended as a "demonstration windfarm".

In a separate development, plans are being drawn up in China for a factory to produce small wind turbines based on a Swedish design. The Chinese state-owned company Hua Rui is working with SVIAB of Sweden to develop the design for use in China and subsequently to produce machines not only for Chinese consumption but also for export.

The Chinese government has estimated that the country at present has the potential for about 30,000 small wind turbines with rated outputs of 1 kW or less.

Part of this potential is already being tapped by a number of non-Chinese concerns, amongst them the Northumberland Energy Workshop (NEW) of Hexham in Britain. NEW has already participated in a project to bring small wind turbines to Mongolia and this has been followed up recently by the visit to China of the company's technical director, Dr. Geoff Watson.

Dr. Watson returned to China to advise on the siting, design and installation of a wind-diesel generator hybrid system for the island of Kongdong, located near the industrial city of Yantai in Shantung Province.

According to Dr Watson, "the Chinese are looking to install a 55 kW wind turbine to supplement the existing diesel generator on the island. The power output from the wind turbine is dependent on the wind speed distribution at the site and although records show an annual average wind speed of 6 m/s, more accurate data will become available following the installation of an NEW windlogger."

Dr. Watson estimates the final wind turbine installation will cost approximately US$100,000, but if it is successful it will encourage other Chinese islands to install similar systems.

(Source: *Windpower Monthly, News Magazine,* 3(3), March 1987).

IT Collaborates in Windpump Manufacture

UAC of Nigeria Ltd., a public company, has acquired the licence to manufacture and sell the Intermediate Technology (IT) Windpump in Nigeria. IT Windpumps will provide low cost water to farmers and livestock owners, to villages and small-scale industry throughout the country.

The Nigerian company has been involved in the economic growth and development of Nigeria for over a century. The licence allows the local manufacture of IT Windpumps with minimum import necessity. Development Techniques Ltd., a subsidiary of the Intermediate Technology Development Group, will provide the company with complete documentation to manufacture, market, erect, commission and service the windpumps. Exports from Nigeria will also be permitted.

There is good potential in the Nigerian market for these windpumps. Windpumps are very much cheaper to operate than diesel or electric driven pumps — from 50% to 70% less on average — and they operate even in medium to low wind regime areas. With their long-life, reliability and "free" operation, windpumps are ideally suited to the vast rural regions of Nigeria where water is needed to increase food production.

The Nigerian company operates in all nineteen states of the country and has around 10,000 employees. The company has nineteen operating divisions in the manufacturing, technical sales and service, merchandising and marketing, and the service sectors.

The windpump for water supply was originally conceived of and developed by the British registered charity, the Intermediate Technology Development Group for local manufacture and use. It was specially engineered to be made in workshops in developing countries. Modern design concepts were applied to produce a highly efficient and reliable machine with direct drive, requiring minimum maintenance and having a long-life. The windpump will pump water from 200 m depths or at 300 m^3/day from shallow wells.

The aim of Intermediate Technology is to widen the range of technical options available in developing countries, so that more appropriate choices can be made to suit local economic, natural, and human resources and needs. The

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Italian Wind Energy Network

Italy has a network of institutions dealing with wind energy resources. They are pleased to answer queries from developing countries and can be reached c/o UNITAR/UNDP Centre on Small Energy Resources, via Panama 12, 00198 Rome, Italy. (Tel: (06) 84595-48 Telex: 610181 FAO I UNITAR)

Public Bodies

ENEA (The Italian National Committee for Research and Development on Nuclear and Alternative Energy) is mainly concerned with wind energy by acting as a promoter of wind energy related industrial projects. In particular, its FARE Department has been responsible for launching the "Wind Energy Systems" project, which comprises:

- Wind energy sites and analysis of wind.
- Stations for testing medium-sized and small wind turbine generators.
- Promotion of the development of small wind turbines to pump water and generate electricity for isolated consumers, and for connection to the grid.
- Promotion of the development of large and medium-sized wind turbine generators.

CNR (The Italian National Research Council) is engaged mainly in applied research, and is at present involved in wind energy through "Energy Project 2" (PFE 2). PFE 2 was set up and is jointly co-ordinated by CNR and ENEA, and covers research on large wind energy systems, wind surveys, small and medium-sized wind energy systems, and electricity production and storage.

ENEL (The Italian National Electricity Board) has so far been concerned mainly with wind energy through the VELE Project, which involves the selection of wind energy conversion sites, the testing of wind turbine generators of less than 100 kW, and the design, construction, and operation of a wind power demonstration plant comprising 10 units with a total capacity of 500 kW. ENEL also co-operates with ENEA and with manufacturers in the testing of medium-sized machine prototypes.

The Ministry of Industry co-ordinates Italian policy in accordance with the directives issued under the National Energy Plan (PEN), and is, among other things, responsible for implementation of Law 308, which provides for incentives in the use of renewable energy sources.

Industry

AERITALIA is the main Italian aerospace company. Its wind energy activities range widely, from wind surveys to energy planning, to small, medium, and large wind turbine generators. As regards machines, Aeritalia is directly responsible for both design and manufacture, enlisting the co-operation of both Italian and foreign companies.

Riva Calzoni. This company has long been well-known as a manufacturer of hydraulic turbines. As regards the wind energy field, Riva Calzoni is concerned with the design and manufacture of small and medium-sized wind turbine generators, all of which are characterized by a single-blade rotor, within the framework of co-operation with the MBB (Messerschmitt-Bolkow-Blohm) Group of West Germany.

The *Consortium Aeritalia-Fiat Aviazione for Wind Energy* was set up by the two companies to develop large wind turbine generators. Having previously researched a multi-megawatt machine, the Consortium is now about to make a 1 MW (GAMMA 60) wind turbine generator.

(Source: UNITAR/UNDP Centre on Small Energy Resources – Newsletter, Feb. 1987, Issue No. 6)

Wind/Diesel Workshop Discusses Marketing

How the wind industry can best penetrate the world market, the development of a common wind power terminology, and short-term energy storage for wind diesel systems were the main topics at the CanWEA/AWEA workshop in mid-May.

The workshop on wind diesel technology and turbine performance attracted about 75 participants from Canada, Denmark, the Netherlands, United Kingdom and USA. The workshop marked the first time the Canadian Wind Energy Association (CanWEA) and the American Wind Energy Association (AWEA) have cooperated on such an event.

The workshop was held at Dartmouth College in New Hampshire, in northeastern US, and over the course of three days participants met in more than 20 sessions. At the workshop on wind turbine performance, some of the industry's top experts noted that certain terms such as "capacity factor" can mean different things, therefore it was agreed that standardisation of terms is needed for better cooperation.

At the wind diesel technology session, diesel grid penetration, input management and power source mix were discussed, and short-term energy storage devices received some attention at the final session, especially the application of flywheel technology to battery storage.

The key non-technical question emerged at the close of the workshop – how to sell more systems abroad. The group decided that better use should be made of agencies working in the Third World such as the World Bank, USAID or CIDA, the Canadian International Development Agency, Canada's equivalent of USAID. These agencies must be made aware of wind energy. The workshop participants considered it imperative that only successful and reliable projects should be installed, and recognized that attention must be paid to the power needs of individual countries, summarised Mr Lacey.

A report of the CanWEA/ AWEA workshop proceedings will most likely be made available, he added.

(Source: *Windpower Monthly,* June 1987)

Regional Wood Energy Development Programme in Asia (GCP/RAS/111/NET)

Project Steering Committee Meeting, Bangkok, Thailand 7-10 July 1987

The Regional Wood Energy Development Programme in Asia is the outcome of the recommendations of the FAO/ESCAP Regional Workshop on Wood Energy Development, held at Bangkok in December 1983, attended by 9 countries (China, India, Indonesia, Malaysia, Pakistan, Sri Lanka, Nepal, Thailand, Vietnam). Recognizing that the large majority (more than 80%) of rural populations in Asia are dependent on woodfuels for their daily energy needs and that fuelwood scarcity situations prevail in most countries, the workshop strongly recommended regional cooperation in wood energy development in Asia.

With assistance from the Government of the Netherlands, FAO started this regional cooperative project initially for a two year period (1985-1987). Towards the end of Phase I, the project was reviewed by a mission comprising of representatives from the donor government, FAO and the member countries. This mission visited five countries (Bangladesh, India, Nepal, Philippines and Thailand) and held discussions with key government officials, and visited selected field projects. The review mission recommended continuation of the project for a further period of two years (1987-1989). The project will be evaluated in September, 1988.

Project Objectives

The immediate objectives of the project are:

1. To assist the member countries to develop and improve wood energy resources for meeting the energy needs of rural and urban households, rural industries and agricultural activities.
2. To promote the exchange of technical information and expertise through Technical Cooperation Among Developing Countries (TCDC).
3. To assist in strengthening the research, development and implementation capabilities of the participating countries to improve wood energy production and end-use conversion systems.
4. To assist in developing suitable technical and social science skills required for the implementation of the national programmes through a multi-country programme of training of trainers and researchers.

Project Steering Committee Meeting

The first meeting of the Steering Committee of the Regional Wood Energy Development Programme in Asia was held in Bangkok, from 7 to 10 July, 1987.

The meeting was attended by senior government representatives from 8 countries (India, Indonesia, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, Vietnam) and observers from the host country and from international organizations (ESCAP, AIT, JICA, USAID/Winrock International). Bangladesh and Burma could not participate.

Agenda items of the meeting were as follows:

- Presentation of project status report
- Presentation of country status reports by the delegates
- Prospects of wood energy development in the region
- Review of Phase I (1985-1987) project activities
- Findings of project review mission (10-28 November, 1987)
- Work programme for Phase II project (1987-1989)
- Priority proposals for technical and other assistance from the project
- Voluntary contributions and assistance to the project, by the participating countries
- Prospects beyond present project E.G. TCDC, cooperative network, etc.
- Counterpart support to Project Activities
- Wood energy policies and strategies

A one day field visit to energy forestry plantations, a cookstove manufacturing unit and fuelwood-using rural industries in Ratchaburi Province in Thailand was also arranged with the assistance of the Royal Forestry Department and the National Energy Administration of Thailand.

Remarks from the Meeting

The meeting expressed satisfaction with the project's progress during its initial period (Phase I) and reiterated the need for continuing and strengthening regional cooperation in wood energy development. Promotion of TCDC activities and mutual self-reliant efforts were emphasized.

The meeting also concluded that the needs of the countries are partially met by the project. Some additional needs requiring project assistance are: wood energy planning, data on resources, consumption, marketing and distribution of fuelwood, etc. For wood energy planning, in particular, it was stressed that planning must precede programme implementation.

Further details on the Regional Wood Energy Development Programme and on the Project Steering Committee Meeting are presented in the "Report of Project Steering Committee Meeting, Bangkok, Thailand, 7-10 July 1987, Regional Wood Energy Development Programme in Asia (GCP/RAS/111/NET)", published by Food and Agriculture Organization of the United Nations, Bangkok (Maliwan Mansion, Phra Atit Road, Bangkok, Thailand).

Energy Information Service, CSIRO

Survey of Clients of the Energy Information Service

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ABSTRACT

The first survey of clients shows a high level of satisfaction with the speed and type of information supplied. The importance of workshops in attracting and holding new users is highlighted.

1. Introduction

How users view the performance of the Energy Information Service is examined by a survey questionnaire. This survey concentrates on:
— who the users are;
— where they are;
— how useful the information they receive is; and
— how long it takes to arrive.

The Service received three times more requests in 1986 than in 1985. While this is pleasing, it is essential to know more about the market. How are customers satisfied with the Energy Information Service?

2. Aims

The survey:
— describes who uses the service by economic sector;
— maps where they come from by region and country;
— defines their attitude to the information they received;
— determines the time lag in delivery; and
— correlates results with attendance at workshops; receipt of the *Renewable Energy Index;* and receipt of the *Renewable Energy Directory.*

3. Method

3.1 Selecting the sample

The sample was selected from the files of requests for the preceding 15 months. Even if the person made more than one request for information during that period, they received only one questionnaire.

Many requests did not have sufficient detail about the person's name or address. This applied particularly to phone enquiries and to requests received during workshops and conferences. These could not be included in the sample.

In a number of cases it was known that the person who had made the request was no longer at that address. These people were excluded from the sample. The resulting sample gave 219 individuals.

3.2 The Questionnaire

Writing a questionnaire posed a number of interesting problems.

It had to be clear to readers in 19 countries scattered around Asia and the Pacific. It would be answered by many people who did not use English as their first language. Are market research questionnaires used in some of these countries? Did the users care enough about the service to bother sending it back? After all, they had to pay the return postage.

3.3 Response rates

The questionnaire and covering letter were posted on 31 March 1987. Because of the distances involved, reminder letters were not sent until 29 May.

Two questionnaires were returned because the person was no longer at that address. Two companies wrote that the requester was no longer with them. In at least three cases the questionnaire was not received although the reminder letter was.

A coup occurred in Fiji in the middle of the survey. As Fiji is one of the major users of the Service, it is hoped that this has not affected the sample. Initially no questionnaires were returned, but in the end 10 (56% of those sent to Fiji) were returned.

Even though returns were still trickling in, the sample was closed on 6 July 1987. A total of 134 (61%) had been returned. Of these, 127 (58%) were usable.

(Note: by 11 August a further 11 questionnaires had been returned. They are not included in the analysis.)

3.4 Distribution by country

The distribution of sent and received questionnaires are compared by country in Fig. 1.

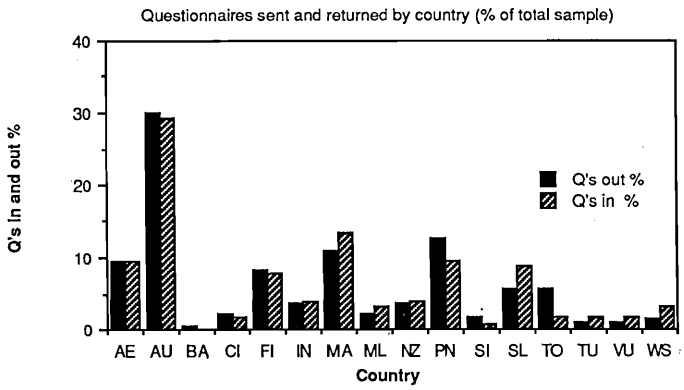
There is one more questionnaire in for Western Samoa than was sent out. A respondent studying at USP in Fiji asked that his country be recorded as Western Samoa.

How do we show that no country is over or under represented in the returns? The numbers out and in can be viewed as 16 pairs of numbers — one pair for each country. The number out is the independent variable, and the number in the dependent variable.

Cont. P. 16

Survey of Clients of the Energy Information Service

From P. 15



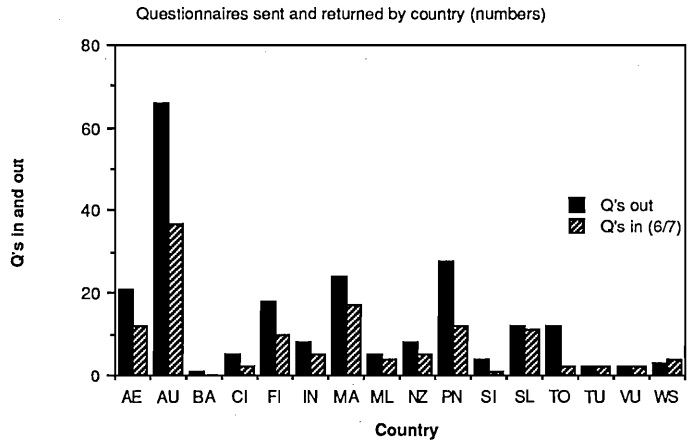


Fig. 1 Comparison of returns by country

Plotting these in a graph gives Fig. 2. The line through the points is the line of best fit. The correlation co-efficient for this line is 0.97. This says that the relationship between numbers out and in for each country is very closely related. Therefore, we can assume that no country is grossly over or under represented in the proportion of returned questionnaires.

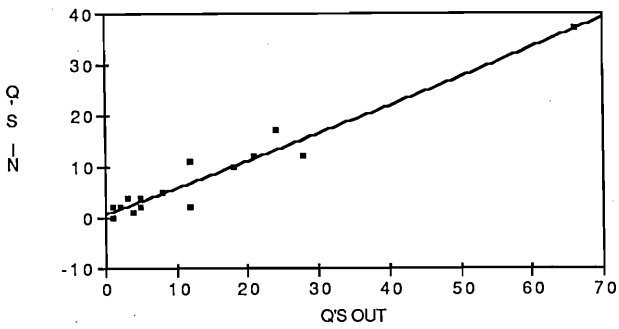


Fig. 2 Sent and returned questionnaires by country

4. Results

4.1 Question 1. Where do you work?

	f (n=128)	%
Teaching	29	23
Government administration	29	23
Industry	23	18
Other	13	10
Research	12	9
Forestry, agriculture & fishing	12	9
Wholesale and retail trade	5	4
Student	4	3
Remainder	1	1

Almost one quarter of respondents work in teaching. Another quarter work in some form of government administration. 18% or almost one in five work in industry.

A further 10% of respondents did not fit easily into one category. These are listed as Other. Many of these respondents described themselves as working in more than one area.

Research accounted for 9% of respondents. The remainder described a variety of activities.

These responses show that the major client groups are in government, or in teaching, which is usually government sponsored.

4.2 Question 2. How did you learn about us?

	f (n=117)	%
By attending a workshop	43	37
Through the *Renewable Energy Index* or *Renewable Energy Directory*	22	19
From colleagues	19	16
From your national liaison centre	15	13
Brochure or published article	7	6
More than one response	7	6
Other	4	4

Over one third (37%) of respondents learnt about the Energy Information Service by attending a workshop.

A further one in five learnt about it from one of the regular publications. One in six became aware through contact with colleagues. National liaison centres accounted for 13% of respondents. Brochures or published articles brought the Service to the attention of only 6% of respondents.

A further 6% gave more than one answer, apparently learning about the service from more than one source before deciding to use it.

4.3 Question 3. How did you contact us?

	f (n=123)	%
By letter	56	46
In person	29	24
Combination of ways	18	15
By phone	13	11
By telex	5	4
Other	2	2

Almost half (46%) of the respondents made contact by letter. A further 29 respondents (24%) contacted the service in person. Of these 29, 21 had attended a workshop or demonstration of the service; many of these requests were collected then.

A range of methods were given by 15% of respondents. Many of these appear to be regular users.

Telephone contact was used by only one in ten (11%) of respondents. Telex accounted for only 4%.

4.4 Question 4. How long did you wait for a reply?

	f (n=119)	%
One week	27	23
Less than one month	70	59
More than one month	22	18

Almost a quarter of respondents (23%) received their reply within a week. Over half (59%) received a reply in less than one month. The remaining 18% waited more than one month.

In Question 6 we will see that only once was the reply too late in arriving to be useful.

4.5 Question 5. Was the reply useful?

	f (n=122)	%
Very useful	64	53
Moderately useful	53	44
Not very useful	3	2
Not at all useful	1	1

Just over one half the respondents (53%) said that the reply was "very useful". A further 44% described the reply as "moderately useful". Only 3% felt the reply was not useful.

There remains one respondent who felt the reply was of no use. The answers to this question were cross-tabulated with the results of the questions on workshops and the *Renewable Energy Index* and the *Renewable Energy Directory*. This respondent had not been to a workshop and did not receive either of the regular publications. It therefore appears that they were a transient user of the service.

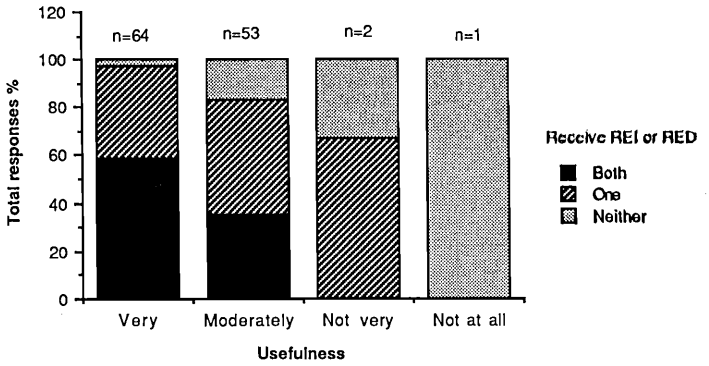


Fig. 3 Usefulness of the reply (Q5) crosstabulated with use of REI and RED (Q8 & 9).

The effect of receipt of the regular publications on the usefulness of replies is quite marked. This is shown in the stacked column graph in Figure 3.

Almost 100% of the most satisfied group receive either the Directory or the Index or both. Over 80% of the next group do. In the third group no one receives both, but over 60% receive one. In the lowest satisfaction group, neither is received. Remember, this last group has only one member.

4.6 Question 6. If the reply was not useful, why not?

	f (n=10)
Insufficiently detailed	5
Out of date	2
Irrelevant to your topic	1
Too late in arriving	1
User said that he should have asked a more precise question	1

Even though only four respondents had answered in the previous question that the information was not useful, 10 gave reasons why it was not useful. Five of the 10 said the reply lacked detail. Two noted that the information was out of date. Only one said the information was irrelevant. One answered that the information was too late in arriving. One respondent wrote that he should have asked a more precise question.

4.7 Question 7. Have you ever attended a workshop on our Service?

	f (n=125)	%
Yes	50	40
No	75	60

60% of respondents had not attended a workshop. Over one in three (40%) have been to a workshop.

Survey of Clients of the Energy Information Service

From P. 17

In question 2 it was asked how respondents first heard about the Energy Information Service 43 said a workshop was their first contact. Here we see that this 43 out of 50 (86%) of workshop attendees are making their first contact with the Service.

4.8 Question 8. Do you receive the Renewable Energy Index?

	f (n=124)	%
Yes	69	56
No	55	44

Over half of the respondents (56%) receive the *Renewable Energy Index.*

4.9 Question 9. Do you receive the Renewable Energy Directory?

	f (n=124)	%
Yes	63	51
No	61	49

Just over half of the respondents receive the *Renewable Energy Directory.*

4.10 Question 10. In what country do you live?

The results of this question were presented in Section 3.4 on the distribution of the sample and the returns by country.

Questionnaires were also returned from these non-member countries:

Brazil	Kenya
Britain	Peru
Indonesia	Philippines
Israel	Tahiti
Japan	

4.11 Question 11. Any additional comments?

A number of requests for information were made in the answers to Question 11. These were answered in the usual fashion and are not included in this analysis.

The most frequent comment was "the service is useful" or "keep up the good work." Comments along these lines accounted for 23 out of 52 suggestions (44%).

The second most common comment was a request for more workshops or training (13%).

Four respondents (8%) said that the speedy service was impressive. Three of these were from Australia and one from Sri Lanka.

Four respondents (8%) asked to receive the *Renewable Energy Index* or *Renewable Energy Directory* regularly.

There were four requests (8%) for more information relevant to tropical or developing countries and for greater use of local contacts.

Three respondents urged greater advertising of the service.

The following comments were made once:

- Energy conservation is important.
- Make the service available through public libraries.
- Strengthen the national liaison centre (This country's liaison centre has recently changed).
- Include more technical papers.
- Keep product information current.
- Microfiche are not convenient (Documents are now being copied on paper and fiche are no longer distributed).
- People are not interested in the service (The other comment from this country was "keep up the good work").

5. Conclusions

The main client groups of the Energy Information Service are in teaching, government, industry and research.

Half of the overseas users learn about the service at a workshop. Published articles, such as this one, do not bring in users.

While over 80% of replies arrive within one month, only half score the highest rating of usefulness. Lack of detail is the most common complaint about replies. Out of date material is also criticised. Workshops are mostly attended by new users.

Although the bulk of the comments were positive, some important suggestions were made. The most popular request is for more training. There were also requests for more technical and practical information relevant to tropical and developing countries. These are areas where definite improvement is possible.

We have already begun to incorporate these results into our operations.

Acknowledgements

Andrew Carter and Penny Braybrook contributed to the design of the questionnaire.

This survey, like the service it examines, was financed by the Commonwealth Secretariat and the Australian Development Assistance Bureau.

Finally, the author wishes to thank all the users who took the time to answer the questionnaire. Their comments and suggestions will help the Energy Information Service to provide a better service.

New Book Reviews

The worldwide market for electric power-producing wind turbines is documented in a new book entitled *Wind Energy 1987: Wind Turbine Shipments and Applications*, by Thomas F. Jaras, published by the Wind Data Center, STADIA, Inc., July, 1987. Hardcover 8 1/2 × 11 inches, 314 pages, US$300.00.

This first annual yearbook contains the complete statistics on wind turbine shipments and applications in the world. The database developed for the yearbook documents more than 75,000 shipments over the 1981-1986 period, representing 1,657 MW of turbines and sales of US$1.7 billion. The database covers the shipment of 563 wind turbine models to 95 countries from 234 manufacturers in 25 countries. A network of industry experts from around the world assisted in verifying and expanding upon the raw data.

The book contains annual summary statistics for 1981-1986 for all wind turbines rated at more than 40 W. The data and supporting analyses are presented by 1) regions of the world, with country-specific data, as appropriate, 2) market applications, ranging from battery charging to windfarms, 3) rotor diameter class, and 4) manufacturing and import/export values. In all cases, wind turbine shipments are quantified and aggregated in terms of units shipped, nameplate rating, and F.O.B. price. A convenient appendix describes all 151 active turbine manufacturers and their commercial and prototype machines.

The yearbook is the product of more than 10 years of market assessment experience by the members of the Wind Data Center and an exhaustive 12-month survey of wind turbine manufacturers throughout the world. The book is a basic planning and reference document for the wind energy industry and for companies, institutions, and government agencies interested in wind energy.

For information or to order the publication contact: Wind Data Center, STADIA, P.O. Box 442, Great Falls, VA 22066, U.S.A., Telephone (703) 759-6520

Publications Received

- *Renewable Energy Sources for Rural Water Supply*, Technical Paper Series No. 23, E.H. Hofkes and J.T. Visscher, International Reference Centre for Community Water Supply and Sanitation (IRC), Hague, Netherlands, xv+168 p., December 1986.
- *INNERTAP Renewable Energy Index No. 4*, An Index to NRSE (New and Renewable Sources of Energy) Documents Available in the Member Countries of the Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific, INNERTAP, vii+156 p., May 1987.
- *Production and Utilization of Biogas in Rural Areas of Industrialized and Developing Countries*, Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) GmbH, Eschborn, West Germany, 278 p., 1985.
- *Pyrolysis and Combustion of Wood and Peat as a Single Particle and a Layer*, Research Report 465, M. Aho, Valtion Teknillinen Tutkimuskeskus (VTT), Espoo, Finland, 116 p., February 1987.
- *Development of Appropriate Rice Husk Gasification Systems for Energy*, Report of the FAO Technical Team on Rice Husk Gasification (RAPA No. 67), FAO Regional Office for Asia and the Pacific, Bangkok, Thailand, iii+18 p., January 1983.
- *Directory of Solar Research Institutes in Developing Countries*, Industrial and Technological Information Bank (INTIB), United Nations Industrial Development Organization, Vienna, Austria, iv+127 p., 1986.
- *Solar Energy: Theory and Design of Solar Thermal Systems*, W.W.S. Charters and T.L. Pryor, Victorian Solar Energy Council, Australia, 162 p.
- *Regional Information in Photovoltaics, South-East Asia, Volume I*, F. Lasnier, T.G. Ang, K.S. Lwin, and Anna Adidepvoraphan (Comp.), Energy Technology Division, Asian Institute of Technology, Bangkok, Thailand, 241 p., July 1987.
- *A Linear Programming Approach for the Construction of Energy and Resource Flow Models*, Research Report 464, E. Tamminen, Valtion Teknillinen Tutkimuskeskus (VTT), Espoo, Finland, 70 p., February 1987.
- *Numerical Simulation of Peat Dust Explosions*, L. Kjaldman, Valtion Teknillinen Tutkimuskeskus (VTT), Espoo, Finland, 85 p., March 1987.

IT Collaborates in Windpump Manufacture
From P. 12

Group has worked on projects in more than 60 countries since its founding in 1965 by the late Dr. E.F. Schumacher and is considered to be the leading agency of its kind in the world today.

The IT Windpump took eight years to develop and test in partnership with local organisations in six developing countries. It is now in production in Pakistan and Zimbabwe. The Kijito model was developed by BHEL in Kenya from the IT Windpump. Kijito and the windpumps are pumping water for famine relief camps, villages and farms, livestock, crop irrigation, tree nurseries, clinics, and schools.

A number of firms in several other countries including Zambia, Canada, India, Portugal and Brazil are also considering producing the windpump.

(Source: Press Release, ITDG, U.K.)

Diary of Events

- November 5-7, 1987, Raffles City Convention Centre Singapore, Singapore

4th ASEAN Energy Conference

The conference is organized by Science Council Singapore on behalf of the ASEAN Working Group on Non-Conventional Energy Research, sponsored by ASEAN Australia Economic Cooperation Programme and ASEAN Committee on Science & Technology, and managed by Conference & Exhibition Management Services Pte. Ltd.

For further details:
The Conference Manager
4th ASEAN Energy Conference
Conference & Exhibition Management Services Pte. Ltd.
1 Maritime Square #09-43
World Trade Centre
Singapore 0409

- December 1-4, 1987, New Delhi, India

National Solar Energy Convention '87 and Workshop on Technoeconomics of Renewable Energy Power Generating Systems

Venue: Indian Institute of Technology New Delhi
Dates: Workshop, December 1, 1987
Convention, December 2-4, 1987

Renewable Energy Resources Information Center (RERIC)

RERIC aims at answering energy and renewable energy questions, with particular regard to applications in tropical regions. The main topics covered by RERIC are energy conservation, energy planning, solar energy, biofuels, wind energy and small-scale hydropower. The center's regular publications are a quarterly newsletter RERIC News, the Renewable Energy Review Journal (two issues a year), the RERIC Holdings List, and Abstracts of AIT Reports and Publications on Renewable Energy Resources.

MEMBERSHIP FEES: Members from USA, Canada Europe, Australia, New Zealand, Japan and Middle East — individual = US$40, institutions = US$75; all other countries individual = US$25, institutions = US$45; supporting members = US$120. The RERIC's regular publications are provided on a total-package basis to RERIC members.

AIR MAILING CHARGE: Members from Asian countries, excluding Thailand, US$9; all other countries US$15.

For further information write to: The Director, RERIC, Library & Regional Documentation Centre, A.I.T., G.P.O. Box 2754, Bangkok 10501, Thailand.

Topics of the Convention

- o Resource assessment and analysis of data (solar, wind, biomass and hydro).
- o Low temperature solar thermal application, solar concentrators, solar thermal power generation, process heat, solar photovoltaics, solar passive architecture, thermal storage, electrical storage, system studies, field experience and case studies.
- o Wind mills, wind pumps, aerogenerators.
- o Biomass, biological and chemical conversion of biomass, combustion and utilisation.
- o Hydro, micro- and mini-hydro.
- o Instrumentation and control systems.
- o Energy materials.
- o Economics of renewable energy systems.
- o Integrated energy planning.
- o Manpower development in renewable energy technologies.

For further details contact:
Dr. N.K. Bansal
Organizing Secretary
NSEC– 1987
Centre for Energy Studies
Indian Institute of Technology
Hauz Khas, New Delhi – 110016
Telephone: 654054, 665921, 666969 PABX Ext. 254
Telex: 31-3687 IIT IN

- December 1-14, 1987, Dhaka, Bangladesh

Regional Workshop on Solar Thermal and Photovoltaic Conversion

The workshop is organized by Renewable Energy Research Centre of Dhaka University and is sponsored by International Centre for Theoretical Physics Trieste, Italy and UNESCO.

Topics to be covered

- o Solar radiation
- o Concentrating and non-concentrating collectors
- o Testing of collectors
- o Solar thermal modelling
- o Solar thermal system design
- o Solar cells
- o Photovoltaic system and design
- o Economics of solar energy

Programme

There will be lectures by resource persons, seminars by invited speakers and participants, some practical sessions, and a display of equipment.

Participants

Applications and nominations are invited from South Asian and Southeast Asian countries. They should contain full bio-data of the intending participants. A limited number of travel grants and subsistence allowances will be available for the regional participants.

For further details contact:
Dr. Muhammad Ibrahim
Secretary, Organizing Committee
Renewable Energy Research Centre
University of Dhaka
Curzon Hall, Dhaka-2, Bangladesh.

RERIC news

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MALAYSIAN BIOMASS PROJECT

Malaysia's primary economic activity is based on agricultural production. It is the world's premier exporter of palm oil, rubber and tropical woods. As a result of these activities, the amount of agricultural wastes produced is very large, posing pollution problems at the sites of the respective industries. Some of the wastes are being disposed of either by burning, filling land or other means.

In Malaysia, disposal of rice husks and its ash has always been a problem for the rice milling industry. An estimated 2 000 000 tons of husk are produced annually by the rice mills. The rice husks are usually disposed of by open field burning creating about 30 000 tons of finely divided siliceous ash. This fine silica ash poses a health hazard to workers in the mill as well as to the general population staying in the vicinity of the mill when open burning is practiced.

As a step in dealing with these agricultural waste disposal problems, The Standards and Industrial Research Institute of Malaysia (SIRIM) is conducting a pilot plant study of the fluidized-bed combustor system to burn rice husks, presized free-flowing solids and a variety of liquid wastes. This project, which is known as the 'Malaysian Biomass Project' is being sponsored by the Australian Government under the ASEAN-Australia Economic Co-operation Programme.

The objective of the 'Biomass Project' is to investigate the technical and economic viability of a fluidized-bed combustor in the Malaysian agricultural industry.

The Spouted/Fluidized-Bed Combustion System

The spouted/fluidized-bed pilot plant was developed and produced by Pyrecon Pty. Limited, Gladesville, New South Wales, Australia and incorporates patents held by the Commonwealth Scientific and Industrial Research Organization (CSIRO) and Pyrecon Pty. Limited.

The pilot plant was designed to burn rice husk, presized free-flowing solids and a variety of liquid wastes (Fig. 1). It is comprised of:

Contents

Biomass Energy 1
Biogas 6
Energy 8
Solar Energy 10
Wind Energy 11
Hydropower 12
Publications Reviews 15

Fig. 1 The spouted/fluidized-bed combustor pilot plant at SIRIM, Malaysia.

wind and sun compendium
Development of wind and solar energy for water pumping
tool
cwd

Energy Information Service, CSIRO
Incorporates news from the Energy Information Service, CSIRO and Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).
INNERTAP

MALAYSIAN BIOMASS PROJECT

From P. 1

(i) *The Combustion Chamber*

The 1.0 m^2 combustor has a refractory lining with an internal height of approximately 3.3 m. The combustor is filled with a sand bed (previously screened) of height 0.6 to 0.75 m. Its operating temperatures is normally in the range of 750 — 900°C. Air supplied from the main blower is passed through the bed creating a spouting and circulating pattern which assists in the distribution of rice husk and rapid combustion.

(ii) *The Rice Husk Supply/Feed System*

The feed bin has a capacity of 3.0 m^3. Rice husks from the storage area is fed into the hopper by a manually operated pneumatic transfer system. Two screw conveyors are used to feed rice husk into the combustor. The variable speed screw controls the rate of fuel injection. The fixed speed screw discharges feed into the combustion chamber. When the feed system is not in use, a slide valve located between the two screws closes to prevent hot combustion gases leaking back into the hopper or pressurized air leaking forward into the bed.

(iii) *Gas Cleanup/Ash Handling*

On leaving the combustor, the hot combustion products enter the cyclone at very high speeds. The bulk of the ash drops out through an ash discharge outlet. The ash is then transported through an air quenched pipe line to a load out bin. Hot gas from the cyclone is injected into the scrubber before it is released to the atmosphere.

(iv) *Bed Makeup/Removal System*

Sand as a medium for heat transfer must be added to maintain a steady level of bed in the combustor. Bed level is normally maintained at approximately 600 mm to 800 mm above base plate, corresponding to a bed differential pressure of approximately 8.5 to 10 kPa.

The bed make-up system is comprised of a bed make-up blower which draws dry, screened sand from a bed storage area and discharges it directly into the combustor via an automated slide valve. The bed removal system discharges sand bed at approximately 1.5 ton per hour. It is comprised of a bed removal standpipe, a static screen and a transfer hopper with a pneumatic ejector and elevator pipe.

(v) *Gas Warmup System*

To enable the initial ignition of solid or liquid fuels to start in cold conditions, it is necessary to preheat the bed with gas. Gas is supplied from the LPG reticulation system and the bed is heated for two hours with constant pressure until the primary set point temperature (700°C for rice hulls) is reached.

(vi) *Bed Temperature Quench System*

The combustor is fitted with a bed temperature quench water system. Water-based quench results in the ability to consume more rice husk or other calorific wastes whilst evaporating the water-based wastes in the combustor.

Direct use of fresh water supply as the quenching medium is also possible. This is to protect against the occurrence of extremely high bed temperature conditions (which might cause bed sintering) if a shortage of water-based wastes occurs.

(vii) *Liquid Feed System*

The liquid feed tank has a capacity of 1400 litres and is equipped with a stirrer. The stirrer must be on for at least 30 minutes before the liquid feed system may operate. A variable speed pump controls the rate of feed delivered into the combustor.

At present, the pilot plant is running on rice husks supplied by the National Rice and Padi Board

Cont. P. 5

Fluidized-Bed Combustion of Rice Husk for Energy and Pozzolana

A fluidized-bed rice husk combustion system was developed at the Energy Technology Division of the Asian Institute of Technology, Bangkok. The heat power generated is about 200-300 kW, and the combustion efficiency is about 95%. The by-product, reactive rice husk ash, can be used for making pozzolana which has higher compressive strength than pure Portland cement.

Two kinds of fluidized-bed combustor were used to investigate the rice husk burning — one is a laboratory scale fluidized-bed combustor (lab. FBC) and the other is a pilot plant scale fluidized-bed combustor (pilot FBC).

Laboratory Scale Fluidized-Bed Combustor

The lab. FBC (Fig. 1), made of mild steel tube, is 2 m high and has a diameter of 0.15 m. The combustor consists of two parts: the lower part is 1 m high with three groups of water tubes round the outside of the steel wall to control the bed temperature. The upper part can be used in two different diameters: 0.15 m and 0.3 m (enlarged freeboard). The outside of the combustor is insulated with rock wool. Fluidizing air was supplied by an air blower, metered and introduced into the bed through an air-distributor plate. Two kinds of air-distributors were tested. One is a perforated plate with holes of 1 mm diameter, in a square pitch of 10 mm. The other is a multi-jet tuyere distributor.

Rice husk was supplied from the hopper and fed via a screw feeder with a variable speed motor to the bed at 70 cm above the distributor plate. A copper water tube was fixed round the outside of the screw feeder to maintain cooling.

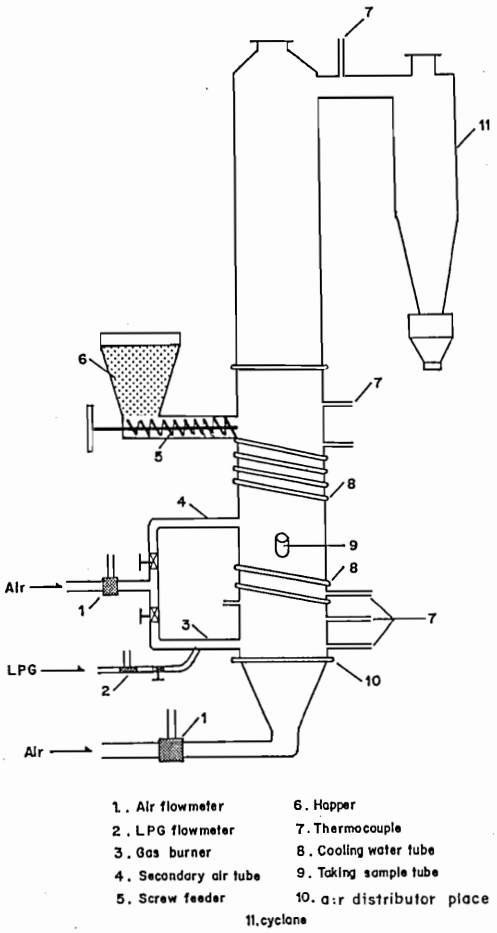

Fig. 1 Laboratory scale fluidized-bed combustor.

Building sand was used for inert bed material and the test bed depth was about 15 cm. The temperature records could be made by thermocouples. Normally the exhaust gas was sampled from a point just down stream of the cyclone. Gas analysis was carried out by a Portable Fryzer CO meter and Orsat apparatus. For start-up, a gas burner under the sand bed was used to preheat the bed material.

Pilot Fluidized-Bed Combustor

The pilot plant scale FBC (Fig. 2) was developed from the lab. FBC. The pilot FBC has firebricks as inside insulation wall and steel shell as outside wall. It is 2 m high and 0.4 m square in section. A tuyere air-distributor was used for the test. Three gas burners were used for startup. Two were under-bed gas burner, one was an over-bed gas burner. LPG was premixed with air before supplying into the bed. To achieve combustion control, a LPG flow meter and an air flow meter were used.

Other developments were as follows:

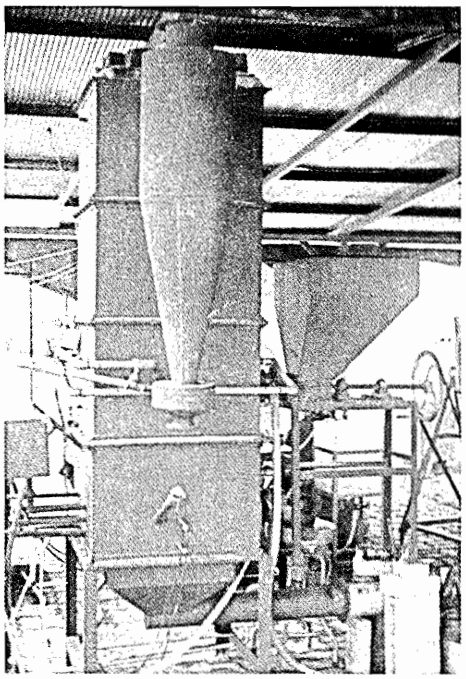

Fig. 2 Pilot plant scale fluidized-bed combustor.

i. Fuel could be fed both under-bed and over-bed with water cooling.

ii. There were two groups of secondary air tubes. One was set 20 cm above the outlet of the under-bed feeder because near the outlet of the feeder there is always a fuel rich area which needs more air. The other group was set in the four sides of the wall 80 cm above the distributor plate.

iii. There was a view window of quartz glass, by which the burning process could be observed during the operation. Beside it a door was set up for checking or repair work when needed.

iv. There were three separated immersed water tubes in the bed to remove the heat from the combustor when the bed temperature was too high.

Test Results

The test results showed that the pilot fluidized-bed rice husk combustor is a very efficient and attractive combustion system for producing energy and ash for making cement. The heat power generated is about 200-300 kW, when the FBC works with 20% excess air, and the combustion efficiency is higher than 95%.

There is strong freeboard combustion over the bed. To achieve good combustion efficiency, secondary air is very important and must be supplied uniformly.

The start-up of FBC using the gas burner is convenient. The period for start-up is about 20-30 minutes. When charcoal is used for start-up, a careful control of the charcoal feed rate is needed during the start-up to avoid excessive accumulation of char in the bed.

The combustible loss in fluidized-bed combustion of rice husk is mainly due to the CO loss in the flue gas. More excess air and better mixing are useful to reduce the CO loss.

The tuyere distributor is more suitable for FBC of rice husk than perforated plate. It not only gives low pressure drop, but also reduces the clogging of the distributor holes.

The FBC system also produces a useful by-product, reactive ash which can be used for making cement. When the rice husk ash/ Portland cement ratio is 30:70, the pozzolana cement obtained has a higher compressive strength than pure Portland cement and pozzolana cement obtained using ash from electric burner and open-field burner.

Further details of the fluidized-bed rice husk combustion system are available in "Fluidized-Bed Combustion of Rice Husk for Energy and Pozzolana", Master Degree thesis by Wu Zeizhang, Energy Technology Division, Asian Institute of Technology, Bangkok, 1987, viii+ 61p.

(Contributed by Dr. S.C. Bhattacharya, Energy Technology Division, Asian Institute of Technology, Bangkok.)

Rice Husk Briquettes

Under the ASEAN-Australian Programme on the Management and Utilization of Food Waste Materials, the Standard and Industrial Research Institute of Malaysia (SIRIM) is undertaking a project to study the feasibility of briquetting food waste materials into log for use as fuel; the project is being financed by the Australian Government. Among the materials under study, rice husk is considered to be of high priority.

Briquetting System

The complete briquetting system consists of a dryer and a briquettor. The material to be briquetted is first passed through a shifter and transferred to a rotary dryer via a screw conveyor. It is then fed to the briquettor through a cyclone and a feed hopper.

The briquettor (Fig. 1) consists of a 15 HP motor, a screw and a cylindrical die which is heated by a 5 KVA heater. The material is dropped on the screw and compressed through the die and extruded as a cylindrical log. The material to be briquetted has to have a moisture content of about 13%; briquetting of material of moisture content more than that gives rise to an incomplete briquette and it is extruded with explosion. This is due to the fact that the moisture is superheated within the die.

Table 1 Comparison of calorific values and costs of various fuels.

Fuel	Calorific Value			Cost	
	kcal/kg	Btu/lb	Joules/g	US¢/kg	US¢/100 kcal
Rice husk briquettes	3,635	6,543	15,210	5.8	1.6
Carbonized briquettes	4,011	7,220	16,780	15.0	3.7
Green firewood	2,500	4,500	10,460	4.0	1.6
Charcoal	5,610	10,100	23,480	21.0	3.7

Rice Husk Briquette

Rice husk was briquetted without drying as the material obtained has a moisture content of about 11%. Briquetting was carried out at temperatures 300°C – 400°C and it was found that at temperatures of 350°C and above it could be extruded with ease and the briquette obtained was of smooth surface. At temperatures below 350°C, the extrusion was not steady, probably due to high friction within the die and cracks appeared on the surface of the briquettes. The throughput at 350°C was 80 kg/hr. The briquette obtained is a cylindrical log (Fig. 2) and the surfaces are charred.

The briquettes could be carbonized by a bench scale metal charcoal kiln. The quantity of carbonized briquettes obtained was about 40%. Both briquettes could be burnt easily but with a slow and steady flame. Calorific values of the rice husk and carbonized briquettes were 3635 and 4011 kcal/kg respectively.

Comparison of calorific values and costs of various fuels has shown that briquettes and carbonized briquettes are comparable to firewood and charcoal respectively in terms of energy costs (Table 1). There is a tremendous cost saving for using briquettes instead of fuel oil in drying and steam generation.

A preliminary estimation of the production cost for the briquettes based on a typical LPN (National Rice and Padi Board) mill (3200 tons of husk produced/yr) was carried out. 10 briquettors with the same output as in the experiment are required. The capital cost was found to be US$117,000 with the product cost of US$58 and US$-150/ton for briquettes and carbonized briquettes respectively.

Extracted from "Rice Husk Briquettes – Source of Energy and Solution to Pollution Problems" by Pang Teck Siong and Lu Sim Hoay, Paper presented at ASEAN Conference on Energy from Biomass, 13-15 October 1986, Penang, Malaysia.

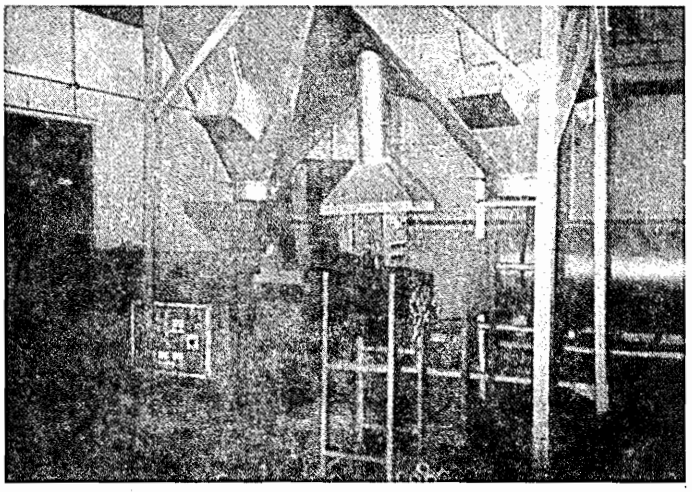

Fig. 1 The briquettor

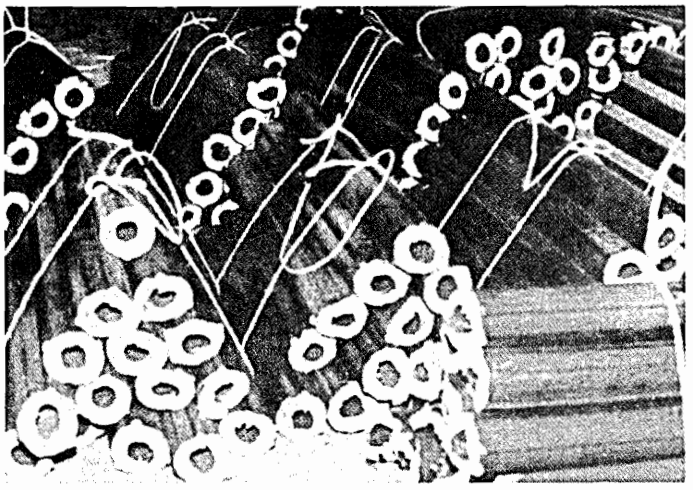

Fig. 2 Rice husk briquettes

Dendrothermal Power Plants Planned - Thailand

A master plan for a dendrothermal power project foresees 83 plants being built throughout Thailand to generate 2,075 MW of electricity, said the Secretary-General, Prapath Premmani, of Thailand National Energy Administration (NEA).

A Swedforest consultant, provided by the Swedish Government at a cost of nearly seven million bahts, has been working on the Master Plan for a *Eucalyptus* Plantation and Dendrothermal Power Plant Project since early 1987. The project will focus on the potential for generating electricity in areas of the country where the soil is inadequate for farming, where there is not enough rainfall or in deforested areas.

Drawing on a report to be submitted to NEA in November 1987 Secretary-General Prapath says there are several significant possibilities for producing electricity from firewood to meet the country's growing demand.

The study reveals, he said, that 83 dendrothermal plants capable of generating 25 MW of electricity each, including 50 in the Northeast, could be powered by firewood produced on about 3.8 million rai of land by 200,000 to 500,000 families. Each plant will need at least 46,000 rai of reforested land to produce about 225,000 tons of firewood a year for fuel and each will need about 100 workers.

The project is of interest because it is not only aimed at producing electricity but also at helping solve unemployment, deforestation and at utilizing land with poor soil or low rainfall. Although the programme would upgrade Thailand's technology, 30 to 40 per cent of the equipment could be made locally. In fact, dendrothermal power is not new to Thailand, and it has been used in the past to produce electricity. However, the boiler used to run the generator has been improved since the old days and is now more efficient.

The study also says that farmers providing fuel for the plant would get at least 80 satang (US$0.032) a kilogramme for the estimated 3.7 tons of green wood they would grow a year on each rai of land. Preliminary estimates show it would cost 1.10 to 1.20 bahts (≈ US$0.044-0.048) to produce a kilowatt-hour of electricity.

A plant run by firewood would save about 40 million litres of bunker oil a year or 4.6 million cubic feet of natural gas a day. A 25 MW dendrothermal plant would cost about 900 million baht (≈ US$36 M), he said, but the private sector could probably build one for less.

The study says that besides 50 plants in the Northeast, seven would be suitable for the East, 10 for the Central Plains and the South and 16 for the North and West. A pilot project with a 3-5 MW plant is underway in Khon Kaen's Mancha Khiri district. The project would require about 150 million baht (≈ US$6 M) for construction and 36 million baht (≈ US$1.44 M) for reafforestation.

Mr Prapath said that the master plan and the results of the pilot project would eventually be submitted to the Cabinet.

(Source: Bangkok Post, Home News, October 19, 1987, p. 3)

MALAYSIAN BIOMASS PROJECT

From P. 2

(LPN) complexes in Sekincan, Selangor. Performance and operating conditions of the system, and heat recovery potential and efficiency are being investigated. So far the system is running smoothly on rice husks. Other potential feed to be tested includes empty bunches of palm oil fruits, sawdust and palm oil mill effluent.

Further details of the Malaysian Biomass Project are available in:

1) *Biomass Project,* Project Abstract, Standards and Industrial Research Institute (SIRIM), Kuala Lumpur, Malaysia.
2) Malaysian Experience on Fluidized-bed Combustor for Agricultural Wastes, Hamdan Mokhtar, Ahmad Hazri Ab. Rashid, Mohd. Shuid Salleh and Zanariah Ujang, *Proceedings of ASEAN Conference on Energy from Biomass: Development towards efficient utilization of biomass energy,* 13-15 October 1986, Penang, Malaysia. ASEAN Working Group on Non-Conventional Energy Research, pp. 62-75.

New Name for RERIC

Starting January 1988, the *"Regional Energy Resources Information Center"* will be the new name for RERIC instead of Renewable Energy Resources Information Center. This change retains the acronym "RERIC" and emphasizes RERIC's regionality while enabling us to include an expanded subject coverage.

Energy planning and energy conservation technology (rational use of energy) are now being added to the primary subjects covered by RERIC which are solar energy, biomass energy, wind energy and small-scale hydropower.

For details on RERIC's activities and services please contact:

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G.P.O. Box 2754
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Biogas from Marine Algae

Investigations into the possibility of converting the presently wasted Malaysian sea lettuce, *Ulva reticulata* FORSSKAL, into biogas via biogenic processes were carried out. The contamination levels of environmental pollutants, i.e. trace metals, PCBs and persistent pesticides were also verified.

Figure 1 illustrates a simple practical semi-continuous integrated household biogas digester and gas collector model for marine algae. The 50% (w/v) marine algal substrate is fed down the inlet pipe to the bottom of the first compartment of the double compartment digester. The level of the liquid substrate in the digester is controlled by the over-flow level of the outlet pipe. In the process of digestion, the liquid travelled through the compartments and out of the outlet pipe. At this juncture, when assuming a digester 60 cm in diameter and 60 cm in height (fluid level) the system would theoretically produce daily 60 L of gas from 88.7 kg wet algal thalli. Since the normal optimal retention time of the substrate in the digester is ca. 40 days, one can have a working semi-continuous integrated system by feeding ca. 23 kg wet algal thalli every ten days at 50% (w/v). At this feeding rate the retention time of each batch would be 40 days, i.e., before final discharge in the outlet pipe, which is the time required by the substrate to travel from one compartment to the other over the weir and out. The produced biogas is trapped by a floating drum, which acts as a gas storage chamber. This accumulated biogas can then be drawn-off as required for lighting and cooking purposes.

Production of biogas by marine methanogenic bacteria was found to be 33.4% greater than freshwater methanogenic strains. Analysis of fuel gas showed that it contains 58% methane gas, 35% CO_2 while the remaining fractions are assumed to be H_2S, NH_3 and O_2.

It is obvious that the feasibility of biogas production from marine algae is quite promising. The proposed digester could be an economical asset to rural fishing communities during this period of the energy crisis and economic recession. Further, besides employing marine algae as a substrate, the auxiliary feeding of organic household plant waste, poultry and human excreta could be considered.

Comparison of the methane constitution of the biogas produced from marine algae (58%) to that of human and poultry excreta (60 — 65%) reflects not a very drastic difference. In countries where the concept of excreta digesters are not readily accepted, this proposal for the utilization of wasted marine algae could possibly play the function of a forerunner to its acceptance.

The question of having either a marine or freshwater methanogenic bacterial strain digester system depends on the requirements in the further utilization of the effluent slurry as nutrient recycling. Normally, owing to the conversion of the digested slurry into nutrients in available forms for plant life, it is employed as soil conditioners, or as enrichments in fish culture ponds. However, the marine methanogenic bacterial strains system slurry is not viable for the former use because of the high content of salts, which are detrimental to plant life.

Source: Extracted from *Marine Algal Biomass as a Possible Bioenergy Resource*, by P.M. Sivalingam, Paper presented at the ASEAN Conference on Energy From Biomass, 13-15 October 1986, Penang, Malaysia.

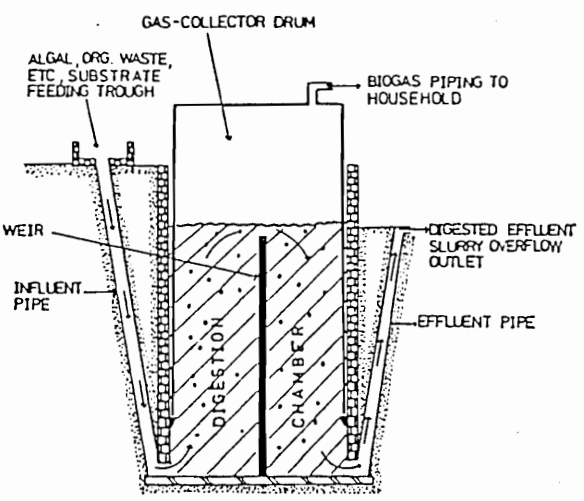
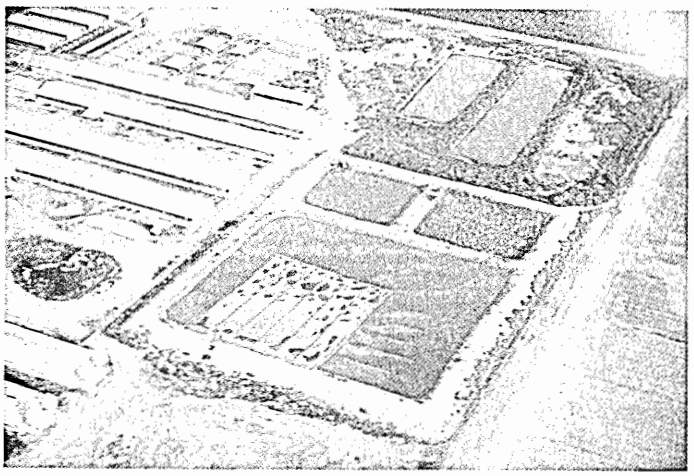


Fig. 1 A practical simple semi-continuous integrated household unit biofuel-gas digester and gas-collector for algal and other household organic waste substrates.

Royal Farms' 75 kW Covered Lagoon Biogas System

Royal Farms is an 8000 total population farrow-to-finish pork production unit in Tulare, California. Approximately 2½ tons of manure solids are removed from the barns each day by flushing the floor area with a 50/50 mixture of fresh and recycled water. The slurry flows by gravity to a sump and is pumped into an anaerobic lagoon treatment system consisting of three lagoons. The primary lagoon has a surface area of approximately one acre. Bacteria break down manure in the lagoon producing biogas, which is composed primarily of methane and carbon



Royal Farms anaerobic lagoon treatment system

Floating hypalon cover

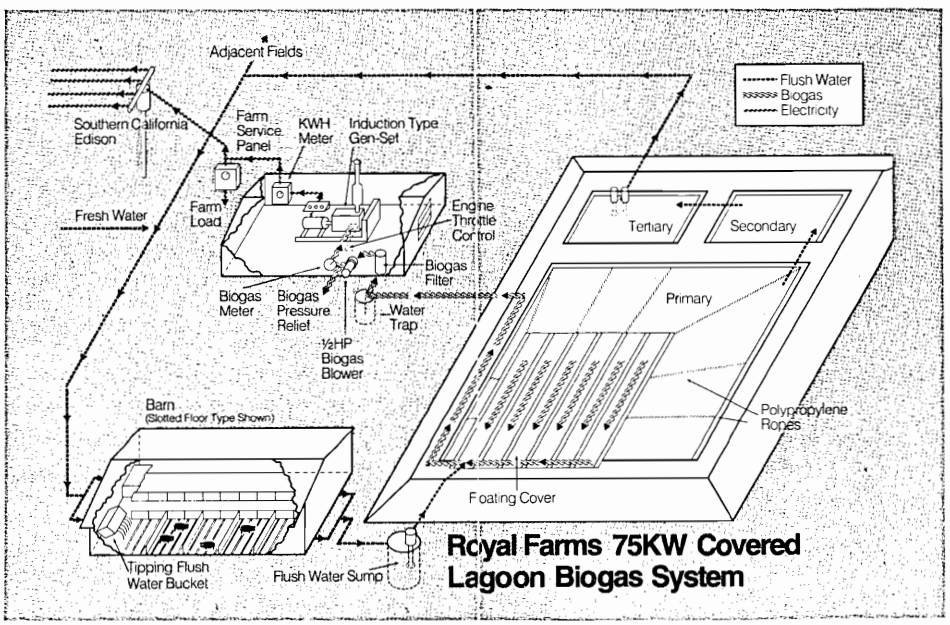
dioxide. Biogas can be converted to electricity or used in any operation requiring natural gas.

The primary lagoon at Royal Farms has been producing biogas which previously was escaping into the atmosphere. Roy Sharp, the owner of Royal Farms, was interested in capturing the wasted biogas to produce energy. Because methane fermentation technology is relatively new, he sought government assistance in sharing the risk of developing and demonstrating this technology. Mr. Sharp applied to the California Energy Commission for funding through the Biomass Demonstration Program, which provides nointerest loans to demonstrate innovative energy-producing technologies. He installed a system which recovers the biogas to produce electricity for on-site use and for sale to Southern California Edison Company (SCE). A rubberlike membrane was placed over onethird of the primary lagoon's surface (12 600 square feet) to collect most of the biogas produced. The collected biogas fuels a 75 kW engine generator. The engine generator produces waste heat which Roy Sharp is considering using to heat barn space or dry grain.

Biogas production from the system ranges from 36 000 cubic feet per day during the summer to 25 000 cubic feet per day during the winter. The biogas produced has a fuel value of 700 Btu per cubic foot. Lagoon temperatures range from 72°F (summer) to 52°F (winter). Even during the winter months, biogas production from this covered lagoon system is superior to typical production from a conventional biogas system at a flush-type farm.

The initial capital cost of the 75 kW Royal Farms covered lagoon biogas system is US$89 000. However, first-year revenues from the combined sale of electricity to SCE and electricity savings are expected to be over US$36 000. The system has a 34 percent rate of return and is expected to have a payback period of less than 2.9 years.

The Royal Farms system is the first in the United States to employ a cover sized and installed to collect biogas for energy purposes. Historically, conventional biogas fermenters have worked poorly at farms using flush-type manure handling systems. Most have been uneconomical and require a considerable amount of maintenance by a highly skilled operator. Maintenance at Royal Farms is essentially limited to engine generator servicing. Since the project's start-up in April 1982, the Royal Farms covered lagoon biogas system has proved a positive example to the nearly 650 swine and dairy farms using flush-type systems throughout California.



Royal Farms 75KW Covered Lagoon Biogas System

(Source: Information obtained from: California Energy Commission Development Division, Biomass/Cogeneration Office, 1516 Ninth Street, Sacramento, California, 95814, U.S.A.)

Brunei Darussalam It's Energy Sources

Brunei Darussalam ("Abode of Peace") is located on the northern coast of the island of Borneo with an area of 5,765 square kilometers and population of 226,800 (25,000 of whom are temporary residents). Brunei has a per capita income of about US$17,000 a year.

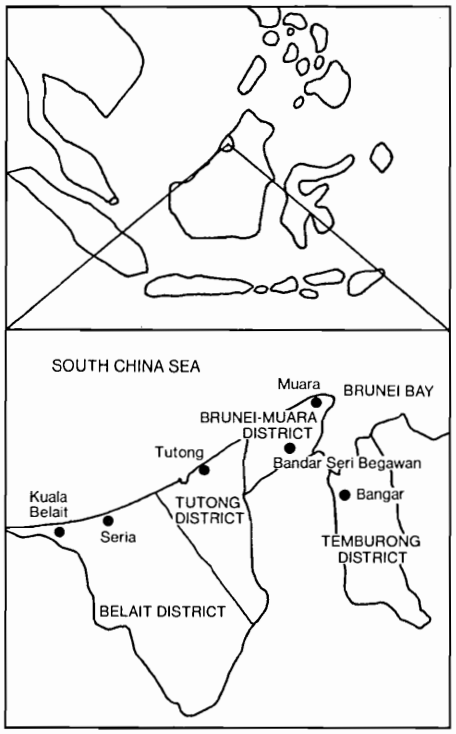
The Oil-Based Economy

Oil and natural gas in 1985 provided the Government with more than 88 per cent of its revenue and contributed B$5.4B (≈ US$-2.6B) to the Gross Domestic Product (GDP). Brunei Darussalam is the third largest producer of oil in South-East Asia after Indonesia and Malaysia.

The onshore Seria field was found in 1929, but was not fully developed until after World War II. By 1956 the field was producing 114,700 barrels a day. Offshore production began in 1964 and today there are some 182 offshore structures operated by Brunei Shell Petroleum Company (BSP), jointly owned by the Brunei Government and Shell.

Annual oil production in 1985 was estimated at 61.3 million barrels or 168,000 barrels a day, down from a peak of 261,000 barrels a day in 1979 under the depletion policy which seeks to ensure a set recovery rate suited to economic needs. This aims at bringing production down to 150,000 barrels a day by 1988 and into the next century.

In 1985 Brunei's oil exports were estimated at 34 per cent to Japan, 12 per cent to the United States, 35 per cent to other countries. Brunei Darussalam uses only three per cent of its oil for domestic purposes, the new Seria refinery (capacity 10,000 barrels/day) producing 5-6000 barrels/day for the country.



Natural Gas

Brunei Darussalam is the world's fourth largest producer of liquefied natural gas. A plant set up in 1973 by Brunei LNG Sdn Bhd (50 per cent owned by the Government, and 25 per cent each owned by the Royal Dutch Shell Group and Mitsubishi Corporation) exports five million tons annually to Japan under a 20-year contract ending in 1993. It is estimated that about 34 percent of Brunei's large natural gas reserves have been recovered.

A B$304.5 M (≈ US$147.8 M) (total current approved budget) co-generation project, which is expected to be completed in 1987, will provide power for industrial and domestic use. It is a joint project between the Government, Brunei Shell and Brunei LNG.

Electrical Services

The major electric power stations in Brunei are located in Gadong, Seria, Temburong, Muara, and Layong. The electric generators are driven by gas turbine, diesel or by standby system. In 1984 the total electric power generated was 632.83 MW.

The Department of Electrical Services has been involved in the rural electrification programme under the 3rd and 4th National Development Programme. Table 1 shows the percentage of population which had electricity supply by 1984.

Overall, only 3% of the population in the whole state had not received electricity supply. The small increase and the remainder of the population without electricity supply in various rural districts are due to the widely dispersed locations of the villages which are not easily accessible by road.

The growth of electricity demand is forecasted to be at 10% in the next 10 years. These forecast therefore envisage a maximum demand of 250 MW in 1990 and 497 MW by the year 2000.

(Extracted from: Brunei Darussalam Facts & Figures, *Muhibah*, September/October 1987, pp. 38-40, and *Review* 1983/84, Ministry of Development, Department of Electrical Services, Negara Brunei Darussalam.)

Table 1 Percentage of population with electricity

District	Early 1980	Late 1984	% Increase
Brunei/Muara	98%	99.5%	1.5
Belait	95%	97.0%	2.1
Tutong	69%	89.0%	29.0
Temburong	87%	90.0%	3.5

Industrial Energy Management Project - Singapore

In the last few years, ASEAN cooperation on energy research has attracted substantial funding from developed countries such as Australia, Canada and the USA. Singapore has been designated as the ASEAN focal-point on Energy Conservation Technology.

The project on Industrial Energy Management is the major sub-project on Energy Conservation Technologies under the ASEAN-Australia Economic Cooperation Programme on Energy. The project team is composed of members of staff from the Department of Mechanical and Production Engineering of the National University of Singapore and from the School of Mechanical and Production Engineering of the Nanyang Technological Institute.

Major objectives of the project are:

(i) To conduct an energy survey and audit of the major industrial sectors in Singapore;

(ii) To provide continuing education and training on energy conservation technologies to Singapore industries;

(iii) To conduct on-site energy utilization studies of a number of establishments in each industrial sector; and

(iv) To initiate a programme of applied research on thermodynamic efficiencies, thermoeconomics and on energy conservation and recovery in industrial processes.

Progress on Industrial Energy Management Project

(i) *Applied Research Studies*

Good progress has been achieved in the applied research programme. To date, analyses based upon the first and second law of thermodynamics have been applied to industrial processes. The methodologies developed are used to evaluate the first-law and second-law efficiencies of a number of industrial sub-processes, namely, steam heating and pasteurization processes, cooling processes, mixing, blending and homogenizing processes and combustion processes.

(ii) *On-site Industrial Process Studies*

Work in the area of on-site industrial process energy studies has been initiated during the past 18 months. Evaluation of the energy consumption and on-site experimental studies have been conducted for a number of establishments and these include 3 structural brickworks, 3 food-processing plants and one beverage plant. While process and plant analyses have been carried out for most of the above establishments, there have been instances where detailed analysis could not be made due to a lack of instrumentations.

Structural brickworks

The three structural brickworks were selected for on-site studies on the basis that they are representative of the different levels of production volumes and degree of mechanization existing in the brick manufacturing industry in Singapore. One of the brickworks is a large-scale plant having a daily production of 200,000 bricks and the other two brickworks have each a daily production of about 55,000 bricks. The results of the experimental studies showed that the first-law efficiency of the large-scale plant is 62% and those of the two medium-size plants are lower at about 55%. The second-law efficiencies are lower and the average for the three brickworks is about 20%.

Bakery plant

The bakery plant consists of four processes, namely, dough-preparation, dough-cutting and rounding, fermentation and baking. Energy analysis of the plant was based on the dough-preparation, fermentation and baking processes only as the dough-cutting and rounding processes are essentially mechanical processes and in comparison to the other processes, are minor energy consuming processes. Energy inputs to the bakery are in the form of electricity, steam and diesel fuel. The first-law and second-law efficiencies of the bakery were found to be 43.0% and 15.5%, respectively. Energy consumption by the bakery oven accounts for more than 90% of the total energy input to the plant.

Condensed milk production

The condensed milk production line consists of six processes, namely, dissolving, homogenizing, milling, pasteurizing, steam-injection and flash-cooling. Steam and electricity are the energy input to the plant. Energy consumption by the steam-injection and flash-cooling processes account for 25% and 33%, respectively, of the energy consumption of the production line. The first-law and second-law efficiencies of the condensed milk line were found to be 59.6% and 19.4%. respectively. Analysis of the sub-processes indicated that steam injection is an efficient process and that this could be used to replace the steam-coil heating processes.

Instant noodles

The production process of instant noodles consists of dough kneading, rolling, slitting, steaming, noodle frying and finally cooling. Steam and electrical energy are the main sources of energy used.

Malt-beverage powder

This is a chocolate flavoured, fortified food drink in powder form and consists mainly of malt extract, sugar, milk solids, butter oil, cocoa powder, mineral salts and various vitamins.

The overall plant first-law and second-law efficiencies of the in-

Cont. P. 10

Rolled Solar Collectors

A prototype of a lightweight, simple, robust and cheap solar collector with high efficiency, that can be rolled up for transport and easily installed on site has been tested in the Studsvik solar simulator.

The collector has been developed by Fedor Stranicky in Solna, with funding assistance from STU. The project, which has been given the name Swewater, has been patented in 17 countries.

The solar collector can be used for large-scale energy production, for district heating, for electrical energy generation and desalination.

Figure 1 is a schematic diagram of the main features of the design. The absorber consists of rubber hoses that have been vulcanized together with a thin casing of black brass. The hoses rest on a layer of insulating material between them and the ground. The back of the reflector, which may be made of either sheet metal or film, is insulated to reduce heat losses. Its angle can be adjusted for maximum insolation on the absorber.

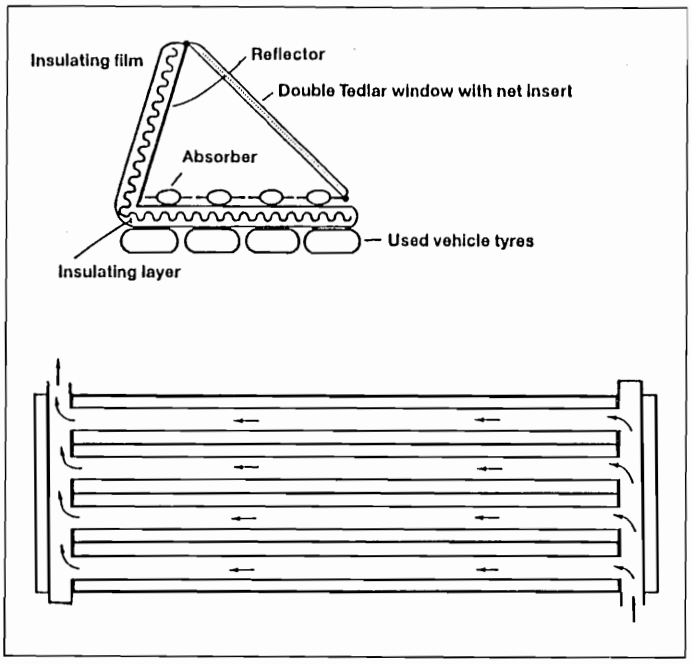


Fig. 1 Schematic diagram of the solar collector.

Industrial Energy Management Project – Singapore
From P. 9

stant noodles and malt-beverage production lines are dictated by the major energy consuming sub-processes of each plant. For each batch of 525 kg of instant noodles, the total energy and available energy inputs were 1407 MJ and 438 MJ. The palm-oil heating and frying processes were the main energy consuming processes. These two processes accounted for a total of 89.4% and 82.2% of the energy and available energy input to the plant.

Energy and available energy consumption of the malt-beverage plant are 2571 MJ and 1280 MJ, respectively, for a batch of 1100 kg. The plant first-law and second-law efficiencies are dictated primarily by the drying process. This process alone consumes 92.4% and 90% of the total energy and available energy input to the plant. The first-law and second-law efficiencies of 23.6% and 7.9% for the plant are a consequence of the low first-law and second-law efficiencies of 21.3% and 8.2% of the drying process.

(iii) *Energy Consumption Survey of Singapore Manufacturing Industries*

A survey of output-related energy consumption in selected manufacturing industries in Singapore was carried out. With the cooperation of the Singapore Manufacturers' Association (SMA), the survey was conducted among the members of SMA whose membership covers more than 90% of the manufacturing establishments in Singapore.

The project was carried out by the School of Mechanical & Production Engineering, Nanyang Technological Institute (NTI). The entire project includes data collection, computer software development, data processing and analysis of documentation.

The following 10 industrial sectors were selected for the survey:

- Beverage
- Textiles and textile manufacturers
- Paper and paper products
- Industrial chemicals and gases
- Other chemical products
- Petroleum refineries and petroleum products
- Pottery, China, earthenware and glass products
- Non-metallic mineral products
- Iron and steel
- Electrical machinery, apparatus, appliances and suppliers.

The selection was based on higher energy used per establishment and higher energy cost factor according to information published by the Department of Statistics. The survey included basic company information, age and capacity ratings of energy consuming equipment and the monthly production and energy data for the two calendar years 1983 and 1984.

Survey forms were sent to 346 companies in the selected sectors. The response rate was 23.7% but many of these forms could not be used. In fact only 9.5% of the total numoer of firms surveyed returned usable forms. The low response rate is due mainly to the fact that many companies are unwilling to disclose their production data.

As the percentage of useful returns from the survey is relatively low, the sectoral average specific energy consumptions obtained are by no means accurate and representative. However, the present phase of the project has successfully developed the necessary basic software for processing energy and production data into useful infor-

Protection against external moisture is provided by a plastic film. The convection baffle, which is welded or glued to the vapour barrier, is also made of plastic film.

The collector requires no special foundations, and can be simply laid out on wooden beams — or even on old vehicle tyres — directly on levelled ground. A simpler and cheaper heat insulation has also been developed and is available for use.

The collector can be manufactured in 50-100 m long strips, which can then be rolled up, complete with insulation, reflector and all other parts. After transport to site, they are simply unrolled and connected up into the required number of units.

The specific price per m^2 of collector, installed and ready to use, is about SEK 1000 (≈ US$160) including heat insulation, reflector and transparent cover.

According to the test, with an energy absorption rate of 500 W/m^2 and a water flow rate of 3 L/s, the temperature increase over a 100 m long section of collector was 40 K. The dynamic pressure drop was 5000 N/m^2, which is very low and would essentially permit longer absorber hoses, up to 200 m. Efficiency is of the order of 70-80 per cent, depending on solar elevation.

These performance figures are, however, theoretical. The prototype that has been tested is considerably shorter than a full-scale unit. As a result, its flow velocities are lower and end losses are greater. However, it was possible at times to reach an efficiency of 50 per cent during the trials in the Studsvik simulator test facility.

Comparative measurements in the solar simulator indicate that the Swewater solar collector captured about 15 per cent less energy per m^2 per year than a vacuum tube solar collector would have done. This difference is quite small, particularly when it is borne in mind that the vacuum tube collector is considerably more expensive. Since then, development and outdoor trials have confirmed the above mentioned efficiency of 70-80 per cent.

(Source: Rolled solar collectors by the metre: Development of a new type of solar collector for solar district heating systems, *Energy Technology*, No. 3, 1987, pp. 6-7. Swedish Board for Technical Development.)

mation. The data base can be updated and expanded whenever necessary.

According to the project team so far the project on industrial energy management has progressed satisfactorily. In the coming months, further effort shall be made in the areas of in-situ energy conservation studies, equipment and instrumentation acquisition and development. In the area of energy survey, the work anticipated shall be in the areas of upgrading the software capabilities, incorporation of data from other countries and expansion of the data bank through further surveys. Emphasis shall also be placed on the various aspects of the development of short courses and training programmes on industrial energy conservation.

Further details of the project and progress achieved are available in "Industrial Energy Management" by J.C. Ho, T.T. Chandratilleke, S.N. Tay and R. Osman, paper presented at the Seminar on Energy Conservation Technology, 12 September 1986, National University of Singapore, organized by the Energy Project Committee, Department of Mechanical and Production Engineering for the ASEAN-Australia Economic Cooperation Programme of the ASEAN Working Group on Non-Conventional Energy Research.

Vertical-Axis Wind Turbine A Modified Design

A vertical-axis rotor was developed by S.J. Savonius in 1929,[1] with an alternative version being reported by G.J.M. Darrieus in 1931.[2] However, the system never became popular for harnessing wind power because of its low efficiency. Nevertheless, this design possesses significant advantages compared with those for the more widely used horizontal-axis wind turbines. These are:

(a) simplicity of construction;
(b) it is self-starting;
(c) it is able to accept wind from any direction and harness power from it; and
(d) no over-speed control is required.

These advantages usually make it a commercially viable proposition when built with local labour and indigenous materials for small-scale applications in developing countries.

During the past two decades, research attention has been focussed on improving the performance of vertical-axis wind turbines. The highest measured efficiency[3] is 33% while the power coefficient measured by Modi *et al.*[4] was 0.22. Therefore, the School of Mechanical Engineering at the Cranfield Institute of Technology (UK) has made investigations aimed specifically at developing a wind turbine suitable for providing power for water pumping.

Modified Rotor Design

A Savonius rotor was selected because, in addition to the advantages mentioned above, for the envisaged application it exhibits the following benefits: significant torques are developed even at low wind speeds; it can be robust; and it is simple to maintain.

The blade profile for a conventional Savonius rotor was chosen according to the recommendations of Modi *et al.*[4] However, each Bach-type blade[5] for the present investigation consisted of five pieces: the semi-circular portion of each blade involved four flaps, with the straight portion in a single piece (see Fig. 1). The latter was fixed between the two end-plates.

Cont. P. 12

Vertical-Axis Wind Turbine: A Modified Design

From P. 11

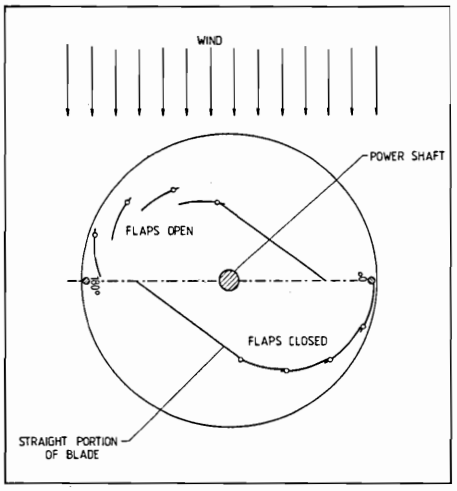


Fig. 1 The modified Savonius rotor.

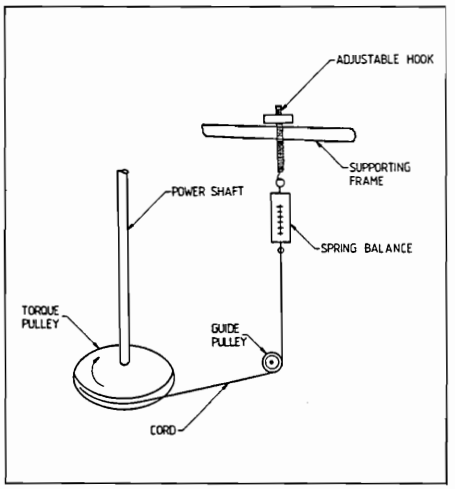


Fig. 2 Apparatus for measurement of the static torque experienced by the wind turbine.

Each of the four flaps was pivoted about one of its vertical edges, its free edge overlapping and resting against the hinged edge of the adjacent flap. This arrangement facilitated the opening of the flaps when moving into the wind. The hypothesis was that by allowing the flaps to open in the way described, the drag on each blade when moving into the wind would be reduced, so resulting in an improved power output from the turbine.

Performance Testing

The performance of the modified rotor was compared with that of the conventional one of similar dimensions with respect to the static torque produced by the wind. The arrangement for the measurement of static torque is shown in Fig. 2. The static torques for the modified and conventional rotors were measured at several angular positions. The effect of the flap opening was also studied.

The rotor with flaps experienced a positive torque at all orientations of the rotor system with respect to the wind. The results indicated an increase of 35.1% and 32.7% in average static torque experienced by the modified rotor, with flaps openable to 60°, compared with the conventional rotor, at the wind speeds of 6.67 and 7.67 m/s respectively.

There will be an optimal permitted angle of flap opening for a particular geometry to achieve the greatest harnessing of the wind power, but more results are needed to identify this.

References

1. Savonius S.J.. The S-rotor and its applications, *Mechanical Engineering,* 53(5), 1931, pp. 333-8.
2. Darrieus G.J.M.. *Turbine having its rotating shaft transverse to the flow of the current,* US Patent No. 1 835 018, 1931.
3. MacPherson R.B., *Design, development and testing of low-head high-efficiency kinetic energy machines – an alternative for the future,* M.Sc. thesis, University of Massachusetts, Amherst, Mass., USA, 1972.
4. Modi V.J., N.J. Roth and M.S.U.K. Fernando, Optimal configuration studies and prototype design of a wind-energy operated irrigation system, *Journal of Wind Engineering and Industrial Aerodynamics,* 16, 1984, pp. 85-96.
5. Bach G., *Investigations, concerning Savonius rotors and related machines,* Translated into English by the Brace Research Institute, Quebec, Canada, 1931.

(Extracted from: Tabassum, S.A. and S.D. Probert, Vertical-Axis Wind Turbine: A Modified Design, *Applied Energy,* 28(1), 1987, pp. 59-67).

Standardized Small Hydropower Plants

A UNIDO/China expert group meeting was held in Hangzhou, China, 18-21 May 1987 and a post-meeting study tour took place in Zhejiang and Guangdong Provinces, China.

The meeting, financially supported by the Swiss, Swedish and Chinese Governments, was executed by UNIDO and entrusted to Hangzhou Regional Centre for Small Hydro Power (HRC) for concrete implementation.

The objectives of the meeting were to:

- o consider proposals on standardized small hydro power (SHP) models and select those suitable for local production and operation in developing countries.
- o identify specific technical assistance requirements that would facilitate local manufacturing of the selected SHP equipment and execution of associated civil works.
- o collate information on manufacturers of SHP equipment in developing countries with a view to preparing a directory of such manufacturers.
- o specify appropriate international co-operation measures that would facilitate technology unpackaging in the SHP sector.
- o analyse the costs and benefits of technology unpackaging in the SHP sector and make appropriate recommendations.

Based on the discussion paper issued by UNIDO, "Report on Standardization for Indigenous Manufacturing of Small Hydropower Plants" prepared by SWECO, Sweden, and the "Report on Standardization of Civil Works for Small Hydropower Plants" prepared by ELECTROSTAT, Switzerland, some extensive and intensive discussions took place. Chinese experts submitted a report entitled "Application of Standardized SHP Installations in China" and two reports on propeller and tubular turbine models. OLADE delivered a report

Visit of Advisory Board Member to RERIC

Earlier this year, in August, whilst vacationing in Thailand, Prof. William J. Chancellor visited the Renewable Energy Resources Information Center (RERIC). Prof. Chancellor is Professor of Agricultural Engineering at the University of California, Davis, U.S.A. He has served as an Advisory Board member of RERIC since 1984, and his contribution to RERIC has greatly benefitted RERIC's activities and services.

In answering to a question put to him by Mr. H.A. Vespry, Director of the AIT Library & Regional Documentation Center and Director of RERIC, Prof. Chancellor mentioned that one of his special interests in Asia is the design of buildings to provide sufficient thermal comfort by natural features. He added that due to urbanization, modern Thai houses have lost many of the natural cooling design features of the traditional Thai farm house design, such as the east-west orientation of the long axis for maximum internal shade, the insulating character of thatched roofs, orientation of buildings for prevailing wind directions, and the arrangement of window areas and internal partitions to maximize air flow.

One of the natural cooling applications that he has applied to his own house in California was also mentioned. By fixing white aluminum roofing sheets on the roof, it was possible to reflect solar radiation back to the atmosphere and to reradiate building heat to the cool night sky, thus reducing the regular use of the air conditioner to only about 3 days last summer. He hopes to carry out a number of research projects on natural cooling features in the future.

In reply to a question regarding utilization of gasohol in the U.S.A., Prof. Chancellor mentioned that due to the legislation on reduction of lead content in gasoline, 10% ethanol is added frequently to gasoline of moderate octane rating to further increase the octane number of the fuel which is then sold under the name "super-unleaded" rather than gasohol. This has resulted in the increase of alcohol use for fuel in the United States.

During the visit, Prof. Chancellor demonstrated to the RERIC staff methods of retrieving of his database which contains technical articles published in the Transactions of the ASAE, Agricultural Engineering and Applied Engineering in Agriculture since 1954. One copy of the database is kept in the RERIC office, and one copy in the Agricultural and Food Engineering Division, AIT, for the use of researchers, students and faculty members.

A set of the IBM-PC type database disks (including the DOS search programs) will be made available to one individual in each organization who provides Prof. Chancellor with seven formatted, doublesided, double-density, 360 kbyte disks, and who in his or her letter of request, indicates willingness to allow others in the same organization or vicinity to make copies of the database.

For further details about the database, please contact:

Prof. William J. Chancellor
Agricultural Engineering Department
University of California
Davis, California 95616
U.S.A.

From left: Mr. H.A. Vespry (Director, LRDC/RERIC), Prof. W.J. Chancellor (Univ. of California, Davis, U.S.A.), Dr. Somchart Paisarnrat (Information Scientist, RERIC), Mrs. On-anong Suraniranat (Senior Information Scientist, RERIC).

entitled "Experience in the Standardization of SHP Stations".

The meeting was attended by 48 participants from 25 countries, each presented a country paper which gave a briefing on SHP resources and their future development in respective countries.

Mrs. Santos, the present Coordinator of the Regional Network for Small Hydro Power (RN-SHP), presented a report summarizing the current situation of RN-SHP in the Asia-Pacific Region. This was received enthusiastically and it was concluded that similar network activities would be beneficial also in Africa and Latin America.

(Source: SHP News, No. 2, 1987)

Standards for Testing Water Pumping Windmills

The Consultancy Services Wind Energy Developing Countries (CWD) in cooperation with the World Bank and UNDP is involved in developing standards for the testing of water pumping windmills. These standards will make it possible to compare the performance of different windmills tested at different test sites and to predict the output of a tested windmill in any wind regime.

The document that is being prepared to disseminate these standards consists of two parts. The first part entitled "Standards for Testing on Test Sites" is to describe recommended practices for the testing of water pumping windmills in test sites conditions (i.e.) with ample monitoring equipment available. The second part entitled "Monitoring Procedures for Comparative Evaluation of Technical and Economic Performance" is to describe recommended practices for technical and economic evaluation of water pumping windmills "in field conditions" (i.e.) which are in use for irrigation or drinking water purposes.

For further details please contact:
Mr. Dick Veldkamp
CWD
P.O. Box 85
3500 AB Amersfoort
The Netherlands

Energy Research and Training Center - Thailand

The Energy Research and Training Center (ERTC) of Chulalongkorn University (Bangkok, Thailand) was established in 1982. The Center undertakes research and development work related to energy through subcontracts to faculty members in the University. The center also organizes training programs as well as all types of meetings dealing with energy problems.

Research areas are energy technology, energy systems, energy conservation, and energy economics and planning. Research projects on the following topics have been undertaken to date: energy conservation in airconditioned buildings, energy use patterns in households in the Bangkok area, development of attitudes towards energy-saving measures in various social groups, the use of LPG on diesel buses in a dual fuel mode, lignite combustion in fluidized beds, the present use of solar energy systems in Thailand, a survey of energy-saving measures in industry, the economic impact of the Sirikit oil field, drying efficiencies of agricultural produce in a flow through drier, methodology for control of electricity production and use, survey of cooking stove makers and rice hull combustor makers in Cholburi, Rajburi and Nakorn Pathom Provinces, and cogeneration for electricity and for industry.

The following seminars have been organized by ERTC: Manpower Needs in Energy Planning and Management, Energy Planning for Industrial Development, Energy Efficiency and Conservation, Energy Transport and Distribution, Energy Use in Buildings, Present and Future Roles of Renewable Energy, Government Regulations on Granting of Permits to Produce In-Plant Electrical Power, and the UNESCO-sponsored Regional Workshop on Energy Conservation in Industry.

ERTC also conducts other activities, such as special in-company training sessions on electrical and process energy-saving measures, training on energy management and planning, and training on the efficient use of energy in industrial plants.

For further information, please contact: Energy Research and Training Center, Chulalongkorn University, Phya Thai Rd. Bangkok 10500, Thailand.

Anaerobic Digestion of Biomass

Edited by
David P. Chynoweth and Ron Isaacson
Elsevier Applied Science Publishers Ltd.
(Crown House, Linton Road, Barking, Essex IG11 8JU, England)
ISBN 1-85 166-069-0
1987, x+279 p.

The book "Anaerobic Digestion of Biomass" is the result of an effort to document the status of anaerobic digestion processes for conversion of biomass and wastes to methane at the commercial, developmental, and research levels and to identify data gaps to commercialization and development, process limiting steps, and research needs.

The Gas Research Institute (GRI) of the United States has a program centered on the production of methane from various types of biomass and wastes. This program is devoted to the biogasification (anaerobic digestion) of these feedstocks to methane. Although anaerobic digestion has been extensively studied and applied commercially to treatment of domestic sludge, study and application of the process to other feedstocks such as municipal solid wastes and aquatic, herbaceous, and woody species has been minimal. Furthermore, the state of knowledge of this process at the fundamental level is deficient. Consequently, in certain applications, the process suffers from process instability and low conversion efficiencies. In addition, because biomass feedstocks differ in physical and chemical properties, a number of questions are raised relative to biodegradability, front-end processing, materials handling through the digester, effluent dewatering, and by-product recovery. In view of this national effort on anaerobic digestion, there was a need to (1) document the state-of-the-art of this process; (2) identify currently recognized and poten-

Publications Reviews

tial problems in its application for biogasification of biomass; and (3) develop a data base and documented criteria to guide research programs in this area.

The purpose of this book is to identify and evaluate the status of commercialization and process development units. In addition, it is to review basic and applied research in the areas of microbiology and process development and to provide a basis for recommending research needs and priorities related to improvement of yields, rates, process stability, net energy production, and process economics. The emphasis of the review is on biomass rather than wastes. Literature on processes for conversion of municipal, industrial and animal wastes is used only where the information is relevant to the development of processes for conversion of biomass. This review does not represent an exhaustive description of the literature, but rather draws upon recent key publications to document status and research needs in this field.

The scope, content, and R&D recommendations contained in this book were reviewed by an Editorial and Advisory Panel consisting of recognized experts in this field. Relevant information was obtained via a literature search, personal contacts, and input from several consultants.

Renewable Energy Sources for Rural Water Supply

E.H. Hofkes and J.T. Visscher
International Reference Centre for Community Water Supply and Sanitation (IRC), Technical Paper Series No. 23
(P.O. Box 93190, 2509 AD The Hague, The Netherlands)
ISBN 90-6687-007-9
1986, xv + 168 p.

The potential of using renewable energy sources (solar energy, wind energy, hydropower, biomass energy) to power water pumping systems for rural water supply is receiving increased attention. Assessment and selection of these energy sources and pumping systems require careful analysis of a wide range of factors. This book provides guidance and information to support the systematic consideration of renewable energy sources and devices for rural supply pumping. This book is divided into two parts. In Part I, the various factors to be considered and the selection methodology to be followed in energy sources assessment and pumping system selection are discussed. In Part II, state-of-the-art information on the technology of solar pumps, wind pumps, hydropowered pumps, and pumping systems using biomass energy are presented.

IRC is an internationally operating independent, non-profit organization dealing with information and technology support for water and sanitation improvement. With its partners in developing countries and with United Nations agencies, donor organizations, and non-governmental organizations, IRC assists in the generation, transfer and application of relevant knowledge. The focus of this co-operation is on the rural and urban fringe areas where the need for technical assistance is greatest.

Support is provided by means of publications, training and education, evaluation and advice, and development and demonstration. IRC's information-oriented programmes include: community participation including the role of women; hygiene education; human resources development; appropriate technology including operation and maintenance; programme evaluation; and community-based financial management.

Requests for information about IRC should be addressed to IRC, P.O. Box 93190, 2509 AD The Hague, The Netherlands.

Source Book for Energy Auditors, Volume 1 & 2

Edited by M. D. Lyberg
International Energy Agency (IEA)
Energy Conservation in Buildings and Community Systems
Swedish Council for Building Research
Stockholm, Sweden
ISBN 91-540-4763-3
1987, 2 Volumes
(Distributed by Svensk Byggtjanst, Box 7853, S-103 99 Stockholm, Sweden)

This *Source Book for Energy Auditors* is the result of the collaboration of 9 countries and the Commission of the European Communities within the International Energy Agency. Knowledge of energy conservation measures in existing buildings in three countries has been combined, and it is presented in a way that should make it easy to apply. The work is directed towards larger buildings with a certain complexity of systems for energy use and supply, such as multifamily buildings, offices, commercial buildings etc., but it is of course also applicable to other buildings.

In the first volume the process of energy auditing is discussed, and general guidelines are given on how to select buildings for auditing, how to evaluate present energy consumption and to select what energy conservation measures to recommend. Approximately 250 energy conservation opportunities (ECOs) are described, and references are given to auditing procedures, measurement techniques, common values on consumption and technique to analyze measured data and judge the cost-effectiveness.

In the second volume these procedures and methods to collect and analyze data are presented, as well as reference values and other background material.

The Source Book contains numerous references to literature giving more detailed information.

Photovoltaic Publications and Computer Software

Photovoltaic Engineering Handbook and Computer Manual

Within the past ten years, PV-powered systems have been installed in developing countries to provide power for water pumping, communications, refrigeration, lighting and other basic necessities.

Some countries in Asia are building up their own silicon solar cell manufacturing capacity while several others have started module encapsulation factories through joint-ventures with overseas companies.

In order to assist the development of the photovoltaic industry and the widespread dissemination of photovoltaic systems, human resources have to be developed and people's familiarization with the technology has to be promoted as well.

With these factors in mind, the *Photovoltaic Engineering Handbook and Computer Manual* are produced to:

- materially support regional training activities in photovoltaics; and
- provide the system design engineer with conceptual tools to study the viability of photovoltaic systems in terms of various applications in developing countries and to perform preliminary engineering designs of stand-alone photovoltaic power systems for specific applications.

These books are available at the price of US$70 per set for developed countries and US$45 per set for developing countries including mailing charges.

Regional Information on Photovoltaics: South-East Asia

This book is a compilation of information on projects and institutions involved in photovoltaics in South-East Asia. It is aimed to assist professionals in the explicit and implicit assessment of the potential use of photovoltaic systems over the region.

The document is available at the price of US$20 per copy including mailing charges.

PVMOD 1.0

PVMOD 1.0 is a user interactive software written to assist photovoltaic performance testing. PV module performance testing can be divided into two stages, the monitoring and the analysis stage. PVMOD 1.0 takes over all data processing and file management in the analysis stage. Furthermore, the software provides graphical and statistical descriptions of the test data; together with numerical and theoretical methods of PV module characterization.

PVMOD 1.0 assists users in the following area:

- Automates daily data processing and provides qualitative analysis of data.
- Provides convenience in checking the stability of meteorological parameters such as insolation temperature and wind speed during the measurement of I-V characteristics. Thereby, helping the user decide on the acceptability of the data.
- Assists the user in grouping I-V curves of the same cell temperature with varying insolation levels or grouping I-V curves of the same insolation level but varying cell temperatures.
- Provides graphical representation of data easily on the screen or on a printer.
- Provides a graphical analysis of the influence of cell temperature and insolation intensity on the performance of modules.
- Provides a simple summary of the data or a full print of the data.
- PVMOD 1.0 provides numerical and theoretical characterization of PV modules.

PVMOD 1.0 comes in two diskettes and a manual. They are available at the price of US$20 per set including mailing charges.

To obtain the above publications and software, payment should be made by cheque or draft payable to the Asian Institute of Technology and sent along with your order to:

Dr. F. Lasnier
Asian Institute of Technology
Energy Technology Division
P.O. Box 2754
Bangkok 10501
THAILAND.

Publications Received
From P. 18

* *Legal Aspects of the Practical Application of Solar Energy Technology in Australia, Main Report: The Law Relating to Solar Access,* A.J. Bradbrook, Victorian Solar Energy Council, Melbourne, 1984, 226 p. + xxxvi.
(*available from: Victorian Solar Energy Council, 10th Floor, 270 Flinders Street, Melbourne, 3000 Australia, Phone: (03) 6544533, Telex: Minerg AA36595).

WIND ENERGY

o *Wind Energy Resource Survey of New Zealand: National Resource Assessment,* Summary and Final Report, N. Cherry, New Zealand Energy Research and Development Committee, Report No. 140, University of Auckland, Private Bag, Auckland, New Zealand, 1987, 54 p.

BOSTID Publications Available from RERIC

The Board on Science and Technology for International Development (BOSTID), U.S. National Research Council, has agreed to have the Asian Institute of Technology's Library and Regional Documentation Center (AIT-LRDC) act as the BOSTID distributor in Thailand. To obtain copies of the following listed BOSTID publications, please contact:

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P.O. Box 2754
Bangkok 10501
Thailand.

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Innovations in Tropical Forestry

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US$6.50 Sowing Forests from the Air. 1981. 64 p

US$6.50 Mangium and Other Fast-Growing Acacias for the Humid Tropics. 1983. 63 p.

US$6.00 Calliandra: A Versatile Small Tree for the Humid Tropics. 1983. 56 p.

US$8.00 Casuarinas: Nitrogen-Fixing Trees for Adverse Sites. 1983. 118 p.

US$8.00 Leucaena: Promising Forage and Tree Crop in Developing Countries (Second Edition). 1984. 100 p.

Managing Tropical Animal Resources

US$7.50 The Water Buffalo: New Prospects for an Underutilized Animal. 1981. 118 p.

US$6.00 Butterfly Farming in Papua New Guinea. 1983. 36 p.

US$6.00 Crocodiles as a Resource for the Tropics. 1983. 60 p.

US$8.00 Little-Known Asian Animals with a Promising Economic Future. 1983. 133 p.

Plants

US$6.00 The Winged Bean: A High Protein Crop for the Tropics (Second Edition). 1981. 59 p.

US$7.50 Amaranth: Modern Prospects for an Ancient Crop. 1983. 81 p.

US$10.00 Jojoba: New Crop for Arid Lands. 1985. 102 p.

US$6.50 Underexploited Tropical Plants with Promising Economic Value. 1975. 190 p.

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o *Energy Research: Directions and Issues for Developing Countries*, Energy Research Group, International Development Research Centre (P.O. Box 8500, Ottawa, Ont., Canada K1G 3H9) and United Nations University, Tokyo, Japan, 1986, ix+184 p. ISBN: 0-88936-479-6.

o *A Systems Approach to Energy Quality and Efficiency*, M.G. Patterson, New Zealand Energy Research and Development Committee, Report No. 143, University of Auckland, Private Bag, Auckland, New Zealand, 1987, 155 p.

o *An Optimisation Model of the New Zealand Agro-Food System*, M.G. Patterson, New Zealand Energy Research and Development Committee, Report No. 144, University of Auckland, Private Bag, Auckland, New Zealand, 1987, 62 p.

o *Industrial Electric Motors and Controllers*, Worley Consultants Limited, Auckland, New Zealand Energy Research and Development Committee, Report No. 145, University of Auckland, Private Bag, Auckland, New Zealand, 1987, 142 p.

o *Thermal Energy Storage Technology in Sweden: R&D Program, Technology, Economics, Application*, Seven-Erik Lundin et al., Swedish Council for Building Research, Stockholm, Sweden, 1987, 62 p., ISBN 91-540-4761-7.
(Distributed by: Svensk Byggtjanst, Box 7853, S-103 99 Stockholm, Sweden).

BIOMASS ENERGY

o *Biomass Potential Study of Victoria, Volume I — Overview with Summary, Conclusions and Recommendations*, R. Mendelsohn and P. Hinkley, Victorian Solar Energy Council, Melbourne, Australia (10th Floor, 270 Flinders Street, Melbourne, 3000 Australia), 1985, 63 p. + app.

o *Biomass Conversion for Energy Thermochemical Conversion, Proceedings of the First Technical Consultation of CNRE*, 14-17 October 1985, Freising, F.R. of Germany, CNRE Bulletin No. 10b, Food and Agriculture Organization of the United Nations, European Cooperative Networks on Rural Energy, Rome, 1986, 95 p.

SOLAR ENERGY

o *Design, Development and Deployment of Public Service Photovoltaic Power/Load Systems for the Gabonese Republic*, Final Report, Contract No. DEN 3-347, William J. Kaszeta, Solavolt International (Phoenix, Arizona, U.S.A.), prepared for National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio, 1987, 127 p. + app.

o *Proceedings of FAO/CNRE Workshop on Solar Heating of Animal Houses*, Lund, Sweden, 10-12 March 1986, CNRE Bulletin No. 12, Food and Agriculture Organization of the United Nations, European Cooperative Networks on Rural Energy, Rome, 1986, 63 p.

* *A Victorian Solar Energy Council Demonstration Project: Solar Domestic Hot Water Heating, Maryborough and District Hospital*, M.H. Hall and P.J. Quinn, Victorian Solar Energy Council, Melbourne, 1985, 19p. +Figs.

* *The Near-Term Potential for Solar Industrial: Process Heating in Victoria*, Julian Higgs, Victorian Solar Energy Council, Melbourne, 1984, 99 p.

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- November 5-7, 1987, Raffles City Convention Centre Singapore, Singapore

4th ASEAN Energy Conference

The conference is organized by Science Council Singapore on behalf of the ASEAN Working Group on Non-Conventional Energy Research, sponsored by ASEAN-Australia Economic Cooperation Programme and ASEAN Committee on Science & Technology, and managed by Conference & Exhibition Management Services Pte. Ltd.

For further details:
The Conference Manager
4th ASEAN Energy Conference
Conference & Exhibition Management Services Pte. Ltd.
1 Maritime Square #09-43
World Trade Centre
Singapore 0409

- November 26-28, 1987, Canberra, Australia

Solar 87: Creating the Future

The conference is organized by the Australian and New Zealand Solar Energy Society in association with the Australasian Wind Energy Association.

For further details contact:
Solar '87 Conference Secretariat
c/- John Ballinger
School of Architecture
University of N.S.W.
P.O. Box 1
Kensington, NSW 2033
Australia

- December 1-4, 1987, New Delhi, India

National Solar Energy Convention '87 and Workshop on Techno-economics of Renewable Energy Power Generating Systems

Venue: Indian Institute of Technology New Delhi
Dates: Workshop, December 1, 1987
Convention, December 2-4, 1987

Topics of the Convention

o Resource assessment and analysis of data (solar, wind, biomass and hydro).
o Low temperature solar thermal application, solar concentrators, solar

Diary of Events

thermal power generation, process heat, solar photovoltaics, solar passive architecture, thermal storage, electrical storage, system studies, field experience and case studies.
- o Windmills, wind pumps, aerogenerators.
- o Biomass, biological and chemical conversion of biomass, combustion and utilisation.
- o Hydro, micro- and mini-hydro.
- o Instrumentation and control systems.
- o Energy materials.
- o Economics of renewable energy systems.
- o Integrated energy planning.
- o Manpower development in renewable energy technologies.

For further details contact:
Dr. N.K. Bansal
Organizing Secretary
NSEC– 1987
Centre for Energy Studies
Indian Institute of Technology
Hauz Khas, New Delhi – 110016
Telephone: 654054, 665921, 666969
PABX Ext. 254
Telex: 31-3687 IIT IN

• December 1-14, 1987, Dhaka, Bangladesh

Regional Workshop on Solar Thermal and Photovoltaic Conversion

The workshop is organized by Renewable Energy Research Centre of Dhaka University and is sponsored by International Centre for Theoretical Physics Trieste, Italy and UNESCO.

Topics to be covered

- o Solar radiation
- o Concentrating and non-concentrating collectors
- o Testing of collectors
- o Solar thermal modelling
- o Solar thermal system design
- o Solar cells
- o Photovoltaic system and design
- o Economics of solar energy

Programme

There will be lectures by resource persons, seminars by invited speakers and participants, some practical sessions, and a display of equipment.

Participants

Applications and nominations are invited from South Asian and Southeast Asian countries. They should contain full bio-data of the intending participants. A limited number of travel grants and subsistence allowances will be available for the regional participants.

For further details contact:
Dr. Muhammad Ibrahim
Secretary, Organizing Committee
Renewable Energy Research Centre
University of Dhaka
Curzon Hall, Dhaka-2, Bangladesh.

• January 10-14, 1988, New Orleans, LA, USA

Seventh ASME Wind Energy Symposium

The symposium will be held at the 11th Annual Energy-Sources Technology Conference and Exhibition.
For details contact:
Andrew Swift, Symposium Chairman
Mechanical & Industrial Engineering Department,
University of Texas at El Paso,
TX 79968-0521, USA
Tel: (915) 747-5450.

• February, 1988, Hull, Quebec, Canada

Utilization of Waste Biomass

For details contact:
PACE
600-191 rue du Portage
Hull, Quebec, J8X 2K6, Canada
Tel: 819-777-9696

• February 21-24, 1988, Baghdad, Iraq

Third Arab International Solar Energy Conference

The conference is organized by the Iraqi Solar Energy Research Centre in Baghdad.

The conference aims toward providing a scientific and technical forum to exchange latest experiences among Arab scientists and researchers and those from other regions, through plenary and special sessions.

The topics of the conference will range from solar radiation and solar collector technology to renewable energy experiences in developed and developing countries and solar energy education.

For more information contact:
Third Arab International Solar Energy Conference
Solar Energy Research Centre
P.O. Box 13026
Jederiyiah, Baghdad, Iraq
Tel: 776-1990
Telex: 2187 IK

• April 4-6, 1988, Kuala Lumpur, Malaysia

The First National Conference on Thermal Engineering

Sponsored by the Malaysian National Working Group on Non-Conventional Energy and organized by the Faculty of Engineering, University of Malaya.

Objective

Thermal Engineering plays an important role in both industry and in our daily life. Recent activities in the region indicate that it is now opportune to organize a conference on Thermal Engineering, which will provide a forum for presentation and discussion amongst scientists and engineers in ASEAN countries. The conference also aims at developing Thermal Engineering Studies, particularly in Malaysia.

Conference Topics

Papers are invited on basic studies as well as on experience in applications, as described by, but not limited to, the following four broad areas:
- o Fundamentals
  Conduction, Convection, Radiation, Condensation and Boiling, Two-Phase Flow, Porous Media, Thermophysical Properties, Computer Utilization, Measurement and Modelling Techniques, Education Aspects.
- o Applications
  Heat Exchangers, Augmentation, Processes, Fluidized or Packed Bed Systems, Buildings, Airconditioning and Refrigeration.
- o Thermal Power
  Power Systems, Heat Engines, Turbines, Alternative Engines Fuel, Combustion, Fuel Economy, Nuclear Power.
- o Thermal Energies
  Energy Sources, Conservation and Management, Alternative Energy Resources and Utilization (agricultural

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Diary of Events

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and municipal wastes, solar, biomass and geothermal).

For further information contact:
Department of Mechanical Engineering,
University of Malaya
59100 Kuala Lumpur, Malaysia
Telex: UNIMAL MA 39845
Phone: 03-7553466
(attention: Dr. Baharuddin bin Ali or Dr. C.P. Tso).

- **April 10-14, 1988, Golden, CO, USA**

Solar and Energy-Efficient Building Sessions

The 1988 ASME Solar Energy Conference will be held at the Denver Marriot West in Colorado. The purpose of this conference is to give persons in the solar engineering field from the U.S.A., Canada, and other countries the opportunity to meet and discuss results of research and development in more than a dozen areas of solar application.

Topics to be covered in Buildings Sessions include passive solar building design and performance (heating and/or cooling), building controls, building-to-earth thermal coupling, commercial solar systems experience, energy conservation in buildings, HVAC diagnostics, performance measurements of buildings, solar system reliability in buildings and innovative solar systems for buildings.

For more information contact:
Dr. L.M. Murphy
SERI
1617 Cole Blvd.
Golden, CO 80401, USA
Tel: (303) 231-1050

- **May 2-July 2, 1988, Enschede, The Netherlands**

International Course on Rural Energy Planning

Annual course for district and regional level energy planners, emphasizing energy technology, planning methods, and implementation and management, directed especially to the problems and needs of developing countries.

For information contact:
Course Administrator
International Course on Rural Energy Planning
Technology and Development Group
University of Twente
P.O. Box 217
7500 AE Enschede, The Netherlands

- **May 1988, Ratchaburi, Thailand**

Training Course on Ceramic Cookstove Production

The training course is organized for participants from government and non-government organizations, involved in cookstove development programmes. Emphasis will be on the production techniques of ceramic, fuelwood and charcoal stoves.

For further details:
Regional Wood Energy Development Programme in Asia
(GCP/RAS/111/NET)
c/o FAO/RAPA
Phra Atit Road
Bangkok 10200
Thailand
Cable: FOODAGRI BANGKOK
Telex: 82815 FOODAG TH
Tel: 281-7844

Regional Energy Resources Information Center (RERIC)

RERIC aims at answering energy and renewable energy questions, with particular regard to applications in tropical regions. The main topics covered by RERIC are energy conservation, energy planning, solar energy, biofuels, wind energy and small-scale hydropower. The center's regular publications are a quarterly newsletter RERIC News, the Renewable Energy Review Journal (two issues a year), the RERIC Holdings List, and Abstracts of AIT Reports and Publications on Renewable Energy Resources.

MEMBERSHIP FEES: Members from USA, Canada, Europe, Australia, New Zealand, Japan and Middle East — individual = US$40, institutions = US$75; all other countries individual = US$25, institutions = US$45; supporting members = US$120. The RERIC's regular publications are provided on a total-package basis to RERIC members.

AIR MAILING CHARGE: Members from Asian countries, excluding Thailand, US$9; all other countries US$15.

For further information write to: The Director, RERIC, Library & Regional Documentation Centre, A.I.T., G.P.O. Box 2754, Bangkok 10501, Thailand.

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RERIC news

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VOL. 11, NO. 1, MARCH 1988

Photovoltaic Village Electrification in Indonesia

A research cooperation promotion program on "Photovoltaic Village Electrification in Indonesia" is being conducted under the cooperation of the following organizations:

-International Trade Policy Bureau, Ministry of International Trade and Industry (MITI), Japan;

-Sunshine Project Promotion Headquarters, Agency of Industrial Science and Technology, MITI, Japan;

-New Energy Development Organization (NEDO), Japan;

-Agency for the Assessment & Application of Technology (BPPT), Indonesia; and

-Kyocera Corporation, Japan.

This project is one of MITI's activities in the area of technical cooperation with overseas countries. The project has been entrusted to NEDO since 1984, which in close cooperation with BPPT, has been conducting tests and research for the purpose of putting medium-sized photovoltaic village electrification systems into practical use. A meteorological data collection system, a water pumping system and a village power system have already been installed and are at present in operation, while system evaluation and economic assessment are now proceeding.

Fig. 1 Overview of meteorological measuring system.

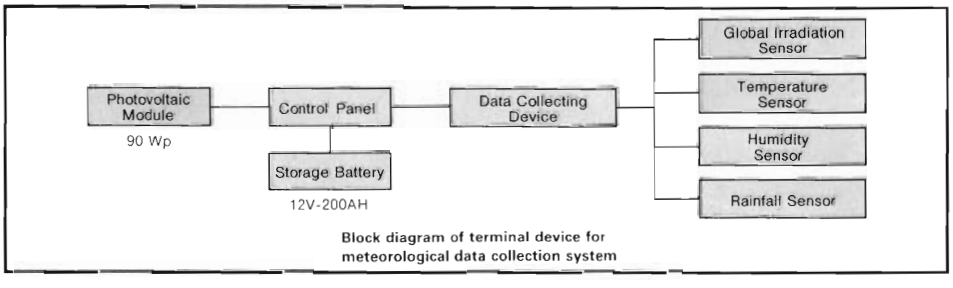

Fig. 2 Block diagram of terminal device for meteorological data collection system.

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Meteorological Data Collection System

This system was constructed to conduct unmanned meteorological observation in an unelectrified area. Kenteng village, located about 60 km from Yogyakarta on Java Island, was selected as the site in order to collect meteorological data for designing a photovoltaic power system before installation of a plant and for analyzing plant operational data after installation.

In order to collect and record data a Random Access Memory cassette is used, which can operate for 3 months. When a cassette is fully recorded, it is sent to a BPPT office where the data is then processed and analyzed by means of a personal computer. An overview of the meteorological measuring system is presented in Fig. 1. Fig. 2 presents the diagram of the terminal device for the meteorological data collection system.

Cont. P. 2

wind and sun compendium
Development of wind and solar energy for water pumping
CWD
Consultancy Services
Wind Energy
Developing Countries

Energy Information Service, CSIRO
Incorporates news from the Energy Information Service, CSIRO and Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).
INNERTAP

Photovoltaic Village Electrification in Indonesia

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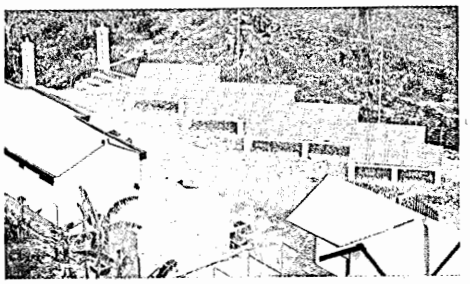


Fig. 3 Overview of water pumping system.

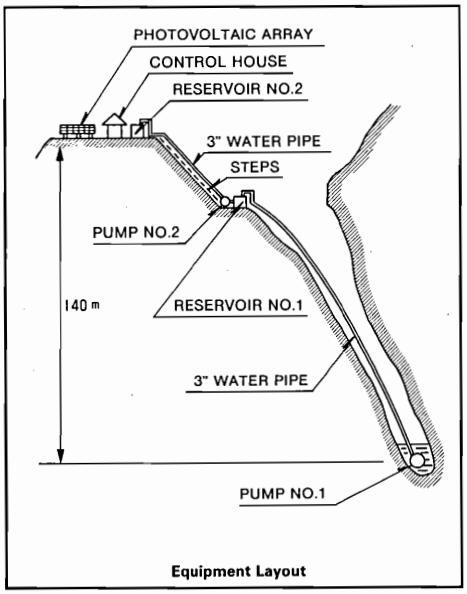


Fig. 4 Water pumping system equipment layout.

Water Pumping System

This system is installed at Cave Gua Gilap, located about 4km from Kenteng village. Two pumps, powered by photovoltaic modules, pump up 10 m^3 of potable water per day from the bottom of a 140 m deep cave, where there is spring water. Storage batteries which store extra electric power secure a stable supply of water without any influence of weather conditions. Until this system was introduced, villagers had to walk down into the dark cave, draw water and carry it up. It can be said, therefore, that this new pumping system has introduced a great deal of convenience into the life of the local people.

Village Electrification System

This system, which is installed at Kenteng village, supplies the as yet unelectrified village with power, which is in turn consumed as shown in Table 1. Storage batteries store power generated during the daytime using photovoltaic modules, and deliver power to an inverter which converts direct current into alternating current. This is then distributed at night to houses through grid lines.

As the villagers previously only had access to kerosene lamps as a source of light, this electrification system will undoubtedly improve their living standard.

Further details of the cooperation project on "Photovoltaic Village Electrification in Indonesia" are available from:

- Solar Energy Department
  New Energy Development Organization
  #170, 1-1, 3-chome
  Higashi-Ikebukuro
  Toshima-ku, Tokyo
  Japan

- Agency for the Assessment & Application of Technology (BPPT)
  Directorate of Energy Conversion and Conservation Technology
  BPP Teknologi Building (14 Floor)
  Jl.M.H. Thamrin 8, Jakarta
  Indonesia.

Table 1 Electricity consumption at Kenteng village

Object of electrification	*Quantity*			*Operation hours*
Private house	85 houses	10W F.L	2 sets/house	5 hours/day
Street light	25 sets	10W F.L	1 light/set	5 hours/day
Public house	1 house	10W F.L	5 sets	5 hours/day
		60W F.L	1 set	5 hours/day
School	1 house	10W F.L	3 sets	5 hours/day
Mosque	1 house	10W F.L	2 sets	5 hours/day
Village office	1 house	10W F.L	3 sets	5 hours/day
Clinic	1 house	10W F.L	2 sets	24 hours
		85W F.L	1 sets	24 hours

Commissioning of a Photovoltaic Diesel Hybrid Generator, Australia

In November 1987, a photovoltaic diesel hybrid generator was commissioned on Coconut Island, a tiny coral cay in the Torres Strait off the north coast of Australia. Serving a village with some thirty buildings and a population of 130, the generator supplies regular 240 AC electric energy at a quality not inferior to that of the electrical grid. Voltage, frequency and harmonic distortion are maintained within standard limits, while there is an emphasis on reliability and safety.

Basically, it is a battery-inverter system with alternative power inputs from a photovoltaic array or diesel engines. Although the solar component may appear to be the new technology, it is expected to cause the least difficulty and to operate reliably and predictably for up to 20 years. The inverter is the crux of the system and of all components received the most attention. Comprising three units in parallel, the inverter is a pulse width modulated type operating at a pulse frequency of 6kHz and producing an efficiency of around 87 per cent at greater than half load. The total harmonic content of the sine-wave output is less than 4 per cent. Since the lead acid battery is permanently connected, the input voltage to the inverter varies up to 30 per cent. When coupled with the load variation, the inverter does well to keep the output voltage within 6 per cent as required.

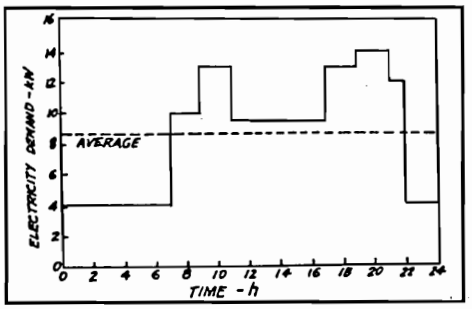


Fig. 1 Design load.

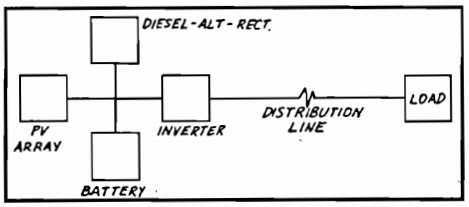
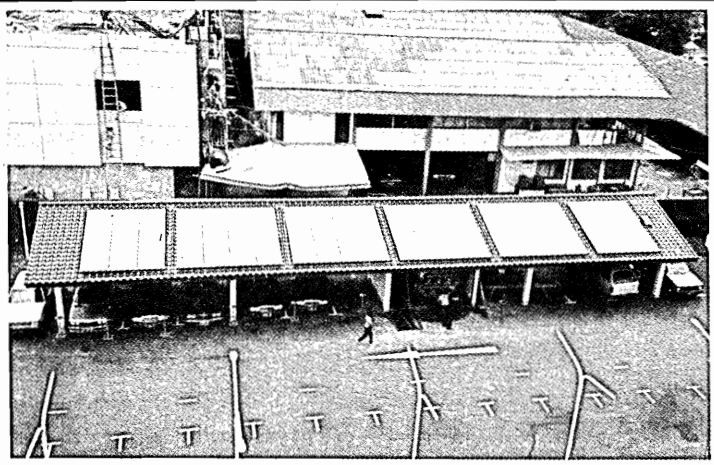


Fig. 2 Basic components.

Solahart Commercial Solar Water Heating System for Midcity, Jakarta



In October 1987, the first commercial solar hot water system in Jakarta was commissioned by Solahart Indonesia for the Health Club of Midcity. The successful operation of this system opens a wide market for solar energy utilisation for hotels, clubs, industries and restaurants, adding to the already popular residential applications.

The Health Club is located in the basement of Midcity at Jalan Jendral Sudirman Kav. 10-11, Jakarta (Latitude 7°). Midcity is a 19 storeys building clad in heat-reflective glass, anodised aluminium and glazed. It provides its local and international tenants with the latest technological facilities including satellite communication systems.

Hot Water Requirements

During the week, except Saturday, the Health Club is estimated to have about 100 members using its facilities daily. On Saturday, this number could rise to 200 people. The Health Club opens from 6 am to 9 pm, 7 days a week. 30% of members are expected between 6 am - 9 am and 70% between 6 pm - 12 pm. The club has three men's and ladies showers each, six hot wash-basins and a 5000 litre communal-whirlpool.

Cont. P. 4

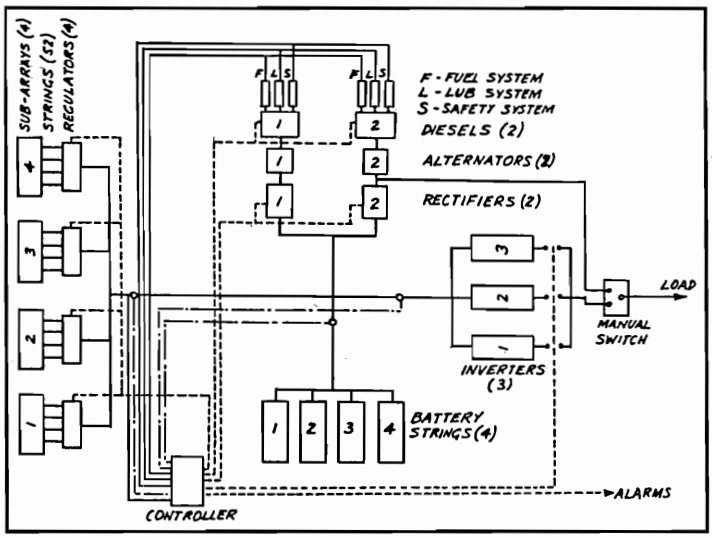


Fig. 3 Schematic circuit.

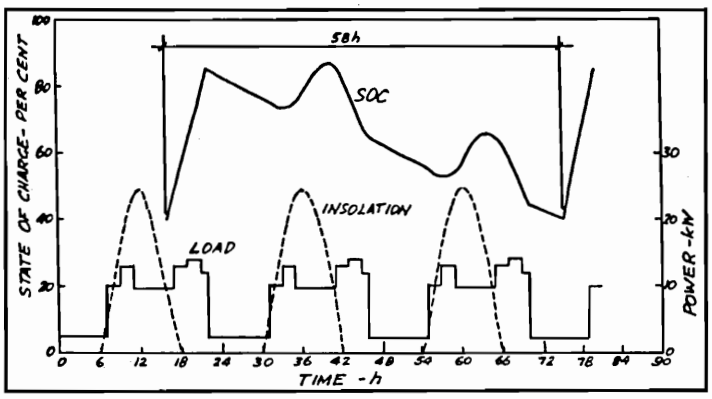


Fig. 4 Hourly calculation of battery state of charge.

For safety reasons, the village is supplied by underground cable provided with multiple-earth-neutral protection.

The system, which will be operated by the Island Council, was constructed on behalf of the Department of Community Services by Westinghouse/IPC, Brisbane. Dr. N.R. Sheridan was the Consulting Engineer.

Distinctive features of the design include:

* Components are modular so that failure of a single component will not disable the system.
* Diesels run only at loads greater than 75 per cent to ensure good fuel efficiency and long life.
* Refrigerators and freezers start without problem.
* System clears faults without causing outages of the whole plant.
* Direct AC generation by diesels is available in the event of total inverter failure.
* Cost of electricity is approximately half that of an existing small diesel plant on the island.

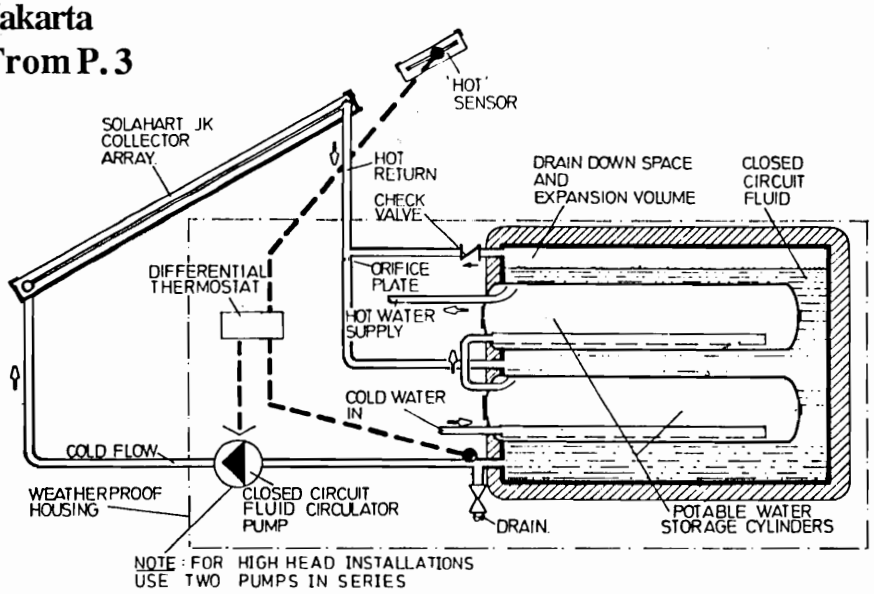
A brief description of the system follows:

DC	:	110V nominal; 105-135V operating
AC	:	240V; 50Hz; single phase; 15kW at 0.8 power factor
PV module	:	ARCO, 12V; 53W; efficiency = 12.4%
PV array	:	468 modules; 42 strings of 9 modules; 23.1kW with 0.93 arraying factor
Battery	:	BP Solar, Type 2P1101; 220 cells; 4404 Ah capacity
Diesel	:	Lister HL4; 37.5 kW; 2 units
Alternator	:	29kW; 3 phase; 2 units
Rectifier	:	160A; 2 units
Invertor	:	Nova sine-wave; 5kW; 3 units
Controller	:	Programmable

(Contributed by Dr. N.R. Sheridan, Reader in Mechanical Engineering, Univ. of Queensland, St. Lucia, Australia)

Solahart Commercial Solar Water Heating System for Midcity, Jakarta

From P. 3



Solar System Specifications

To cater for the above hot water requirements, the specifications for the Solahart commercial solar hot water system selected are as follows:

Type:	Central storage (commercial system)
Principle:	Indirect heating
Nos of panels:	44 panels JK Type
Tank model:	6500J
Back-up heater:	4.8 kW x 10(Thermostatically controlled)
Installation:	Solar panels flat on inclined tile (10 degree) roof of car park

System Principle

The packaged commercial solar system has been pre-engineered for simplicity of operation and minimum on-site installation. A collector array, mounted on the roof of the car-park is connected by flow and return piping to a ground level solar heat storage package.

The heat storage package is complete with closed circuit and open circuit water storage systems. The closed-circuit water system is complete with level and drain valves, relief valve, expansion and drain down space, water circulating pump and controller, all pre-piped, pre-wired and "in factory" tested.

The potable water is stored within the double glass-lined tanks mounted inside the main closed circuit heat storage cylinder.

Closed circuit water from the lowest point of the heat store is drawn out by the closed circuit water circulating pump, circulated up through the collector array where it is heated as it flows through the collectors then returned to the heat store. The continual heating and recirculation raises the heat store temperature.

Cold mains water is fed into the bottom of potable water storage cylinders, which are located inside the closed circuit heat store. The potable water in each row of tanks is series connected to the row of tanks above. The water temperature is raised as it is passed out of the hot outlet of one group of tanks into the cold inlet of the next group of tanks above it and so forth until the potable water is discharged out of the top storage tanks at usable temperature, almost equal in temperature to the heat store top water temperature. The result is that the full potable water storage is ready for immediate use at the maximum draw off rate possible.

A differential temperature controller, installed in the switch box with cold sensor located in the base of the closed circuit store and hot sensor located in a collector simulator, switches on the closed circuit pump to circulate water through the collectors only when enough solar energy is available. Each time this pump switches off, the collectors drain their water charge back into the closed circuit heat store.

The Solahart Commercial System is one of the most technologically advanced solar hot water systems available. Each system has been test rated. As the system operates on an indirect heating principle, and has an anti-corrosion feature, the equipment can be used even under harsh water conditions.

Solahart, based in Western Australia, is one of the world's leading solar energy companies and has over 35 years of continuing experience in the research and development of materials and the manufacture and production of solar equipment. Solahart is now marketed in over 89 countries around the world.

Solahart (Indonesia) is the sole-representative of Solahart products in Indonesia. It is a division of P.T. Panata Tama Inter Instalasi Indonesia, a company engaged in the contracting field of mechanical, air-conditioning and electrical installations. Mr. Djoko Waluyo (General Manager of Solahart Indonesia) states that since Solahart was established in Indonesia just over 9 years ago, over 3000 units have already been installed there.

(Contributed by Prawindra Mukhia, Asia Regional Engineer, Solahart International, 1502 New World Tower, 16-18 Queen's Road Central, Hong Kong)

Low-Cost Steam Engine Adapted in Ghana

The original design of this simple steam engine was done by Professor J. Vanek and his son at the STEVEN Foundation (Solar Technologies and Energy for Vital Economic Needs), in Ithaca, New York. A model of the Vanek Steam Engine was sent to Ghana and design modifications were carried out at the Universtiy of Science and Technology with the main aim to use locally available materials. A number of scrap items from heavy-duty truck garages were employed which reduced the cost of the engine to about US$50. This engine running on solar-generated steam is intended to be used for driving deep-well pumps in the sunny northern region of Ghana.

The steam engine assembly is presented schematically in Fig. 1. During the intake stroke, when the piston is moving upwards, steam is admitted into the cylinder through the injection valve. The action of the injection valve is controlled by a cam which is attached to the main crankshaft. The cam is positioned so that the admission of steam is blocked when the piston is about half the way up the cylinder.

The steam then expands inside the cylinder, pushing the piston further out. The whole cylinder rocks around the centre line, so that by the end of the power stroke it is almost upright. Just before it begins to swing to the right, the exhaust valve which is an ordinary one-way flapper-type check-valve is brought into contact with a stationary poker. The poker pushes the flapper to open the valve and allows the steam exhaust to escape. A flywheel keeps the system running during the exhaust stroke and ensures smooth operation.

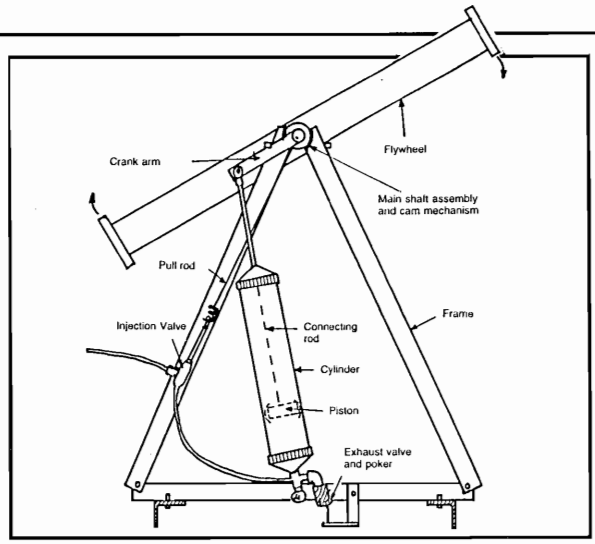


Fig. 1 The low-cost steam engine.

Testings of the modified Vanek steam have been carried out to enable a qualitative analysis of the performance of the prototype to be carried out. The running speed was discovered to be about two cycles per second during these tests.

The predicted power output of the steam engine is 120 watts at a design pressure of 50psi and a calculated thermal efficiency of 3.5 per cent. When coupled to a pump in a 10 metre deep well, the engine should therefore be able to provide a discharge of about 800 gallons/hour which is ample water for many rural communities.

(Source:Extracted from *A Low-cost Steam Engine Adapted in Ghana*, by Abeeku Brew-Hammond. *Appropriate Technology*, Vol. 14, No. 3, 1987.)

ISES Working Group for Passive and Low Energy Architecture

The formation of the Working Group for Passive and Low Energy Architecture was approved by the Board of Directors last September as part of an initiative within International Solar Energy Society (ISES) to establish worldwide organizations for the various application areas of solar energy. The inaugural meeting of this first ISES Working Group was held at the Hamburg Solar World Congress on 16 September 1987. The meeting was attended by about 80 participants representing a cross section of architects, engineers, planners and other environmental disciplines sharing an interest in the field. The outcome of the meeting was to outline the role and purposes of the Working Group and to appoint a provisional Steering Committee.

The Steering Committee elected J. Douglas Balcomb Chairman, Andre de Herde Vice Chairman, and Robert Hastings Secretary. Simos Yannas was designated as Editor of the Newsletter of the working group.

Purpose of the Working Group

The topics that were proposed for the Working Group under its general theme of passive and low energy architecture encompass the following areas:

-Bioclimatic design in architecture
-Passive solar heating
-Natural cooling
-Daylighting
-Hybrid and low-energy design
-Building physics
-Vernacular architecture
-Architectural regionalism
-Urban planning.

The major purposes for the Working Group will be:

-to produce a newsletter reporting on relevant activities in these areas as an information service to its members; and

-to assist in organizing the architecture and planning related programme of the ISES Solar World Congresses.

The Working Group will seek to pull together the diverse elements and disciplines involved in the design of passive and low energy buildings and to establish international channels of communication between like-minded designers and researchers around the world.

The Newsletter

Regular features proposed for the quarterly newsletter include: list of recent publications and, where possible, brief reviews of relevant books and conference proceedings; a calendar of forthcoming events; previews and reviews of major international conferences; presentation of significant buildings and research findings; new and ongoing national programmes; new products; membership information and activities of the Working Group.

The first newsletter was distributed to all ISES members as an insert to ISES News. Future newsletters will be distributed only to those who become members of the Passive and Low Energy Architecture Working Group.

Membership

Any member of ISES or an ISES National Section may join the Working Group. The application form is available at ISES National Section Secretary. The annual membership fee is US$10.00. Membership will receive the newsletter, and will be eligible to participate in Working Group activities including electing members of the Steering Committee.

For further details about the Working Group please write to the Secretary:

Robert Hastings
EMPA-KWH
CH8600 Dubendorf
Switzerland

BIOCOAL FROM RESIDUES AND WASTES

Research Project at AIT, Thailand

In the Asia-Pacific Region, large quantities of agricultural residues are produced annually as by-products of a wide range of primary agricultural production processes. However, the extensive and efficient use of residues as an energy source is often hindered by their low bulk density, high moisture content and other characteristics. The conversion of residues to more convenient and economically transportable fuel would greatly help in meeting the growing energy needs of this region.

Biocoal, which is charcoal produced from biomass and organic wastes, presents tremendous potential as a substitute for wood-derived charcoal. However, biocoal, until recently, has been the subject of minimal research and development activity.

These considerations are central to a biocoal project being carried out by Asian Institute of Technology (AIT), under the sponsorship of the German Agency for Technical Cooperation (GTZ).

The project concerns the production of biocoal from wastes such as agricultural and forestry residues.

The project seeks to stimulate the acceptability of biocoal technology by making techno-economic data accessible to entrepreneurs and by studying consumers' acceptance of biocoal.

Activities to be carried out are as follows:

1.Review and generation of techno-economic data on existing commercial ventures.

2.Review of current biocoal R & D activities by various institutions.

3.Identification of technical constraints and advantages/disadvantages of available biocoal technologies.

4.Characterisation of major residues based on their physical properties, availability and costs.

5.Cost and sensitivity analysis of available technologies.

6.Identification of important R & D problems.

7.Sensitivity test of existing briquetting technology with different types of residues, particularly baggase and peanut-shells.

8.Pyrolysis of briquetted biomass.

9.Continuous pyrolysis of residues.

10.Market survey of biocoal users.

11.Identification of existing and potential users of biocoal and uncarbonized briquettes.

12.Preparation/dissemination of publicity materials.

13.Organization of an international workshop on biocoal technology.

For further information on the AIT-GTZ biocoal project, please write to

Dr. S.C. Bhattacharya
Biocoal Project
Energy Technology Division
Asian Institute of Technology
G.P.O. Box 2754, Bangkok 10501
Thailand
Telex: 84276 TH
Cable: AIT BANGKOK

Inexpensive Hot Water Stove

Researchers in Chile have devised an unusual stove for producing a steady flow of hot water. The stove will deliver about 300 litres per hour of 45°C water while consuming about 7 kg per hour of waste wood. The stove has a simple design. The principal components are two steel drums — one 100 litre drum and one 200 litre drum — and some plumbing fixtures, tubing, and sheet metal.

The stove is fabricated by fitting the lid of the 100 litre drum with a fuel/air inlet and a chimney. According to the stove designers, the conical shape of the fuel/air inlet creates a turbulent airflow that promotes a clean burning fire. This smaller drum is the firebox for the stove and is suspended inside the 200 litre drum (Fig. 1). The larger drum has a cold water inlet and a hot water outlet.

In operation, wood is charged to the firebox and ignited. As the fire develops, cold water in the larger drum is heated and the less dense hot water rises to the top of the drum and passes through the outlet. The

INNERTAP NEWS

Ethanol Production from Sugar Cane and Sweet Sorghum

A research project on village-level alcohol production from sugar cane and sweet sorghum has been conducted at BIOTECH-UPLB, Laguna, Philippines under the leadership of Dr. E.J. del Rosario with funds provided by the Philippine Government through the Bureau of Energy Development. The project includes comparison of sugar yields of several varieties of sugar cane and sweet sorghum and pilot-plant-scale process development of improved fermentation and distillation methods for alcohol production. The use of carrageenan-immobilized yeast for fermentation and desiccant materials for distillation column packing is being investigated. A flowsheet of the process being studied by the BIOTECH-UPLB researchers is shown in Fig. 1.

The agronomic yield results show that the most productive sugar cane variety (Phil 56-226) produced more than 30 MT/ha of sugar 10 months after planting compared to the best sweet sorghum variety (Wray) with 5.1 MT/ha sugar yield. Assuming that the sweet sorghum grains contain 60% by weight of starch, the starch yield for Wray is 4.9 MT/ha; the total yield of sugar and starch is, therefore, about 10 MT/ha in four months. The pro-

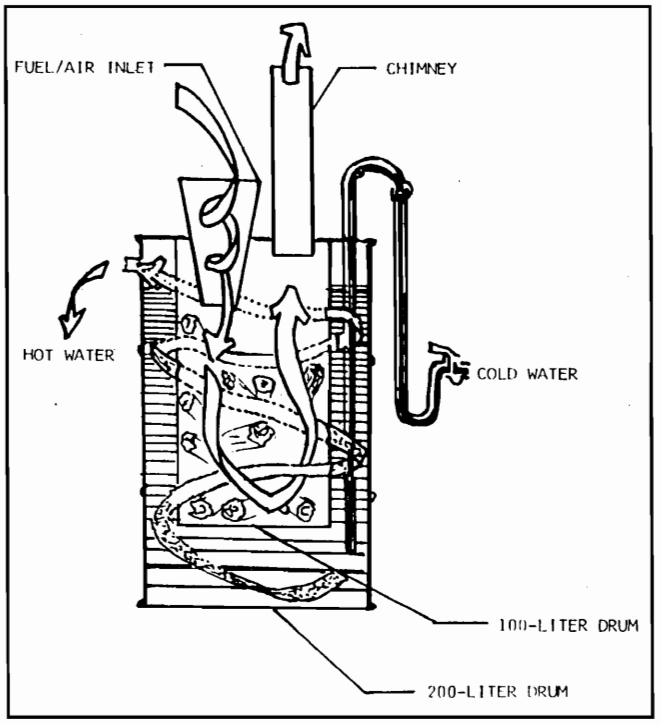


Fig. 1 A Chilean stove for producing hot water.

temperature of the water produced can be controlled by the rate of water flow through the stove. For example, 45°C water is obtained at 5 litres per minute, 75°C water at 3.5 lirtres per minute, and 90°C water at 2 litres per minute.

This stove was developed for use in rural areas where

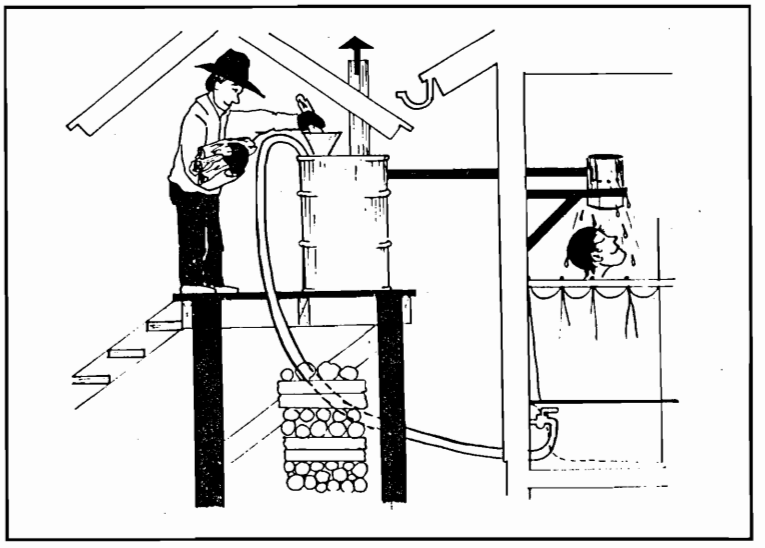
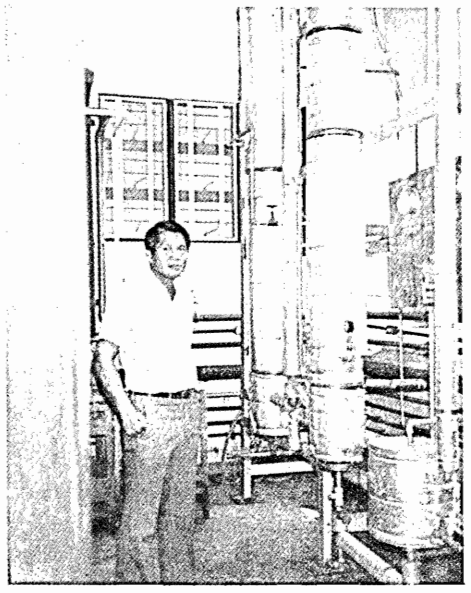


Fig. 2 Hot showers from Chilean stove.

waste wood is abundant and hot water heaters are scarce. The hot water can be used for baths, showers (Fig. 2), laundry, and general cleaning. This stove has been well received in Chile, where about 50 have been built, as well as in Colombia, Peru, and Ecuador.

The stove was designed by scientists and engineers at the Energy Research Center of the Universidad del Biobio. Additional details on the fabrication and use of this unit can be obtained from Dr. Jorge Maldonado Castillo, Energy Research Center, Universidad del Biobio, Avda. Collao 1202, Casilla 5-C, Concepcion, Chile.

(Source: *Inexpensive Hot Water Stove,* by G. Shay. *BOSTID Developments,* Vol. 7, No. 3, 1987.)



Dr. E.J. del Rosario at one of the experimental unit, BIOTECH-UPLB.

ductivities of sugar cane and sweet sorghum in terms of soluble carbohydrate yield are 3 MT/ha-month and 2.5 MT/ha-month, respectively. This simplified calculation indicates that sugar cane is still superior to sweet sorghum in terms of biomass productivity.

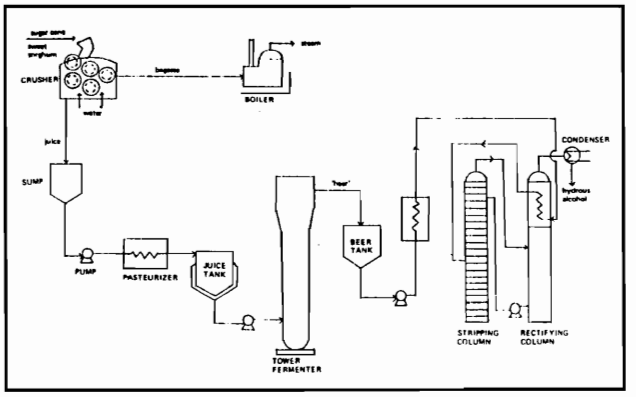


Fig. 1 Flowsheet of pilot-plant-scale alcohol from stalk juices of sugar cane and sweet sorghum.

Bench-scale optimization studies were done on the continuous-flow ethanol fermentation of sugar cane molasses, sugar cane juice and sweet sorghum juice. Using carrageenan-immobilized yeast, a volumetric productivity of 12.9 grams ethanol per litre per hour was obtained for molasses; slightly lower values were obtained for nutrient-supplemented sugar cane juice or sweet sorghum juice. However the residual sugar concentration of the fermented juice was approximately half that for molasses. A preliminary run in the 260 litre pilot-plant-scale fermenter gave satisfactory results. The continuous flow carrageenan-immobilized yeast process is expected to result in reduced capital and operating costs of fermentation.

Bench-scale distillation studies using several packing materials in the rectifying column showed that coconut shell charcoal gave the highest distillation efficiency of 97.4%. Several lignocellulosic and charcoal materials gave substantially higher distillation efficiencies and ethanol concentrations in the distillate compared to broken

Cont. P. 8

How to Cut Energy Cost of Your Home Refrigeration

A lot of energy is used in our homes. Very often we use more than we really need to, sometimes unwittingly. Some of the energy is wasted.

The refrigerator is the biggest energy consumer in your kitchen. It is also the biggest energy consumer in your whole home if you do not have an air-conditioner.

Unlike other appliances, the refrigerator operates automatically 24 hours a day, every day, to keep your food at the right temperature. So it is important to make sure your refrigerator is working efficiently.

***Right Capacity.** Select the right capacity refrigerator for the size of your family. You should also consider your marketing habits, how often you go to the market and the amount of food you store. As a guide, allow at least 60 litres for the first 2 members of your household and 30 litres for each additional person.

***Defrosting.** Regular defrosting is necessary to keep the refrigerator at optimum efficiency. Do not allow more than 6mm of ice to build up in your freezer. Before buying a new refrigerator, compare the energy rating of various models and choose the most economical one. Frost-free refrigerators usually consume more energy but do not require defrosting.

***Thermostat Setting.** Adjust the thermostat to the setting recommended by the manufacturer. Do not set the temperature lower than needed. Overcooling wastes energy.

***Door Fit.** Check the refrigerator door gaskets and hinges for leaks. The gasket is the strip of flexible plastic or rubber which seals the crack between the door and the compartment when the door is shut. To test for leaks in the gasket, place a new dollar note between the door and the cabinet. Close the door and pull at the dollar note. You should feel a slight resistance. Test all round the door. If there are places where the dollar slides out easily, adjust the hinges, replace the gasket or do both. A faulty gasket wastes energy.

***Keep the door closed.** Think of what you need before opening the refrigerator door. When you open the door, close it quickly to keep the cold air in and the warm air out. Each time you open the door, warm air gets into the refrigerator and this must be cooled. It requires energy to cool it.

***Adjust Legs.** Make sure the front legs of the refrigerator are higher than the rear ones so that the door closes automatically when released.

***Ventilation.** Position your refrigerator in a well-ventilated place with enough space from the walls to allow for free circulation of air around the condenser coils. A space of at least 150 mm between the condenser coils and the wall should be allowed. Insufficient ventilation will cause the condenser coils to overheat and overload the compressor.

***Keep condenser coils clean.** Keep the condenser coils at the back of your refrigerator clean and free from dust, lint and grease. These act as insulators and prevent heat from escaping to the surrounding air. If the coils are dirty, more energy is required to maintain the same temperature inside the refrigerator. Clean the condenser coils at least once a year with a cloth or a soft brush.

***Food Arrangement.** Arrange foods in the refrigerator compartment with space between items so that air can circulate freely. For greatest efficiency, keep your refrigerator well-stocked. For the freezer compartment, stack items tightly. Fill empty spaces with bags of ice, if necessary.

***Cool down hot food.** Allow hot foods or liquids to cool before storing them in the refrigerator.

***Covering Contents.** Liquids should always be covered when stored in the refrigerator compartment, otherwise they add to the humidity and the compressor has to work longer. Covering foods and liquids is also more hygenic and helps seal in the flavour.

***During Vacation.** If you are away from home for a few days, switch off the refrigerator. Clean the interior and leave all doors slightly open. The larger your refrigerator, the greater your energy saving will be.

***Humidity Switch.** If your refrigerator has a humudity switch, keep it switched to the power-saving position as long as possible. Switch to "Humidity" position only when there is condensation on the side of the refrigerator compartment. The purpose of the humidity switch is to control small heaters in the door to stop it from "sweating" on humid days. At all other times, this heating serves no useful purpose and is a waste of energy.

These energy conservation measures for the refrigerator were extracted from the booklet entitled "Ideas to Cut Energy Cost in the Home" prepared by the Public Utilities Board of Singapore (111 Somerset Road, #07-06, PUB Building, Singapore 0923). This booklet provides ideas to cut energy costs in your home. Many of these ideas will cost you nothing. Some will cost you only a few dollars. But they all will cut down on the energy you use and save your money, without your having to sacrifice any of the comforts you are used to.

Ethanol Production from Sugar Cane and Sweet Sorghum

From P. 7

glass pieces as control. However, confirmation of the results in the pilot-plant distillation set-up is still being done.

Direct ethanol production from sugar cane juice has good prospects at present due to the low price of sugar in the world market. The economics of the juice-into-ethanol process would depend on the cost of agricultural production, the process technology to be employed and alcohol selling price, as well as government policy and subsidy.

(Source: Extracted from *Ethanol Production from Sugarcane and Sweet Sorghum at U.P. Los Banos,* by Dr. Ernesto J. del Rosario, *Energy Infonet News*, Vol. II, No. 2, April-June 1987.)

The Energy Bus

A Mobile Measuring and Advisory Center for Philippines Industry

PHILIPPINE-GERMAN RATIONAL USE OF ENERGY PROJECT

The Bureau of Energy Utilization (BEU) in cooperation with the Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) have implemented the Philippine-German Rational Use of Energy Project (RUE). The project is testing a new and novel idea to increase the awareness of the need for energy saving measures by providing assistance to local industry in an efficient and cost beneficial manner.

Energy Bus, a mobile advisory and measuring center equipped with process control and measuring instruments, has been conceived in order to conduct efficient testing and measuring and to produce quick results in the form of an energy audit for many industrial sectors and private business. The objective is to bring information to as many clients as possible and to offer on-the-spot solutions as compared to off-plant seminar type theoretical discussions.

The Energy Bus concept is an open-ended approach which can be modified and expanded according to the needs of industry and private business. The concept is based on the following experiences in energy conservation activities:

-Responsible, correct advice beyond the usual "better housekeeping" sermon is only possible through accurate taking of measurements and performance testing of equipment. The Energy Bus is equipped with a range of measuring instruments to evaluate the performance of most energy consuming equipment or processes. As the need arises, the range of measurements can be widened and continously taken over a longer period of time.

-Analysis of data taken is in many cases too cumbersome by hand and leads to risky recommendations because of lack of a sensitivity analysis with respect to the most important parameter. The Energy Bus has a computerized data analysis system with special software programs to evaluate major types of equipment and energy loss phenomena. Also because of a certain lack of useful software programs in the international market, the RUE Project has developed utility programs to support these performance analyses.

-Energy saving measures can sometimes be highly uneconomical and require a careful analysis of the cost/benefits of the recommendations made based on local conditions and banking procedures. Computer softwares on financial analysis are also included in the Energy Bus data analysis system.

-Plant engineers and management require information beyond the usual data analysis. The Energy Bus contains a mini-library, information materials about hardware as well as a TV - video system to show implemented cases and films relevant to energy conservation.

The services of the Energy Bus include:

-Measurement of energy flows in industrial processes and energy conversion systems.

-Identification of the major energy consuming processes to determine potential for conservation.

-Identification of cost saving opportunities.

-Identification of the economics of energy alternatives.

-Test and evaluation of solid, liquid, and gaseous fuels used.

-Test and evaluation of feedwater quality.

-Computer service for detailed analysis of data taken.

-Calibration of monitoring equipment.

-Compilation of a report for the company detailing its energy use efficiency and opportunities for cost savings.

-Backstopping service from a pool of highly specialized experts for rare and unusual process configurations and reported difficulties.

For further information please contact:

The Coordinator
Philippine-German Rational Use of Energy Project
Office of Energy Affairs
Conservation Division
Fort Bonifacio, Makati
Metro Manila
Philippines

Energy Consumption in Urban Suva, Fiji

A study was undertaken to analyze the use of energy in the household, industrial; and commercial sectors of urban Suva, Fiji. It involved surveys of 1011 electrified households, 301 nonelectrified households, 76 industrial establishments, 77 commercial concerns, and 10 large office buildings. The surveys included questionnaire-based interviews, examination of premises, and the study of the records of consumption maintained by users and suppliers of energy.

For householders, transport was found to be the most important single use of energy (38% of total demand). On average, each week, each household used 3.99 l of bus diesel fuel, 2.21 l of taxi gasoline, and 22.69 l of private car gasoline. Consumption of private car gasoline was closely correlated (r = 0.97) with household cash income. Studies of the per-capita use of transport energy elsewhere suggest transport energy could be reduced in Suva.

Household cooking accounted for 36% of the total household energy demand. The two principal fuels used were kerosene and wood. When kerosene was used, 400 ml was used per meal. When wood was used 2.1 kg was used per meal. When wood was used, it was nearly always in an open fire; kerosene was most commonly used with the multiwick burner, which has been shown in tests to have a heat-use efficiency of 49.6%. Use of liquefied petroleum gas (LPG) and electricity was largely confined to higher-income homes. Cost per meal was 2 ¢ for wood, 16 ¢ for kerosene, 30 ¢ for LPG, or 55 ¢ for electricity.*

The chief domestic uses for electricity were for refrigeration (45%), lighting (15%), cooking (12%), and water heating (12%). The efficiency of refrigerators was found to differ widely, ranging from 140 to 200 kWh/m^3 per month. In general, consumers of electricity in Suva are not aware of the domestic energy savings available to them.

The survey showed that most industrial establishments employ fewer than 50 people. Electricity was the fuel for the largest number of industrial uses -- lighting, air-conditioning, cooling and refrigeration, hot air and water, steam, chemical processes, mechanical work, on-site transport of goods and office and ancillary purposes -- but it accounted for only 6% of total industrial demand. There were wide variations in the use of electric lighting (0.2-185 kWh/m^2 per year) and air conditioning (5.1-664 kWh/m^2 per year). However, most of the energy used by Suva's industries is for production purposes, which account for 96% of demand. Coal provides 77% of energy used in industry; energy is also derived from industrial fuel oil, diesel oil, automotive diesel, waste oil, gasoline, wood, kerosene, LPG, oxyacetylene, and premix (a 50 : 1 mix of gasoline and oil for two-stroke motors).

Appreciable savings in industrial energy would be possible through better lighting arrangements, more efficient refrigeration, better use of steam and hot water, and fuel substitution (notably in boilers).

Suva's commercial establishments also make wide use of electricity, which is so versatile that it is used in 15 of 17 end-use categories surveyed. Electricity accounts for 46% of the total energy demand of the Suva commercial sector. Refrigeration accounted for almost 13% of total energy use and 27% of electricity use. Cooking accounted for 11%, fuels used being LPG, kerosene, electricity, and wood. The largest single use of energy, 14% of total demand, was for air-conditioning. Energy savings would be possible in lighting, refrigeration, air-conditioning, cooking and water heating.

The survey of 10 large office buildings showed that air-conditioning accounted for 64% of energy. Other uses for energy were lighting, equipment, and elevators.

Further details on the use of energy in the household, industrial and commercial sectors of urban Suva and recommendations on how the people can make better use of the available energy are available in *Urban Energy in Fiji : A Survey of Suva's Household, Industrial and Commercial Sectors*, Technical Study 59e, by Suliana Siwatibau (1987, xii+72 p.). The publication is available from International Development Research Centre, P.O. Box 8500, Ottawa, Ont., Canada K1G 3H9.

* Cents are in Fijian currency. In 1981, FJD 1 (Fijian dollar) = US$1.1456

Evaluation of Alternative Energy Technologies in Nepal

An evaluation of three "alternative" technologies namely, improved cooking stoves, micro hydro electricity and biogas has been carried out using a combination of both empirical experience with the technologies in the field and the results of financial and economic analyses. These three technologies are currently promoted by His Majesty's Government of Nepal (HMG/N) in their Seventh Five Year Plan.

The purpose of the evaluation is to draw preliminary conclusions on the suitability of these technologies for Nepal, on their ability to substitute for or conserve traditional fuels in rural or semi-urban areas and on required action by HMG/N (if warranted) to further promote the technologies.

From a technical and economic perspective it was concluded that of the three technologies only biogas proved to have economic benefits much greater than financial ones that justified an HMG/N subsidy to promote it.

Improved cookstoves were analyzed to have high financial returns to a user *if fuelwood had a price*. Where there is no cost to fuelwood, experience shows that no amount of subsidy will induce people to use a stove. A direct subsidy on the stove is not warranted in these circumstances.

Micro hydro electricity conversely showed no economic returns and only marginal financial returns under certain conditions. Micro hydro cannot currently be justified in terms of replacement of traditional fuels as it only provides lighting in remote communities. At the same time the amount of kerosene it displaces is minimal (WECS estimates 1 litre/capita/year in remote hilly areas). People are anxious to have electricity and are willing to pay varying amounts depending on their economic circumstance but this is rarely enough to support systems larger than 25 kW. Generally, systems which provide mechanical milling power during the day are found to be financially viable. Since these systems provide marginal economic benefits they should not be eligible for HMG/N subsidies.

Biogas systems on the other hand do

R & D Activities on Energy and Renewable Energy at the National University of Singapore

Besides offering undergraduate and postgraduate courses, the Department of Mechanical and Production Engineering of the National University of Singapore has also conducted many R & D activities on energy and renewable energy. Some of the major research projects are as follows:

Solar air conditioning

(T.Y. Bong, A.O. Tay, K.C. Ng, N.E. Wijeysundera)

The design, installation, and operation of a solar powered air-conditioning system of 2 tons refrigeration capacity was undertaken. Performance and evaluation studies under local conditions were carried out.

Ejectors - analysis, design and construction

(S.K. Chou)

Ejectors were designed and constructed and then tested for the purpose of improving their efficiencies under adverse conditions of high pressure lifts. Further work involves the use of ejectors in a refrigeration plant capable of operating in tropical regions and utilising solar energy.

An experimental and analytical study of heat and mass transfer processes in solar ponds

(M.N.A. Hawlader, N.E. Wijeysundera, J.C. Ho.)

The project has three phases. In phase I, the test rig was constructed and basic instrumentation was installed. The pond was filled with salt solution and exposed to solar radiation. In phase II, the experimental results were compared with the predictions of a computer model. In the final phase, the effect of different layers on the performance of solar ponds will be evaluated.

Performance of a 1.4 kW solar cell array

(J.C. Ho, T.T. Chandratilleke)

An experiment consisting of a solar cell array (1.4 kW panel) provided by GTZ and a two pump (460 W each) pumping system was set up. The system performance was compared to a single pump arrangement (power 2 x 460 W). The results thus obtained will be used to consolidate the computer prediction already available.

Energy conservation using heat pumps and desuper heaters

(T.Y. Bong, M.N.A. Hawlader)

Computer programs for the steady state performance of a heat pump with and without a desuperheater were developed and their results are being verified by actual experiments. When a reasonable agreement can be achieved, the next step will be to determine the heat pump performance over a range of operating conditions as affected by hot water demand.

Effect of moisture on thermal insulation

(N.E. Wijeysundera, M.N.A. Hawlader)

The project involves the measurement of vapour diffusion and moisture condensation in cylindrical pipe insulation, the study of variation of heat flux with moisture condensation and of methods of removing water from moist pipe insulations. Fundamental measurements will be made on the heat transfer in fibrous slab insulants which are laden with moisture.

ASEAN-Australian Economic Cooperation Programmes

i) Energy analysis and modelling of buildings (*S.K. Chou*)
ii) Industrial energy management (*J.C. Ho*)
iii) Optimisation of insulation materials (*N.E. Wijeysundera*)
iv) Heat pumps (*T.Y. Bong*)

Under the ASEAN-Australia Economic Cooperation Programme (AAECP), Singapore was selected to undertake research, development and demonstration work on Energy Conservation Technology. The Energy Project, which comes under the ASEAN Committee on Science and Technology, was initiated in mid-1985 and is funded by the Australian Development Assistance Bureau. The budget over the first three years amounts to A$540,000 and the Science Council Singapore is the executing authority of the project.

The Singapore sub-projects have been formulated to meet the needs of the building and industrial sectors in the ASEAN region. Research activities cover the above areas.

Work is being carried out at the Department, with the collaboration of, or in consultation with, the Nanyang Technological Institute, the Development and Building Control Division, PWD, and the Public Utilities Board.

For further details of the above projects please contact:

Department of Mechanical & Production Engineering
National Univ. of Singapore
Kent Ridge Crescent
Singapore 0511

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provide significant economic benefits both in terms of savings of fuelwood and of kerosene. Their high capital cost makes them unattractive to the user however, and therefore HMG/N subsidies for this technology are warranted. A subsidy of as much as 50% of the capital cost has been shown to be desirable. Biogas can generally only provide these returns under climatic conditions similar to those of the Terai.

Further details of the evaluation are available in "An Evaluation of Alternate Energy Technologies in Nepal", Report: 4/2/250687/1/1, His Majesty's Government of Nepal, Ministry of Water Resources, Water and Energy Commission, Kathmandu, Nepal, 1987.

BOSTID Publications Available from RERIC

The Board on Science and Technology for International Development (BOSTID), U.S. National Research Council, has agreed to have the Asian Institute of Technology's Library and Regional Documentation Center (AIT-LRDC) act as the BOSTID distributor in Thailand. To obtain copies of the following listed BOSTID publications, please contact:

RERIC, AIT-LRDC
P.O. Box 2754
Bangkok 10501
Thailand.

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US$6.50 Mangium and Other Fast-Growing Acacias for the Humid Tropics. 1983. 63 p.

US$6.00 Calliandra: A Versatile Small Tree for the Humid Tropics. 1983. 56 p.

US$8.00 Casuarinas: Nitrogen-Fixing Trees for Adverse Sites. 1983. 118 p.

US$8.00 Leucaena: Promising forage and Tree Crop in Developing Countries (Second Edition). 1984. 100 p.

Managing Tropical Animal Resources

US$7.50 The Water Buffalo: New Prospects for an Underutilized Animal. 1981. 118 p.

US$6.00 Butterfly Farming in Papua New Guinea. 1983. 36 p.

US$6.00 Crocodiles as a Resource for the Tropics. 1983. 60 p.

US$8.00 Little-Known Asian Animals with a Promising Economic Future. 1983. 133 p.

Plants

US$6.00 The Winged Bean: A High Protein Crop for the Tropics (Second Edition). 1981. 59 p.

US$7.50 Amaranth: Modern Prospects for an Ancient Crop. 1983. 81 p.

US$10.00 Jojoba: New Crop for Arid Lands. 1985. 102 p.

US$6.50 Underexploited Tropical Plants with Promising Economic Value. 1975. 190 p.

Wave Power for Scottish Isle

An experimental shore-based wave power installation to be built on the Scottish island of Islay, was designed by engineers at Queen's University, Belfast. It will be based on an oscillating water column. If data gathered on the column in winter 1987 shows it to be worthwhile then a Wells turbine and generator could be added to produce electricity in 1988. A low-cost method of construction has been devised, and it is estimated that 1 MW station based on this concept might achieve generating costs between 3-4.5p/kWh.

The installation is designed to operate in shallow water sites and will be located on the west-facing coast of the island at the end of a natural rock gully. The focusing and resonant effects of the gully on the waves will assist maximum energy capture.

This will be the first wave power installation of its kind in the world, though related

Botswana Energy Workshop
Energy Planning in Developing Countries
Proceedings of the Botswana Energy Workshop,
30 March - 3 April 1987, Gaborone, Botswana

The German Agency for Technical Cooperation (GTZ) has been involved in the energy field in many African countries. Energy programmes which have been and are supported continuously by GTZ are; Energy Master Plans, Master Plans for Sources of Energy, Special Energy Programmes, Energy Conservation Programme or Rational Use of Energy. GTZ then initiated the Botswana Energy Workshop which was supported by the Ministry of Mineral Resources and Water Affairs in Gaborone, Botswana.

The workshop was held in Gaborone, Botswana, during 30 March-3 April 1987. Forty-eight participants from Botswana, Kenya, Lesotho, Sudan, Tanzania, Federal Republic of Germany and Zimbabwe attended the workshop.

The theme of the workshop was "Energy Planning in Developing Countries." The objectives of this workshop were as follows:

-Review and evaluation of new vs. traditional planning concepts; presentation of their advantages and problems;

-Discussions of the problems encountered in the realization of the proposed energy strategies;

-Discussions of the approaches used in institution building and local staff training;

-Improvement of conceptual approaches and, possibly, redefinition or clarification of the goals aimed at; and

-Providing the possibility to exchange experiences and information and document them.

The contributions to the workshop can be classified in the following fields: energy planning concepts, energy demand, institutional & organizational aspects, conventional energies, issues in renewable energy systems, information and data requirements, energy pricing, and sectoral, regional and local planning in particular rural energy supply.

The proceedings contains the papers presented at the workshop and was prepared by the Ministry of Mineral Resources and Water Affairs and the German Agency for Technical Cooperation.

To obtain a copy of the proceedings please contact:

Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) GmbH
Dag-Hammarskj ld-Weg 1
Postfach 5180
D-6236 Eschborn
Federal Republic of Germany

to Norwegian stations, and will be used both to demonstrate the viability of shore-based stations and to provide a marine test-bed for a 180kW two-stage bi-plane Wells turbine. Schemes such as this one could produce electricity on a small-scale for domestic or industrial use.

The construction of this experimental station, which will cost 230,000 pounds, is part of the Department of Energy's continuing research programme on promising wave power devices. Feasibility studies on cost reductions for wave-generated electricity at Belfast University have been underway for 2 years funded by the Department of Energy and the Islay station.

The station design consists of a concrete chamber built across the gully, which would be connected to the turbine and generator by an air duct. The front wall of the chamber is sloped to minimise the effect of wave impact and the back wall is mounted on the gully bed. Incident waves cause the water level in the chamber to rise and fall, so forcing air through the air duct to drive the turbine. The Wells turbine chosen for this application would incorporate two planes of blades instead of one. This is expected to improve turbine performance and operation and to avoid stalling in variable seas.

A new method of construction for the main structure will eliminate the need for specialised equipment and allow local manpower and materials to be used. In this, the front, back and side walls of the chamber will be constructed from hollow reinforced precast units which will be filled with reinforced concrete once they are in place. This minimises the amount of concrete that has to be placed in-situ and enables construction work to be phased to avoid bad weather.

The construction of the main concrete structure of the Islay station is underway and will be followed by eight months of performance monitoring. Information from this stage of the programme will be used to assess the costs and potential of electricity generated by this means and to produce a final design for the turbine and generating plant. If the results are good the turbine could be installled in 1988 and the complete station monitored for 18 months whilst producing electricity.

(Source: *Review*, Issue 1, September 1987)

New Wave Energy Technique Based on Rotors Developed in Sweden

A project to produce wave energy, based on completely new thinking in this field, has been tested and found worthy of further development by the Swedish Energy Research Commission, Stockholm. The device is called "Wave rotor" and it has been developed by a group of researchers at Chalmers Industriteknik -- a spin-off from Chalmers University of Technology in Gothenburg -- under the leadership of the inventor, Fredrik Wincrantz.

The converter basically consists of two counter-rotating wave rotors facing the incoming waves. The floating rotor is long and cylindrical with a number of curved horizontal vanes, divided into transverse compartments. The vanes are filled with water on one side and with air on the other and the moving waves cause a continual

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Dutch Support Wind Evaluation Programme in Sri Lanka

Electricity production in Sri Lanka represents 10 per cent of the total energy used. All fuel used is imported, with only 946 MW of hydro electric power and 200 MW of installed thermal generation as home grown power. Some of this capacity is not due to go on line until later this year.

During the last few years, average annual rainfalls have been lower than normal, greatly reducing the hydro electric power capacity available. The thermal installations, intended only as reserve capacity, have had to be brought on line, but still power failures have been frequent.

Only 169 MW of hydro electric power remains to be developed over the next five years, although neither is this an ideal solution, conflicting as it does with irrigation demands during the dry seasons. Only the southwest of the island does not suffer periodic drought.

A way of stretching the current hydro electric power capacity would be by installing wind turbines, as decided by the energy planners. In a programme sponsored by the Dutch Government, Shavindranath Fernando of the Ceylon Electricity Board is now studying the possibility. His findings were presented at the Windpower Europe '87 Conference held in Holland in October 1987.

Mr. Fernando reported that he had selected the 14.5 MW Taldena reservoir in the central mountains and a windfarm site at Hambantoto, 100 kilometres away from the reservoir on the southeast coast, for an evaluation of the integration of wind energy into existing hydro electric power generation. The Hambantota site is exposed to both the southwest and northwest monsoons which occur from the middle of May to early October and from December to late February respectively.

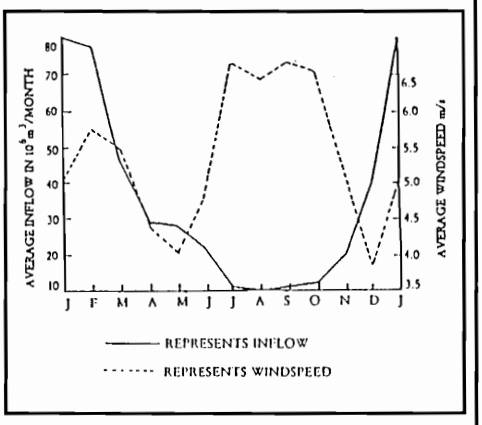

Fig. 1 Variation of water inflow and wind velocity over the year.

Fig. 1 shows that the match between wind and rain for such a hydro-wind integration is very good. Winds are best when rains feeding the reservoir are at their lowest.

Taking current demands on the existing hydro electric power capacity, the power failure rate would drop from 5.5 per cent to 1.7 per cent with the addition of a 2.5 MW wind powerplant; to 0.8 with a 5 MW wind installation; and to 0.4 if 7.5 MW of wind turbines were linked to the system.

(Source:Extracted from *Dutch Support Wind Evaluation Programme in Sri Lanka*, by Jos van Beek, *Windpower Monthly*, Vol. 4, No. 1, January 1988.)

Windpump Manufacture in Nigeria

A Nigerian company is to begin manufacturing the IT Windpump under licence from Development Techniques, the licensing subsidiary of ITDG. UAC of Nigeria Ltd is being supplied with the complete documentation to manufacture, market, erect, commission and service the windpumps.

UAC Nigeria is a Nigerian public company with 130,000 shareholders, which employs some 10,000 people in the country. It is operational in all 19 states in the areas of manufacturing, technical sales and service, merchandizing and marketing.

In 1986, a demonstration IT windpump was erected in northern Nigeria to assess its performance in desert conditions. Shipped from Pakistan, the windpump was sited at Goronyo, 100 km north-east of Sokoto near the border with Niger. It has been very well received by the villagers. The land around Goronyo is semi-desert scrubland, with only a short rainy season of some two to three months. Following the breakdown of the village pump women and children were having to spend hours every day collecting water from a source several miles away.

The estimated market for windpumps in Nigeria is thought to be considerable and, once in production, UAC Nigeria expects to produce more than 100 per year.

UAC Nigeria is part of UAC International, a division of Unilever concerned mainly with Africa.

(Source: *Intermediate Technology News*, December, 1987.)

New Wave Energy Technique Based on Rotors Developed in Sweden

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movement of rotation round the axis which drives the machinery.

The rotors are made of aluminium and specially dimensioned for average wave conditions at the location for which it is intended. The sturdy and relatively simple construction makes the survival rate high, even in stormy weather. Big waves have little effect as the compartments can only take so much water and the rotor's stroke is not limited.

The wave rotor is, at least in its first phase, intended as a standard unit for local limited supply. It would be suitable for direct supply to pumps and desalination units. Power production costs are estimated at US$0.06 per kWh. At a later stage several units linked together could be introduced for medium- or large-scale production for the national grid. Recent tests have shown that the wave rotor is particularly effective in shallow waters and that proximity to the shore would have additional cost-reducing benefits.

Wave energy is relatively unexplored as an alternative to other methods of power production, the inventor claims, despite the fact that it is more ecologically sound than most. The next step is to test the system at sea. Several businesses and some local authorities have expressed interest in the project and if everything goes according to plan, an experimental wave-power station could be launched in 1988.

(Source: The Swedish-International Press Bureau, Linnegatan 42, S-11447 Stockholm, Sweden, December 22, 1987)

China and India Start Major Wind Turbine Manufacturing Projects

Two of the newer Danish wind turbine manufacturers are among the first to sign deals for licence production of WECS in China and India. Both deals are in the form of joint ventures.

Together with Swedish partner New Wind, Vind-Syssel of Denmark has made an agreement with Peking Motor Company for licensed production in China. Danish Windpower has made a similar agreement with Hindustan Brown Boveri of India. In both cases the deals are expected to result in installation of about 50 machines this year.

Danish Windpower's agreement with Hindustan Brown Boveri includes delivery of the more technically advanced turbine machinery, such as control systems and blades, while the remainder of the machine will be built on site. The contract is for eight years.

In both cases supply of technical know-how is a part of the contract and already Danish Windpower has stationed an employee in India. From April 1988, New Wind and Vind-Syssel will be training 15 employees from Peking Motor Company. During the first half of 1988, three Vind-Syssel turbines will be exported to Peking Motor Company for installation in three Chinese provinces. From that point on Peking Motor Company will be responsible for manufacture of the tower and nacelle of the 150 kW Vind-Syssel in the first phase of the agreement. In the second phase, the company will assemble the generator, now under construction and in phase three, the gears and blades will be manufactured in China. Finally, in phase four, the control system will also be built by Peking Motor Company.

In both China and India it appears generally accepted that wind energy utilization is to be measured in terms of thousands of wind turbines.

(Source:*China and India Start Major Manufacturing Projects*, by Torgny Moller, *Wind Power Monthly News Magazine*, Vol. 4, No. 2, February 1988, p.11)

Wind Energy Development Projects

MBB Introduces 30-kW Turbine

West German industrial giant MBB has developed a pitch-regulated, downwind, single-bladed wind generator with significantly greater productivity than its earlier stall-regulated machines, according to a news release from its North American affiliate, MBB-Thermax of Burlington, VT.

A production model of the new Mon 15, which includes a self- erecting 20 m (66 ft) tower, will be installed in September 1987 for extensive field testing at Canada's Atlantic Wind Test Site on Prince Edward Island, the firm said. Testing will include wind-diesel operation, and production units of the new machine are expected to be available for delivery in 1988.

Specifications for the new turbine are as follows: nominal power, 30 kW at 10 m/s (22 mph); cut-in wind speed, 5.0 m/s (11 mph); cut-out wind speed, 16 m/s (36 mph); survival wind speed, 60 m/s (135 mph); rotor, single 7.5 m (17 ft) glass-reinforced polyester blade with hinged hub; airfoil, Wortmann FX84W127; swept area, 170 m^2 (1,830 ft^2); rated rpm, 117; total weight including tower, 3,100 kg (6,800 lb).

The microprocessor-control machine, with synchronous or asynchronous generator, is rated for a 20-year life.

For further information, contact MBB-Thermax, 1 Mill Street, Burlington, VT 05401-1530, USA, Phone 802-658-1098, Telex 503472 thermax btv.

(Source:*Wind Energy Weekly*, May 19, 1987)

Six-Rotor Machine Under Test in Netherlands

An innovative wind machine with six rotors on a single tower is being tested by Dutch manufacturer Lagerweij Wind-turbine in Holland with encouraging results, according to an industry source.

The machine, with six 75 kW generators, each driven by a 15 m (49 ft), pitch-controlled rotor, has been running for two months on the Maasvlakte River near the North Sea in what the source called a "difficult wind regime". The unit is owned by GB, the utility which serves the port of Rotterdam, the source said.

Since the design offers a significant reduction in tower and material costs, it is clearly of interest if the structural problems can be overcome.

(Source: *Wind Energy Weekly*, May 26, 1987)

Wind Pumping in a Wider Perspective

Two concerted action programmes are presently underway that will shortly make windpumping (water lifting by means of wind power) more accessible for those who are not old hands in this technology.

In a multi-donor effort initiated by USAID and inspired by African priorities, the finishing touch is presently being given to a *Handbook for Comparative Evaluation of Technical and Economic Performance of Water Pumping Systems*. It deals with windpumping on an equal footing with fuel engine, grid fed electrical, animal traction, solar and hand powered pumps.

The second activity, the Global Windpump Evaluation Programme (GWEP), under World Bank and UNDP auspices, obviously limits itself to windpumps (mechanical water pumping windmills), but brings together experience from all parts of the developing world.

In both schemes CWD -- Consultancy Services Wind Energy Developing Countries -- of Amersfoort, Holland, plays an executive part.

Guidelines for comparative evaluations

The history of this initiative includes workshops in the USA ('85), England ('86) and Botswana ('87). At the latter 104 water supply experts working in 16 African countries discussed a draft of the Handbook with representatives of the donor community and

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Publications Reviews

Wind pumping Handbook

Sarah Lancashire, Jeff Kenna and Peter Fraenkel
Intermediate Technology Publications Ltd.
(9 King Street, London WC2E 8HW, UK)
ISBN 0 946688 34 6
1987, vi+79 p.

This handbook was first written for a windpump familiarisation seminar held in Nairobi in November 1986. The seminar was organised and presented by I.T. Power, hosted by the Ministry of Water Development of Kenya and funded by the Overseas Development Administration, UK.

The purpose of this handbook is to provide decision-makers and potential users of windpumps with the basic information on windpump technology, economics, sizing to meet domestic or irrigation demand, procurement, installation and maintenance.

The handbook contains a brief outline of the history and development of windpumps. Then multibladed horizontal-axis windpumps—considered as the only practical, commercially-available technology for water pumping at this time—are discussed. State-of-the-art in windpump design, site evaluation and economic analysis are also presented with examples on planning and calculation.

Publications Received

ENERGY

- *Energy Conservation in a Small Scale Production Engineering Facility*, M.R. White and A&T Burt Mechanical Ltd, Chrischurch, New Zealand Energy Research and Development Committee Report No. 142, University of Auckland, Private Bag, Auckland, New Zealand, June 1987, iv+83 p.
- *Energy Conservation with Drying, Conditioning and Storing*, Report of the 1986 Workshop of the European Cooperative Networks on Rural Energy on, Godollo, Hungary, 7-9 October 1986, CNRE Report No. 18, Food and Agriculture Organization of the United Nations, Rome, 1986, 14 p. +App.
- *Industrial Thermal Effluents for Greenhouse Heating*, Report of the 1986 Workshop of the European Cooperative Networks on Rural Energy on, Dublin, Ireland, 17-19 September 1986, CNRE Report No. 17, Food and Agriculture Organization of the United Nations, Rome, 1987, 12 p. + App.
- *Energy Conservation with Agricultural Machinery*, Proceedings of the Second Technical Consultation of CNRE, Gembloux, 26-28 May 1986, CNRE Bulletin No. 14, Food and Agriculture Organization of the United Nations, Rome, 1986, 83 p.
- *Proceedings of USAID-ASEAN Energy Conservation Training Program: Energy Audit in Building*, Jakarta, 2-13 March 1987, Directorate of Buildings, Directorate General of Human Settlement, Ministry of Public Works, Jakarta, March 1987.
- *Report on Energy Audit of Panghegar Hotel*, Research and Development Centre for Applied Physics, Indonesian Institute of Sciences, Bandung, 1986, 24 p.

BIOMASS ENERGY

- *Heat and Power from Biomass*, Report of the 1986 Workshop of the European Cooperative Networks on Rural Energy on, Ormea, Italy, 17-19 October 1986, CNRE Report No. 19, Food and Agriculture Organization of the United Nations, Rome, 1986, 18 p.
- *Cookstoves in India: Roster of Experts*, Consortium on Rural Technology (D-320, Laxmi Nagar, Delhi 110092 India), 1987.
- *Proceedings of the ASEAN Conference on Energy from Biomass: Development Towards Efficient Utilization of Biomass Energy*, 13-15 October 1986, Penang, Malaysia, ASEAN Working Group on Non-Conventional Energy Research (WGNCER Secretariat, King Mongkut's Institute of Tehnology Thonburi, Bangkok 10140, Thailand), 1986, 457 p.

Windpumping in a Wider Perspective

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the specialist authors. Financed by their "own" donor these had prepared chapters on short (USAID) and long term (DGIS, Holland) testing and on economic (USAID/GTZ, US/FRG) and social and institutional aspects (CIDA, Canada) of the six technologies mentioned earlier.

The general aim is to supply the tools with which test and field data from water lifting projects can be checked locally against efficiencies obtained elsewhere or with an alternative technology. And this in a generally accepted manner. The workshop participants felt this to be viable for technical and economic evaluations. The part concerned with social and institutional aspects offers a listing of "red flags" and contains models for questionnaires; the best possible considering the marked regional differences in these fields. In the second quarter of this year the testing part of the final version of the handbook will be available separately. Economics and other aspects are the subject of the companion volume, which will take a little longer to finalize. Besides a hand calculation method, the latter will possibly present PC software for the evaluation of project results.

With the help of the first volume the performance of pumping devices can be quickly checked upon installation, e.g. against manufacturers specifications or project requirements (short term). Its long term section includes other elements of supply systems and their usage too, resulting in a clear picture of total effectiveness in the given context.

For further details please contact:
CWD
Consultancy Services Wind Energy Developing Countries
P.O. Box 85
3800 ab Amersfoort
Holland

Diary of Events

* **May 2-6, 1988, Phoenix, Arizona, USA**

Research in Thermochemical Biomass Conversion

Topics include analysis, catalysis, characterization, combustion, equipment design, gasification, liquefaction, modelling, optimisation, process design, product synthesis, pyrolysis, scale-up, simulation and upgrading.

For more information contact:
Jim Kuester
Dept. Chemical and Biochemical Engineering
Arizona State University
Tempe, Arizona 85287
USA
Tel: (602)965-3313

* **May 9-13, 1988, Florence, Italy**

8th European Photovoltaic Solar Energy Conference

The conference will provide plenary sessions, poster sessions, a panel discussion and exhibition on all aspects of photovoltaic systems, including storage techniques.

For more details contact:
WIP
Sylvensteinstrasse 2
D-8000 Muenchen 70
West Germany
Tel: (49)89/7 20 12 32

* **May 16-20, 1988, University of Tasmania, Hobart, Australia**

Energy for Rural and Island Communities

The 5th International Conference on Energy for Rural and Island Communities, in conjunction with Islands '88 Conference of Islands of the World, will be hosted by the Centre for Environmental Studies, University of Tasmania and organised by the Energy Studies Unit, University of Strathclyde, Scotland.

For further information contact:
Dr. John Todd
ERIC V Conference Organiser
Centre for Environmental Studies
University of Tasmania
G.P.O. Box 252C
Hobart, Tasmania 7001
Australia

* **May 22-26, 1988, Bologna, Italy**

Fifth International Symposium on Anaerobic Digestion

The symposium will promote and enhance the exchange of information and experiences about research and development work related to anaerobic digestion processes for the protection of the environment, and the technology of recovery of renewable resources.

The programme will deal with laboratory, pilot and full scale experiences, current developments and research trends on processes and unit operations which are required for optimal implementation of anaerobic digestion.

The main themes of the symposium will be

- current advances in anaerobic digestion fundamentals;
- process aspects of anaerobic digestion waste treatment;
- anaerobic digestion of recalcitrant compounds and treatment of anaerobic effluents; and
- anaerobic digestion in resource recovery.

Three specialized workshops (two organized by the Commission of European Communities - CEC), open to all participants, will be held in parallel to the poster and short communications sessions.

For more information contact:
Secretariat
Fifth International Symposium on Anaerobic Digestion
Sogepaco SpA
Piazza della Costituzione 4
40128 Bologna
Italy
Telex: 511098 SOPACO I
Tel: (+39 51) 517119, 517188, 503331 (Ms. Gentile)

* **June 5-10, 1988, Tiberias, Israel**

The 2nd International Congress on Energy

The Congress is organized under the auspices of the Ministry of Energy and Infrastructure; Academic institution in Israel; and Israel National Committee.

The congress will be divided into three following technical sessions:

Session A - Policy and economics of international energy cooperation : energy transport; transfer of technology; potential social implications; and international financing.

Session B - Development of energy technologies: energy conversion and storage; solar technologies; wind energy; conventional and alternative sources.

Session C - Energy Management : energy conservation; efficient use of energy; and environmental aspects.

For further details contact:
2nd International Congress on Energy
c/o International Ltd.
P.O. Box 29313
65121 Tel Aviv
Israel

* **June 6-10, 1988, Copenhagen, Denmark**

1988 European Community Wind Energy Conference

For further information contact:
Mr. W. Palz
Commission of the European Communities
Directorate-General (XII) for Science Research and Development
200 rue de la Loi
B-1049, Brussels

* **June 20-24, 1988, Massachusetts Institute of Technology Campus, Cambridge, Massachusetts, USA.**

13th National Passive Solar Conference and the Annual-Meeting of the American Solar Energy Society

The Conference will be hosted by the Northeast Solar Energy Association.

For further information contact:
The American Solar Energy Society
2400 Central, B-1
Boulder, Colorado 80301
USA

* **June 21-24, 1988, Churchill College, Cambridge, UK**

The Recovery of Energy from Municipal and Industrial Waste Through Combustion

This seminar is organized by Warmer Campaign and the Commission of the European Communities to present the state-of-the-art in the municipal waste com-

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Diary of Events

From P. 17

bustion sector.

For further details contact:
Philip Evemy
Warmer Campaign
83 Mount Ephraim, Royal Tunbridge Wells, Kent, UK TN4 8BS

* **June 27-28, 1988, Bologna, Italy**
International Conference on Energy Options and the Rural Sector in Developing Countries (LDC)

The Conference will be held within the VII World Congress for Rural Sociology as part of the celebration of the 9th Centenary of the University of Bologna.

For further information please contact:
Paolo Vestrucci
Laboratoria Di Montecuccolino
Via Dei Colli, 16
40136 Bologna
Italy

* **July, 1988, Naxos, Greece**
1st International Symposium on the Use of New Energy Sources for Local Development

The Symposium is organised by the Municipality of Aperathos, Naxos, the Society of Ecology and Development and the Committee of the Small Communities Development.

For further information contact:
Dr. Mat Santamouris
Society for Ecology and Development
39 Mavromihali Street
106.80, Athens
Greece

* **July 4-9, 1988, Harbour Castle Westin, Toronto, ON, Canada**
Small Hydro'88

The Small Hydro'88 Conference and Trade Show will provide a forum for dialogue and information-sharing amongst manufacturers, consultants, policy makers, academics and others with an interest in international small hydro development.

The sessions at Small Hydro'88 are aimed at providing up-to-date information in the three major areas of policy and planning, small hydro technology, and markets and financing mechanisms. Issues relevant to developing countries will be of particular interest.

THE PROGRAM

The Conference Program is divided into three main segments.

A.) Two Educational Courses in Small Hydro Development each lasting two days and running in parallel on Monday July 4 and Tuesday July 5. The courses are Small Hydro Project Development in Canada and Small Hydro for Developing Countries.

B.) Three days of sessions and workshops on Wednesday July 6 to Friday July 8. Three major "theme sessions" consist of: 1). Session A: Policy, Planning and Utility Issues; 2). Session B: Engineering and Technology; 3). Session C: Markets and Financing.

C.) Tours of local hydroelectric plants on Saturday July 9.

For more details contact:
Congress Canada
Conference Management
73 Richmond Street West
Suite 300
Toronto, Ontario
Canada M5H 1 Z4
Fax: (416)860-0380
Tel: (416)860-1772

* **July 27-31, 1988, Porto, Portugal**
PLEA 88: Energy and Buildings for Temperate Climates

This conference focuses on energy conscious building design in temperate climates, with special reference to the Mediterranean Basin. The conference will comprise formal lectures, round-table discussions and forums for informal discussions. Main topics for forum discussions include:

- Form and technic in architecture
- Passive concepts in the architecture of Le Corbusier
- Passive architecture and urban planning
- Education and training in passive and low-energy architecture.

Two additional technical events will be held during the same week:

- A technical exhibition-fair on Renewable forms of energy" and on "Materials and equipment for low-energy use in buildings".
- An Iberian ISES meeting, a scientific event on the promotion of renewable forms of energy.

For further information contact:
PLEA 88 Secretariat
Av. Antunes, Guimaraes 102-1
4100 Porto - Portugal
Telex: 27223 FEUP P
Telefax: 351-2-319280

* **August 1-4, 1988, Shanghai, China**
Asian and Pacific Area Wind Energy Conference - APWEC'88

The Conference is sponsored and organized by the Chinese Wind Energy Development Centre (CWEDC) and co-sponsored by the Japanese Wind Energy Association (JWEA), Pan Asia Culture Communication Centre (PACCC), and Shanghai Association for Science and Technology.

The subjects to be discussed are: research and demonstration programmes, wind resources and siting, technology development, machines and components, wind energy applications, performance and testing, operation and maintenance experiences, reliability and safety, environmental impact and institutional, economic and legal issues.

For further information contact:
Mr. Lu Zhidi
APWEC'88 Secretariat
CWEDC
P.O. Box 2425
Beijing
China

* **August 8 - September 16, 1988, Reading, UK**
Training Course in the Design, Construction and Testing of Windpumps

The course is intended for engineers, scientists and agriculturalists of graduate or equivalent level. It is concerned with wind energy and development and/or the setting up of windpumping projects in rural areas. The course programme contains all aspects of wind pump design, selection, construction and testing. It covers both the theoretical and practical aspects of design. The deadline for application is July 10, 1988.

For information contact:
Ms. J. Clancy
Dept. of Engineering
University of Reading

Reading, RG6 2 AY, UK
Telex: 847813

* **August 13-18, Tokyo, Japan**
ISES International Congress on Solar Energy
For further details contact:
International Solar Energy Society
UK Section
19 Albemarle Street
London W1X 3HA
UK

* **August 16-19, 1988, Reykjavik, Iceland**
International Workshop - Deposition of Solids in Geothermal Systems
The workshop is sponsored by Orkustofnun, the National Energy Authority of Iceland with the co-sponsor of Hawaii Institute of Geophysics, USA. The workshop will address the scientific and technical aspects of solids deposition in geothermal systems, including the reservoir, wellbore, pipelines, equipment, direct use and electric power plants.
For more information contact:
Dr. J.S. Gudmundsson
Geothermal Division
National Energy Authority
Grensasvegur 9
108 Reykjavik, Iceland
Telex: 2339 ORKUST IS
Tel : 354-1-83600/82857
or
Dr. D.M. Thomas
Institute of Geophysics
University of Hawaii
2525 Correa Road
Hawaii 96822, USA
Cable: UNIHAW
Tel : 1-808-946-6482

* **August 29-31, 1988, Galaxen Convention Centre, Borlaenge, Sweden**
North Sun'88
North Sun'88 is the third in a series of conferences on utilization of solar energy at high latitudes.
For further information contact:
North Sun'88
Jussi Bjoerlings Vag 25
5-781 50, Borlaenge
Sweden

* **September 4-8, 1988, Cambridge, UK**
Symposium on Engineering and Economic Aspects of Energy Conservation in Protected Cropping
For further details contact:
Dr. B.J. Bailey
AFRC Institute of Engineering Research
Wrestpark
Silsoe, Bedford MK45 4HS
UK

* **September 17-22, 1988, Montreal, PQ, Canada**
World Energy Conference
14th Congress Energy for Tomorrow
For further information contact:
Guy Coulombe
Hydro Quebec
1 Place Ville-Marie
East Tower, 28th Floor
Montreal, PQ, H3C 3H2

* **September 19-22, 1988, Sheraton Waikiki, Honolulu, Hawaii, USA**
Windpower'88
The American Wind Energy Association will hold its 18th National Conference in Honolulu, Hawaii. The conference will take place in conjunction with the International Renewable Energy Conference sponsored by the Government of the State of Hawaii.

The AWEA annual meeting will bring together designers, manufacturers, developers, researchers, government program administrators, and utility planners.

The conference agenda will include a special session focusing on international applications, with panel presentations/discussions on the specific problems and opportunities of developing wind energy as an alternative power generation source worldwide.

The conference will also include an exhibit of wind energy products and services, as well as field visits to renewable energy project sites on the island of Oahu. Prospective authors are invited to submit proposals for presentations. The agenda includes: the wind resource; system design; technology development; operations; and economics of wind power systems.
For more information contact:
American Wind Energy Association
1730 N. Lynn Street, #610
Arlington, Virginia 22209
USA
Tel: 703-276-8334 or 802-649-2112
Telex: 6502955124 MCI UW

* **September 20-26, 1988, Beijing, China**
Energy China
The conference is organized by China Association for Science and Technology (CAST) and SHK International Services, Ltd.
For further information contact:
Ms. Amy Lam
SHK International Services, Ltd.
22/Fm 151 Gloucester Road
Hong Kong
Telex: 89587 shkis hx.
Tel: 5-8326100

* **September 26-30, 1988, the Riviera Hotel, Las Vegas, Nevada, USA**
20th IEEE Photovoltaic Specialists Conference
For further information contact:
Programme Chairman
Cosmo Baraona
Nasa Lewis, MS501-17
21000 Brookpark Road
Cleveland OH 44135
USA

RERIC 10th Anniversary
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RERIC 10th Anniversary

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The Biggest Solar Timber Kiln in Thailand

The Asian Institute of Technology (AIT) in cooperation with the Thai Plywood Company at Bangna, Thailand, has developed and constructed a solar timber kiln of 20 m^3 capacity. It is the biggest solar kiln in Thailand, according to Mr. Prasert Rerkkriangkrai, one of the researchers involved in the project. The work was conducted under the guidance of Prof. R.H.B. Exell and Mr. Sommai Kornsakoo of the Energy Technology Division, AIT.

Air-drying is presently used at the Thai Plywood Company for pre-drying of green wood, which has a moisture content of 50-60% wet basis, to obtain wood of 20% moisture content wet basis (Fig. 1). The drying is then completed in a conventional kiln dryer. Dried wood at the Thai Plywood Company is mainly used for making door frames; it must have high standard qualities as specified and inspected by the Thai Industrial Standards Institute, Ministry of Industry. At present, the demand for door frames is increasing and the Company is not able to meet it due to a lack of dried wood. As air-drying is a slow process, which may take 5-6 months for timber of about one inch thickness depending on species of wood and weather conditions, the solar kiln is intended to be a pre-drying system that will minimize the total drying time.

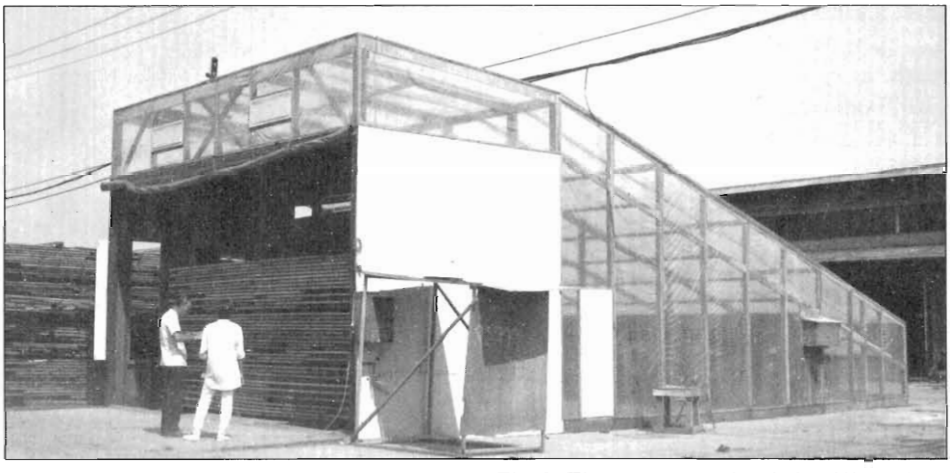

Fig. 2. The prototype solar timber kiln at the Thai Plywood Company, Bangna.

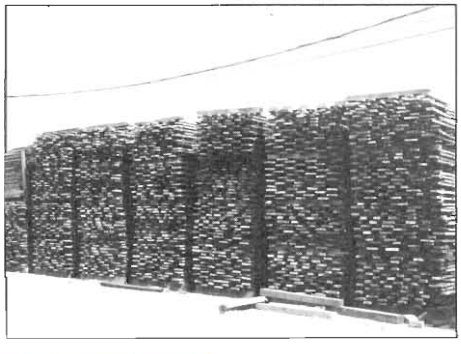

Fig. 1 Air drying (pre-drying) of green wood.

The solar timber kiln developed was based on the AIT portable solar dryer. It is located near the conventional kiln dryer at the Company where a large cemented ground area is available. This kiln consists of a sturdy wooden framework covered with two layers of clear LDPE (low density polyethylene) sheets (Figs. 2-5). Solar heat is absorbed by a false ceiling of galvanized steel sheets above the wood stack and by the cement floor painted matt black. The kiln is divided into two parts. The first part is a solar collector which contains four electric fans that are used for circulating air. The second part is the timber compartment containing a stack of size 1.3 m x 6.0 m x 0.75 m. It is provided with insulation to reduce heat loss through the walls. Mois-

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INNERTAP

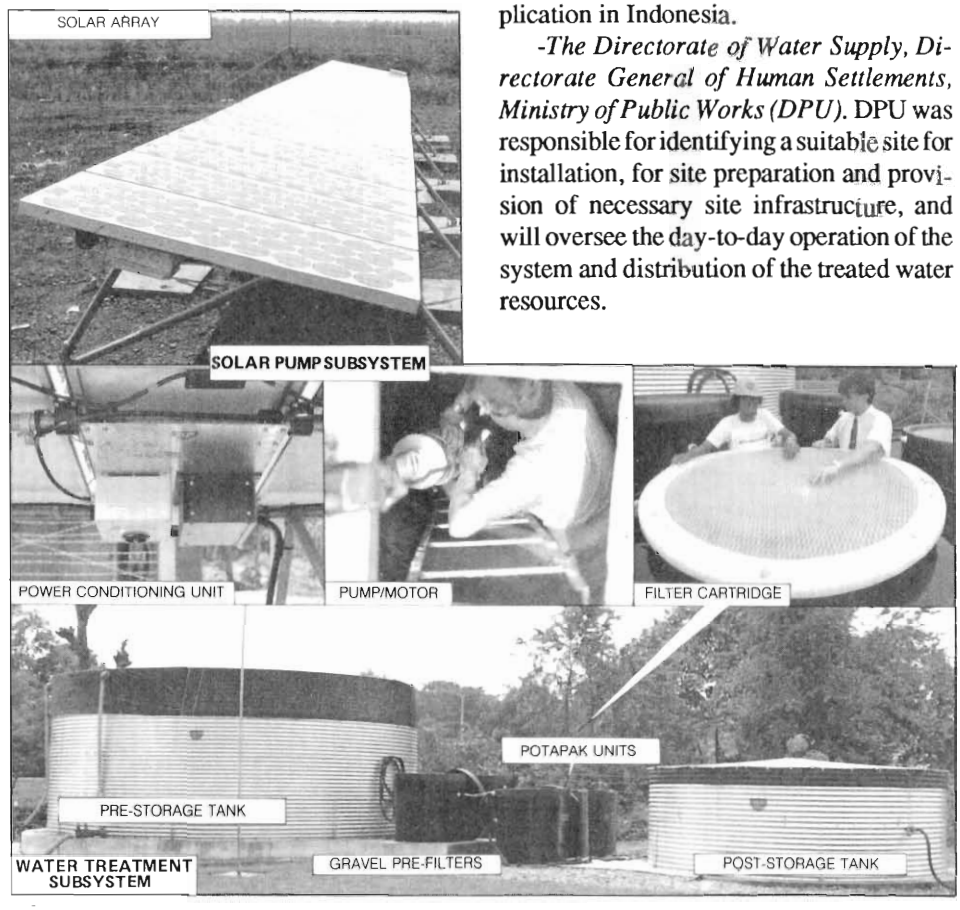
Solar Water Treatment Demonstration Project, Kedung Village, West Java, Indonesia

A solar water treatment demonstration system was commissioned and installed in October 1986 at the Kedung Village of West Java, Indonesia, under the cooperation of the following three organizations:

-*BP Solar International Ltd.* - a wholly-owned subsidiary of the British Petroleum Company plc. BPSI has donated the system hardware to the Government of the Republic of Indonesia, and provided technical assistance during commissioning and installation.

-*The Directorate of Energy Conversion and Conservation Technology, Agency for the Assessment and Application of Technology (BPPT),* under the Ministry of Research and Technology. BPPT, the official recipient of the system on behalf of the Government of Republic of Indonesia, will monitor and evaluate its performance and make recommendations as to the scope for future application in Indonesia.

-*The Directorate of Water Supply, Directorate General of Human Settlements, Ministry of Public Works (DPU).* DPU was responsible for identifying a suitable site for installation, for site preparation and provision of necessary site infrastructure, and will oversee the day-to-day operation of the system and distribution of the treated water resources.



The BPP500 Solar Water Treatment System

The system under demonstration was originally developed by BP Solar International in conjunction with another British company, Potapak Ltd. It comprises a unique method of slow sand filtration of water supplied by a solar-powered pump, designed to provide the necessary head of water where none naturally exists and where conventional power supplies are either unreliable or totally non-existent.

The solar pump is essentially maintenance-free and requires no conventional fuel supply. The water treatment process is passive, with no moving parts, requiring no chemical additives, and only the minimum of maintenance by an unskilled operator. Together they represent a reliable and totally self-sustaining method of providing purified drinking water to rural communities from contaminated river and ground water sources. This system will eliminate up to 99.9% of harmful water-borne bacteria (those that commonly cause typhoid, cholera, dysentary, for example) as well as removing the unpalatable turbidity from the water.

The Biggest Solar Timber Kiln in Thailand

From P. 1

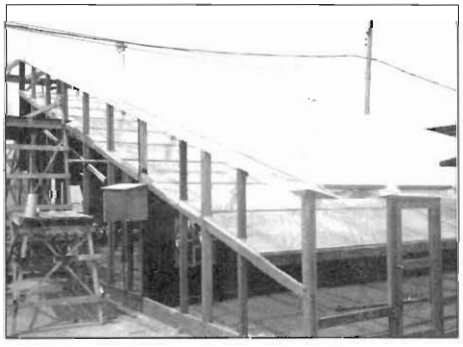


Fig. 3 The collector part of the solar kiln during construction.

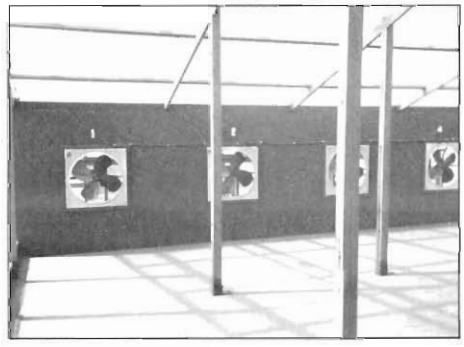


Fig. 4 The four electric fans used for circulating air.

ture is removed from this compartment through damper controlled ventilation. There is a big door at the back of the kiln for loading and unloading wood stacks by means of fork-lift trucks.

The performance of the solar kiln is being investigated to determine specific drying schedules for six species of wood that are commonly used in Thailand, namely: Yang, Khikeow, Thongsuk, Tasual, Champa and Takiensai. A mathematical model to predict moisture removal and drying rate has also been developed.

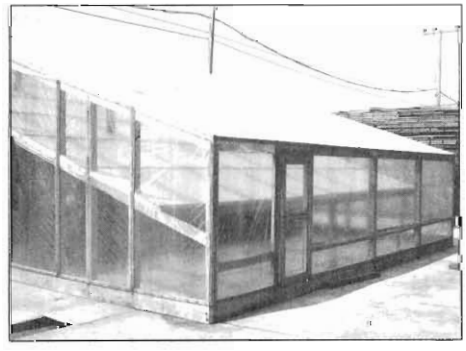


Fig. 5 The front part of the collector.

DESA KEDUNG and Water Supply Problem

Desa (village) Kedung is situated some 65 km west of Jakarta, in the Kecamatan (subdistrict) of Kresek within the Kabupaten (Regency) of Tangerang, in the Province of West Java. Although relatively close to the capital, its situation is typical of many thousands of villages throughout the Indonesian archipelago, particulary with regard to clean water supply, which presents a major problem to its thousand-or-so inhabitants.

Kedung's main source of drinking water, particularly during the dry season, is a nearby irrigation drainage channel, which is also used for daily ablutions, washing clothes and bathing animals and which, as a result, suffers high bacterial contamination as well as heavy turbidity levels (suspended silt particles). This water which, until now has had to be hand-carried, must be allowed to settle for at least three days and then boiled, which still leaves the water well short of the minimum standards suitable for human consumption as defined by the World Health Organization.

The newly-installed BPP500 system is now providing from the same source a tapped supply of up to 25 cubic metres per day (approx. 25 litres per person) of treated water well within the WHO specifications.

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Packaging Photovoltaics in Italy

Italy has more than three hundred islands, and several thousand isolated mountain huts. Until recently, these distant places, hopelessly far-off from the power grid, had to light their houses with candlelight and were forced to keep their food cool either in the snow or in the sea.

The National Electricity Agency (ente Nazionale per l'Energia Electrica, ENEL) has developed an "Isolated Houses" program to serve Alpine refuges 2000 metres high, and beach houses on isolated islands no bigger than a square kilometer. The main component of the program is the provision of photovoltaic-generated electricity in a package. Although PV electricity is considerably more expensive than that generated by conventional means, the distances involved makes the technology economical. The ENEL spent two years working with Italy's three manufacturers of photovoltaic panels -Ansaldo, Pragma, and Helios S.P.A.- to create very small production units that would be affordable to individual consumers.

The company also selected a group of appliance manufacturers who could provide very high-efficiency appliances, capable of making the most of the limited, high-cost electricity from solar energy.

The result is a US$10,000 to US$15,000 package which includes:

- an 11.5 by 23 foot photovoltaic array which produces up to 1040 kilowatts a year;
- a solar collector for hot water which accumulates 150 litres;
- a high-efficiency television and refrigerator to make good use of the electricity, with a distributor;
- six specially designed lights;
- a high-efficiency water pump; and
- a battery which accumulates sufficient energy to power the entire installation.

This package is already in use in twelve mountain-peak refuges in the north of Italy, in an arrangement made by the electric company with the Italian Alps Committee. There are other fifteen units in use in Sicily and on the small islands off the coast. And from 1986 to the end of 1987, ENEL has arranged to sell thirty more of the packages to the Eolian islands, the five small vacation paradises that lie off the northeast coast of Sicily.

"This kind of packaging could easily function in many different countries and situations," says engineer Gianfranco Castelli, ENEL Research Director.

Source: *Packaging Photovoltaics in Italy*, by A. Rosenbaum, *ASE Alternative Sources of Energy*, January, 1988.

Chan Wing Palm Oil Mill Effluent Treatment and By-Product Utilization

A Case Study in Malaysia

The rapid expansion of the palm oil industry in Malaysia during the 1970s saw the enactment of the Environmental Quality Act (Prescribed Premises) (Crude Palm Oil) Regulation in November 1977. According to this Act palm oil millers must apply for a licence from the Department of the Environment (DOE) in order to operate a mill. This licence which is renewable on a yearly basis stipulates the quality of the final effluent to be discharged. The current effluent standards stipulated under this Act to which mills must comply with are shown in Table 1. There are two standards, one for effluent to be discharged to the watercourse and the other for application on to land. The BOD level for the former is 100. mg/l (with mean of 50 mg/l for 4 weekly samples) and for the latter, 5000 mg/l.

Stricter standards for watercourse discharge from mills located in catchment areas have been enforced. In this case effluent has to be treated to a BOD level of 20 mg/l before being allowed to discharge into the receiving watercourse or 100 mg/l for application on to land.

Cont. P. 4

Chan Wing Palm Oil Mill Effluent Treatment and By-Product Utilization

From P. 3

Chan Wing Palm Oil Mill

Located in the southern state of Johore, in peninsular Malaysia, Chan Wing Mill is designed to process 60 tonnes of fresh fruit bunches (FFB) per hour and in the process produces approximately 12 tonnes of crude palm oil (CPO) and 4 tonnes of palm kernels. In addition to these main products, 36 tonnes/hour of palm oil mill effluent (POME) are also produced. On an annual basis Chan Wing Mill processes between 200,000 - 250,000 tonnes of FFB.

Table 1 DOE Standards on Effluent for Palm Oil Mill

	Watercourse Discharge	*Land Application*
BOD, mg/l	100 (50)*	5000
Suspended Solids, mg/l	400	-
Oil & Grease, mg/l	50	
Ammoniacal Nitrogen, mg/l	100*	
Total Nitrogen, mg/l	200*	
pH	5 - 9	
Temperature, °C	45	

Notes: Items marked by an asterisk (*) are based on a filtered sample.
Items marked (+) are derived from the arithmetic mean of 4 weekly samples taken consecutively.

Palm Oil Mill Effluent Treatment

POME is a mixture of wastewater generated from the separation of oil from sludge at the clarification station (about 27 tonnes/hour) and the condensate arising from sterilization of the FFB (about 9 tonnes/hour). POME has a high BOD of about 30,000 mg/l, with pH of around 4 and a temperature of 70-80 °C.

The initial system used at Chan Wing Mill was an anaerobic pond which was later substituted by high rate conventional anaerobic digesters in 1984.

POME is ideally suited to high rate conventional anaerobic treatment, as:

- BOD and suspended solids are high, 30,000 mg/l and 38,000 mg/l respectively.
- POME is available at 70-80 °C and hence can be digested "as it is" at the thermophilic range. Temperature as high as 52 °C can be achieved without external heating.
- The high buffering capacity in the system allows digestion of POME without neutralising prior to feeding.
- No toxic substances at levels likely to inhibit the growth of micro-organisms are present.

The present effluent treatment scheme (see Fig. 1) involves treating the POME produced in two anaerobic digesters. The digested effluent is applied on to land as fertilizers. Biogas produced is used to generate 250 kW of electricity for mill use.

Effluent produced from the two areas of processing (FFB sterilisation and oil clarification) are directed into separate pits and oil, if any, is recovered. From here the effluent flows into a common sludge pit which serves as a storage for POME before it is pumped "as it is" without pretreatment to the anaerobic digesters for treatment.

Anaerobic Digesters

Each of the two anaerobic digesters in operation measures 23 m in diameter by 10.7m high with an operating capacity of 4200 m³. Construction material is mild steel with epoxy coating of the internal surfaces in contact with the biogas.

Each digester is equipped with influent/

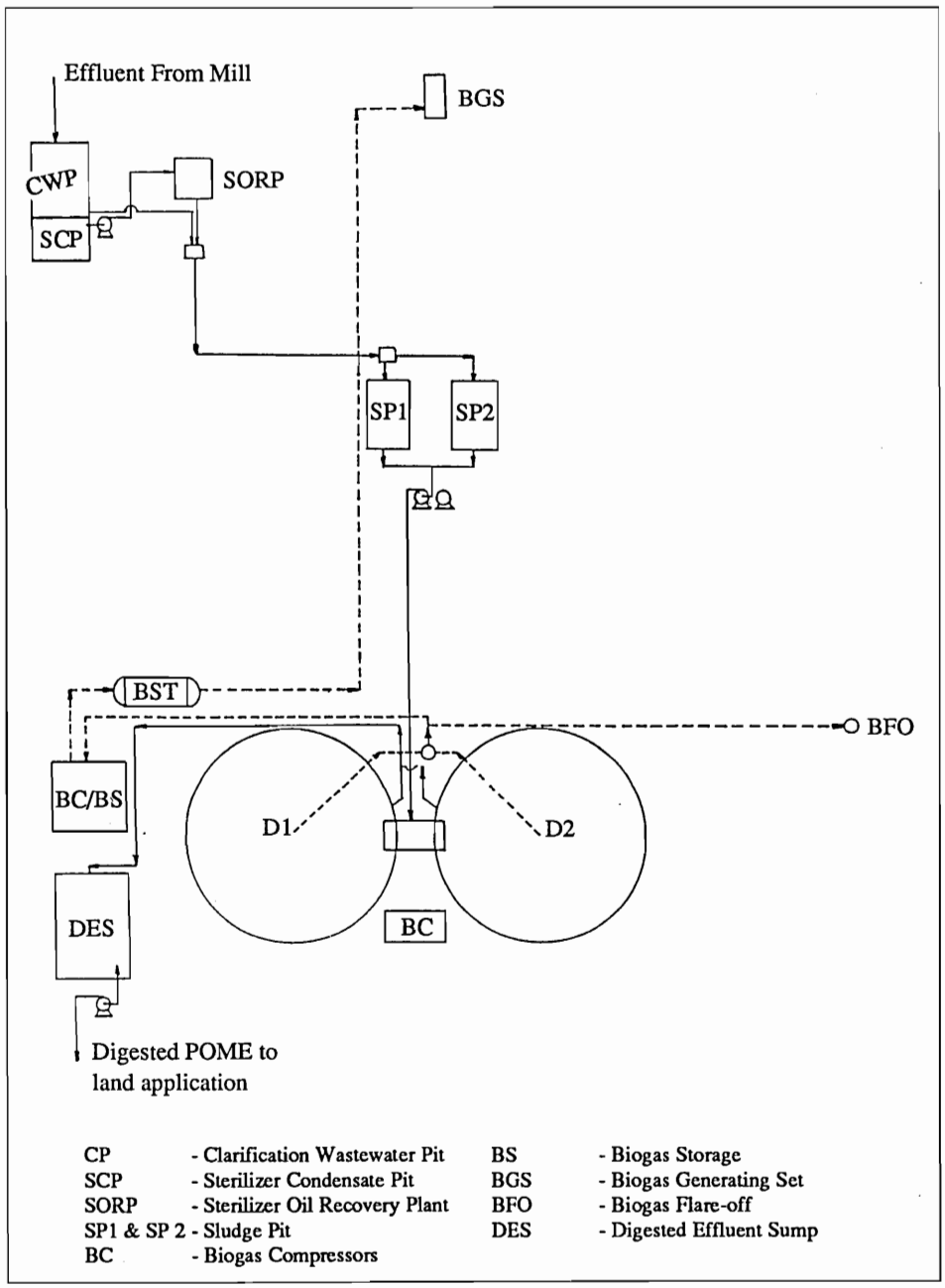


Fig. 1 Chan Wing Palm Oil mill effluent treatment scheme.

effluent pipes as well as pipings for emptying the digester and biogas off-take.

Stirring of the digester contents is achieved by means of biogas recirculation through the use of a biogas compressor driven by a 7.5 kW motor. A total of 3 compressors is used, one for each digester with one as standby.

The digesters are also equipped with flame arresters, pressure relief and vacuum breaker valves. The maximum operating pressure of the digester is 25.4 cm water. Manholes (two at the crown and two at the sides) are provided for easy access during shutdown. Excess biogas is flared off in a wastegas burner.

So far the digesters have not been shut down for normal maintenance which is usually carried out on a 4-5 year basis.

Digested Effluent and Biogas Utilization

Digested POME from the high rate digesters is used for land application as it is rich in plant nutrients namely, N, P and K. It is currently being applied to 100 ha of oil palms.

At Chan Wing Palm Oil Mill, biogas is used to run a 250 kW gas generating set. The system was installed and commissioned in December 1985. Since then the biogas generating set has been running without any problems and had clocked 6088 running hours and generated 694,230 kWh at the end of April 1987.

The 250 kW biogas generating set can easily generate 16,560,000 kWh of electricity per year (operating at 345 days/year at 80% load on a continuous basis) - a total saving of MR 285,800 (US$114,320) per annum over the diesel generating set.

The biogas consumption for the 250 kW biogas generating set is 55% of the total average biogas production from the mill. There is still 45% of biogas energy available for harnessing. As a result, a kernel crushing plant is being planned for construction at Chan Wing Mill to tap the energy potential available from biogas.

(Source: Extracted from *Chan Wing Palm Oil Mill Effluent Treatment and By-Product Utilization - A Case Study*, by Quah Swee Khoon, Lecture Notes for Training Course on Biogas Reactor Design and Development, 11 May - 5 June 1987, KMITT, Bangkok, Organized by the ASEAN Working Group on Nonconventional Energy Research and the ASEAN Working Group on Food Waste Materials, 1987, pp.526-584).

Biogas Research Activities at KMITT Thailand

The King Mongkut's Institute of Technology Thonburi (KMITT), Bangkok, Thailand, has conducted research activities on biogas technology since 1979. After initial work on the production of biogas utilizing aquatic weeds, the scope of research activities was widened on the applied side, and efforts were made to gain more in-depth knowledge of the fundamental aspects of biogas technology. The Biogas Technology Research Group at KMITT has put particular emphasis on the industrial applications of biogas technology and all recent studies reflect this emphasis.

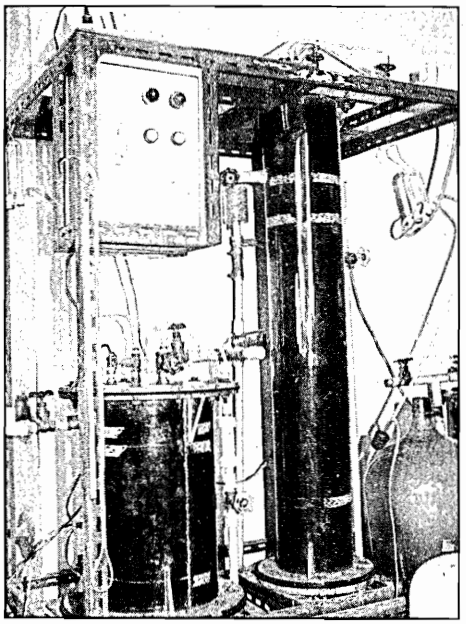
AAECP Food Waste Materials Project

In 1980 the ASEAN Working Group on Food Waste Materials was formed to coordinate research activities on the management and utilization of food waste materials in ASEAN countries. The objective of the Working Group is to carry out cooperative research to develop technology for converting organic wastes into useful products. The activity has been supported by Australia under the ASEAN-Australia Economic Cooperation Programme (AAECP). Biogas technology has attracted considerable interest due to its high potential for converting food industry wastes into useful products. Active cooperation among ASEAN researchers has led to the development of various types of high efficiency bioreactors for converting food industry wastes commonly found in the ASEAN region into biogas. This can be used to partially replace commercial fuels in some factories.

The assistance from Australia has enabled KMITT to develop its capability in biogas from the research level to the design and operation of an industrial biogas pilot plant using advanced high rate anaerobic reactors.

KMITT Activities on Industrial Biogas Technology

Organic wastes from food and other agricultural base industries such as pineapple cannery, tapioca starch factory, tomato paste factory, vegetable canning factory and coconut-milk factory have been studied for biogas production. Current development efforts focus on several



Anaerobic filter bed reactors with different diameter to height ratios used for testing of mixing characteristics.

types of high rate reactors, namely filter-bed, fixed-film and two-stage reactors. Pineapple cannery solid waste has also been studied in plug-flow and solid retained reactors with good success, several 200 litres reactors and a five cubic metres reactor have been used on this study over the last eight years. Most other studies on high rate reactors are carried out in small pilot reactors of 30-40 litres working volume. These studies are aimed at obtaining process design data for a large scale system and to elucidate inherent engineering problems. Recent development indicates that a combination of two-stage technology and filter technology enhances the possibility of using the unit for treating and producing biogas from pineapple cannery wastes.

Strong co-operation between KMITT and the private sector has led to the establishment of a biogas pilot plant for treatment of cassava starch effluents and represents the highlight of KMITT's work in anaerobic digestion.

Several projects on the utilization of biogas produced from the biogas reactor both to produce electricity and as fuel for a boiler or for drying furnaces have been studied. These studies are aimed at providing technical know-how and economic data to potential users of biogas technology. It was found in one of the studies that the cost

Cont. on P. 6

Biogas Research Activities at KMITT, Thailand

From P. 5

incurred in the modification of an existing fuel-oil boiler to accommodate biogas may be as high as 50% of the cost of fuel-oil to be replaced.

Regarding the more fundamental aspects research programmes to study types and distributions of organisms attached in filtered and fixed-film reactors have been initiated. The research programmes involve study of electron-micrograph pictures of the attached microorganisms and kinetic rate studies on the microorganism to test their activities. The latter work will lead towards better mathematical modelling of biogas systems under investigation by members of KMITT's Biogas Technology Research Group. Recently, a regional database on biogas technology was set up at the KMITT Library and Documentation Center. More than 1500 articles have been collected to date and information is regularly sent to ASEAN researchers. Specific requests are also welcome.

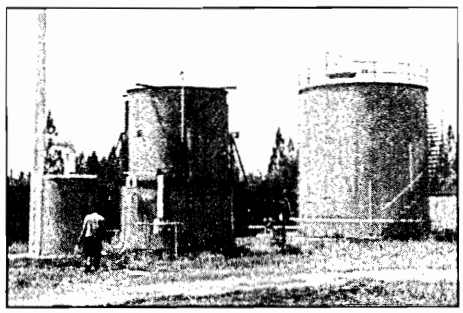
Utilization and Treatment of Tapioca Starch Waste Water Project

Tapioca, also known as cassava, is grown throughout the tropics where it is one of the most important starchy root crops. Thailand is one of the largest producers of tapioca in Asia.

The main products of tapioca roots are pellets, chips and starch. Only the tapioca starch industry has a water pollution problem from its wet processing operation. As tapioca starch is one of the major export products with a promising future, a means to alleviate its wastewater problem has to be developed.

The National Center for Genetic Engineering and Biotechnology under the Ministry of Science, Technology and Energy of Thailand has provided a 4.0 million Baht grant to KMITT to be the coordinator of a research team (consisting of Chulalongkorn, Kasetsart and Mahidol Universities and the Thailand Institute of Scientific and Technological Research) working on a project entitled "Utilization and Treatment of Tapioca Starch Wastewaters". The aim of this project is to determine an appropriate technology for treatment of the tapioca starch wastewater, in order to increase its value.

The project has been divided into 3



Biogas pilot plant at Ban Pong Tapioca Starch Industrial Co., Ltd., Rajburi Province.

phases. In phase I, a study of Thai tapioca starch factories was carried out to investigate production processes, quantity and quality of wastewater, and existing treatment processes. Various utilization techniques were selected and tried on a laboratory scale. These included biogas production in contact stabilization and anaerobic filter systems, food and feed production (Spirulina, Caphalosporium and photosynthetic bacteria) and the production of organic acids for the cultivation of photosynthetic bacteria.

In phase II, promising technologies for implementation on a pilot scale were selected in order to evaluate their technoeconomic feasibility. Those technologies selected are biogas plant and Spirulina cultivation. The last phase involves transfer of suitable technologies to the industry to improve the efficiency of wastewater treatment and utilization.

A filter-bed biogas plant of 160 m^3 capacity was built at Ban Pong Tapioca Starch Industrial Co. Ltd., Rajburi province. The digester is filled up with plastic rings (9 cm diameter, 9 cm long) and loaded with combined waste water. The plant is being tested for technical and economic evaluation before the full scale plant can be implemented. At this stage, the methane gas produced is used as a supplementary fuel along with fuel oil for drying tapioca starch.

In addition to the biogas plant, four high rate 6 m x 33 m x 0.6 m algae ponds have been constructed at the same factory. Several batches of Spirulina have been cultivated and tested for their nutritional value and toxicity, if any, that may arise from the accumulation of heavy metals in waste water. Samples have been sold to animal feed companies for trial runs.

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Pioneering Development in Sugar Cane Leaves Gasification

Nimbkar Agricultural Research Institute (NARI), Phaltan, Maharashtra, India, has pioneered the development of a sugar cane leaves gasification system for running small diesel engines. According to Dr. Anil Rajvanshi, the Director of the Institute and under whose guidance this technology has been developed, this is the first time in India that a small 5 hp diesel engine has been run by producer gas from sugar cane leaves. Up until this time most of the producer gas technologies for 5 hp diesel engines have been based on wood fuel.

The sugar cane leaves are stripped from the stalks during harvesting of cane and left on the ground. Since no use is made of them, they are burned in the fields. Last year

ZMART ZTOVE - A High Efficiency Stove

The ZMART ZTOVE is a stove with a very high efficiency rating, according to Fred W. Hottenroth, the President of the Z.Z. Corp. The School of Energy of Bharathidasan University in India has carefully tested it in accordance with the per cent heat utilized procedure outlined by VITA (Volunteers in Technical Assistance, U.S.A.). The efficiency in bringing 10 kg of water from ambient temperature to boiling in about 40 minutes measured better than 55% on four separate tests.

The high efficiency of the ZMART ZTOVE has been achieved by combining high combustion efficiency with careful focusing of most of the generated heat on the surface of the cooking vessel.

High combustion efficiency and a hot fire generally go hand in hand. To assure a hot fire, the ZMART ZTOVE contains the burning fuel within a well insulated cylinder. Air for combustion is preheated so it aids combustion. When the stove is burning, brisk tongues of flame move almost vertically across the normal upward path of the fire as air enters the combustion chamber. The good combustion efficiency of the ZMART ZTOVE is evidenced by the small

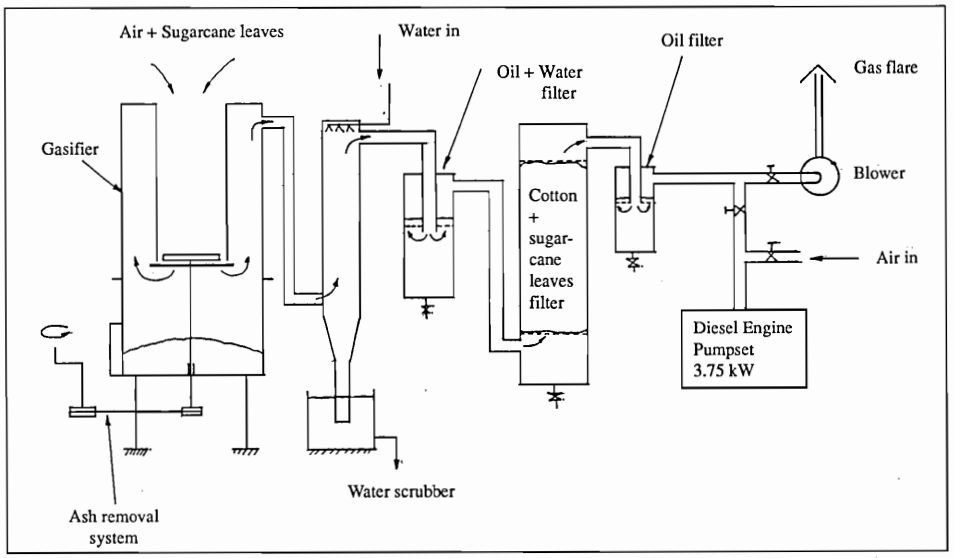

Fig. 1 Schematic diagram of the sugar cane leaves gasification system developed by NARI, India.

alone about 15 million tonnes of leaves were burnt, which meant a total loss of 2.5 x 10^{11} MJ/year (equivalent to 2000 MWe) for the country. In terms of money the total loss is about Rs. 300 crores (US$230M) per year.

A schematic diagram of the sugar cane leaves gasification system developed by NARI is shown in Fig. 1. Producer gas is produced from loose sugar cane leaves in a reactor which operates at temperatures of 800-1000 °C. The gas is then cooled and cleaned in appropriate scrubbers and fed into a 5 hp diesel engine.

The gasification system has been operated for about 250 hours and the test results have shown that between 60-80% diesel saving in engines is effected when running on this producer gas. Besides the gas production, the reactor also converts 24-35% of the biomass into fine charcoal particles. This charcoal when mixed with cowdung (in the ratio of 5 parts charcoal to 1 part cowdung) produces excellent smokeless briquette fuel for chulhas (stoves). Thus this gasification technology produces two useful fuels - gas for running internal combustion engines and charcoal as chulha fuel, Dr. Rajvanshi explained. Moreover, this reactor can run on any loose biomass, such as wheat straw, chopped sweet sorghum, bagasse and safflower husk and straw.

For further details contact:
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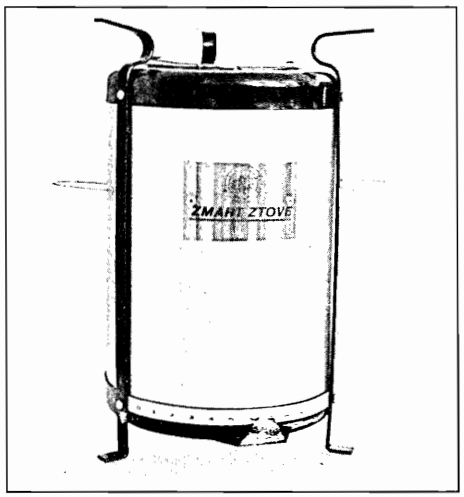
P.O. Box 23, Phaltan 415523
Maharashtra, India



amount of smoke generated in normal usage.

Focusing of generated heat on the cooking vessel by the ZMART ZTOVE is not perfect but it is highly effective. The fire is contained within a cylinder of good insulating material such as vermiculite or diatomaceous silica materials having five times the insulation value of sand. This cylinder effectively limits the quantity of heat moving radially out from the fire.

A radiation reflector under the grate reduces downward heat loss. Open fires and most stoves dissipate a considerable amount of heat energy into the ground. The ground under the ZMART ZTOVE remains cool.

The ZMART ZTOVE directs most of the generated heat energy from the wood upward against the bottom of the cooking vessel. According to the tests at Bharathidasan University it took less than 0.5 kg of wood to boil 10 kg of water and there was more than 0.1 kg of charcoal remaining from the initial 0.5 kg of wood.

For further details about the ZMART ZTOVE please contact:
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Los Alamitos, CA, USA 90720

Ryan's Cooking Fuel Pump

A fuel pump to prepare an alternative domestic cooking fuel from burnable agricultural wastes was developed by Mr. Felix A. Ryan, a consultant to UNIDO and ILO.

Ryan's Cooking Fuel Pump

Diagram A is a 60 cm long cylinder of 18 gauge mild steel plate. Inner diameter is 10 cm. One end is blocked and half the cylinder on the blocked side is perforated, each hole is 1 cm in diameter. In the middle of the non-perforated side a circular opening 5 cm in diameter is made as shown.

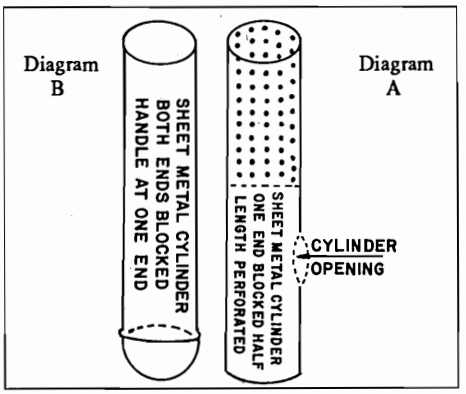

Diagram B is also a 60 cm long cylinder in which both ends are blocked. One end has a handle. The outer diameter of this cylinder is 9.5 cm. The smaller one is put into the bigger, the pump works like a doctor's injection syringe.

The fuel pump or cylinder can be made by any roadside welder or tinsmith and costs less than US$5.00. The cylinders are light and convenient to use and do not require any maintenance.

"Burnables" to be Used

All types of leaves (foliage) from around one's dwelling or surroundings and

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USAID Backed Egypt Wind Energy Farm

Four 110 kW wind turbines supplied by Wincon International Inc. of Pleasanton, California have been shipped to Egypt for installation as the Middle East's first windfarm in a field test demonstration project supported by the US Agency for International Development (USAID).

The machines are expected to be raised this month at Ras Gareb, a Red Sea town 350 kilometers southeast of Cairo on the Sinai Peninsula, with the guidance of Wincon engineer Svend Duus.

The windfarm will displace gas turbine generated power for the local Egyptian Electrical Authority grid served by two 4 MW plants. It is the first of three long awaited wind projects in USAID's Egypt renewable energy field testing programme, the other two being still in the project definition or bidding stage.

The first project totalling about 200 kW will serve a water desalination plant at Hurghada; the second installation, 100 kilometers south of Ras Gareb, and a third group of 1 and 10 kW capacity turbines will serve the village of Dakhalla, 220 kilometers west of Alexandria on the Mediterranean Sea. The Hurghada project will have local power grid back-up. The 1 kW turbines at Dakhalla will charge batteries while the 10 kW machines will charge batteries with diesel back-up, and will also serve reverse osmosis desalinizers.

(Source: Extracted from *USAID Backed Egypt Plant at Last Underway*, by D. Hoffman, *Wind Power Monthly*, Vol. 4, No. 4, 1988).

Local Manufacturer of IT Windpumps in Africa

Stewarts & Lloyds of Harare Zimbabwe has acquired the Licence to manufacture and sell the Intermediate Technology (IT) windpump to supply low cost water to farms, villages, schools and small scale industries throughout Zimbabwe.

This is the third local manufacturing operation to be set up in Africa to make IT windpumps and its variant the "Kijito" windpump. The countries are Kenya, Nigeria, and now Zimbabwe.

Stewarts & Lloyds is an established agricultural and engineering company with a good reputation throughout Zimbabwe. The general manager, Mr. Greg Walpole, regards the IT windpump as a logical extension of the company's activities to provide reliable water pumping equipment for the huge and sparsely populated rural areas of the country.

Prospects for the IT windpump are excellent, with two S & L windpumps already installed, another batch of ten being fabricated, and export enquiries being received.

IT windpumps are very much cheaper to operate than diesel or electric driven pumps - from 50% to 70% less on average, and they operate even in medium to low wind regime areas. With their long-life, reliability and "free" operation, locally manufactured IT windpumps are ideally suited to Zimbabwe.

The IT windpump for water supply was

Ryan's Cooking Fuel Pump

From P. 7

farm waste can be used as fuel. But it must be dried well and kept in store. The collection may include, if available, ground nut shells, corn cobs, coir waste, rice husk, sawdust, wood shavings, bagasse, dried water hyacinth, paddy straw, etc.

How to use the Pump

Feed the mixture (burnables) into the circular opening in the cylinder placed beneath the pot. Insert the second cylinder into the first and push the mixture into the perforated portion and set fire to it. As the flow of air is restricted it will burn with a steady deep fire without flaming, like the charcoal inside the ironing machine. The mixture should neither be compressed tight nor should the packing be too loose. The correct feeding technique can be learnt in a day or two after one or two experiments. During a half hour cooking, feeding and pumping will have to be done about six to eight times depending on the "burnables" used in the mixture.

Further information about the fuel pump is available from Mr. Felix A. Ryan (8, West Mada St. Srinagar Colony, Saidapet, Madras-600015, South India.).

(Extracted from: ATIC Handout 148, Appropriate Technology Information Center, Madras, India).

Delta-Bladed Rotor

A Water Pumping Windmill

Delta-Bladed Rotor, a water pumping windmill was designed by Drs. Jack Kentfield and D.H. Norrie, Mechanical Engineering Department, Canadian University of Calgary, ten years ago, intended as a simple to build windpump suitable for developing countries.

The slow speed, high torque rotor features flat rather than curved blades that can be built from steel or plywood or fabric covered metal frame. In wind tunnel tests at the Canadian National Research Council, it was found to have a power coefficient reaching 0.4, about 20 per cent higher than the traditional American windpump rotor and spread over twice the blade tip speed-windspeed ratio range.

Research and development of the eight bladed design has been supported by Alberta's Department of Energy and Natural Resources and Canada's national wind energy research programme, managed by the Federal Department of Energy, Mines and Resources (EMR).

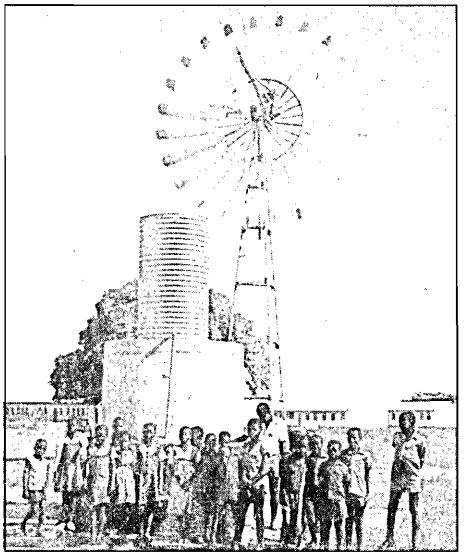
In 1978, the Calgary based Abax Energy Services Ltd., a manufacturer of petroleum processing equipment, agreed to build and test large-scale Delta-bladed wind turbines.

Only five Abax built machines were actually installed. Four were WP-20 units, with the first two having 4.5 m rotors, and one WP-50 with a 16 m rotor.

Government supported performance tests were conducted on the WP-50 during 1986. Performed by DRB Engineering Consultants Ltd. of Calgary, the tests show that the WP-50 can pump some 450 litres per second in 11 m/s windspeed. Operation of the Lethbridge WP-20 has continued through 1987, interrupted as with other machines on the test site, by periodic failures of one or another component. The most recent minor failure was the cable which supports the tailvane arm.

Unfortunately, the Abax Energy Services Ltd. went bankrupt in January 1988. Dr. Kentfield is now seeking for other manufacturers and organizations in North America, Europe and Africa to continue the development of this Delta-bladed turbine.

(Source: Extracted from *Delta Rotor Seeks New Developer*, by D. Hoffman. *Wind Power Monthly*, Vol. 4, No. 5, 1988).



IT Windpump with 6m rotor on a 9m tower, manufactured under Licence from Intermediate Technology the Charity, supplying low cost water to a Rural school in Chiota Province in Zimbabwe.

originally conceived of and developed by the British registered charity, the Intermediate Technology Development Group for local manufacture and use. It was specially engineered to be made in workshops in developing countries. Modern design concepts were applied to produce a long-life, highly efficient and reliable machine with direct drive, requiring minimum maintenance. The IT windpump will pump water from a depth of 200 m or at 300 m^3/day from shallow wells. The IT Windpump took 8 years to develop and test in partnership with local organizations in six developing countries.

The aim of ITDG is to widen the range of technical options available in developing countries, so that more appropriate choices can be made to suit local economic, natural, and human resources and needs. The Group has worked on projects in more than 60 countries since its founding in 1965 by the late Dr. E.F. Schumacher and is considered to be the leading agency of its kind in the world today.

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Feasibility of Wind Energy in India

Interest in wind energy began in the early seventies with the oil embargo. Sustained efforts to tap wind energy started in Australia, Indonesia, Iran, Japan, Maldives, New Zealand, Pakistan, Philippines, Singapore, Sri Lanka, Sudan, Tanzania, Thailand, Papua New Guinea, China, Canada, Kenya, the Federal Republic of Germany, Sweden, France, Switzerland, United States of America and the United Kingdom.

The National Aeronautical Laboratory (NAL), Bangalore, worked on the development of WP-2 type windmills during 1960-65 and more than 70 units were installed in various parts of the country for propagating the use of wind energy for water pumping. Unfortunately, there was not much interest in alternative sources of energy at that time and NAL's plans were unsuccessful.

After the oil crisis in 1973, work on wind energy began and experiments were carried out with catenary shaped Darrieus rotors for energising water pumps. A sail type windmill of 10m diameter with six-sail rotor was developed by NAL. It can produce about 1 kWh daily during the months of January and February.

For Low Velocities

Sherman's Madurai windmill, adopted from the well known Cretan sail windmills, was designed to operate in low velocities. It has a 10m diameter sail rotor coupled with a variable stroke reciprocating pump. Its efficiency is 8.6 per cent at the rated wind speed of 8 km/hr. This windmill can deliver about 80 watts at a speed of 10 km/hr or about 0.8 kWh/day as a minimum guaranted average daily output in the rabi season (November to January). Its life ranges from 10 to 15 years.

The Indian Institute of Science, Bangalore, has designed and installed a small type Savonius rotor at Ungra village in 1977. This delivers on an average 2,500 litres of water daily excluding the monsoon months.

Bharat Heavy Electricals Limited, Hyderabad in collaboration with Indian Institute of Technology (IIT), Madras designed a hexagonal shaped Darrieus rotor to generate electricity. This rotor is rated to produce 1 kW of power in windspeeds of about 25 km/hr. The blades are made from FRP and the generator coupled with the rotor acts as a motor during the starting phase.

Central Salt and Marine Chemicals Research Institute, Bhavnagar, has designed a Savonius type rotor windmill with a projected area of 2 m^2 and a height of 2 m and a prototype of a Savonius rotor with projected area of 7.5 m^2 and a height of 3m. A modified Darrieus type rotor of 2m width and 3m height was also designed.

A sail type windmill of 8m diameter was designed, fabricated and installed near the observatory of the Central Arid Zone Research Institute, Jodhpur, on a wooden tower 6m high. It was field tested in 1976 and 1977. The windmill could pump water from a level of 3.5m below the ground at an average rate of 1,050 l/hr at a mean daily wind speed of 15-20 km/hr and 1,250 l/hr at a wind speed of 26 km/hr.

At Auroville, Pondicherry, three types of windmills were installed. 'Banyans' windmill was erected on a 8m tower and pumps an average of 10 m^3 water daily from a depth of 27 m in average windspeeds of 6 to 8 km/hr. The 'Centre Fields' windmill has a 4m diameter wheel supported by 12 metal wanes. It was erected on a tower made of casurina poles. The 'Toujours Mieux' windmill 'ME2600' was erected on a 27 m deep borewell and operated efficiently under field conditions. The most recent unit for pumping water on the beach is 'Aurobeach' windmill. It has a rotor diameter of 3m with six radiating bamboo sticks and synthetic sails.

AMM Murugappa Chettiar Research Centre, Madras, has developed 'Anila' a new wind device with a horizontal shaft sail rotor. Its application is mainly for water pumping and it is best suited for coastal locations. Palm trees, casurina poles, jute sails and wooden planks, the materials needed, are easily procured from the vicinity. In windspeeds of 25 km/hr, this windmill pump discharges 2,000 l/hr of water at a total lift of eight metres. It can work continuously for a minimum of 12 hours daily.

Institute of Engineering and Rural Technology, Allahabad designed and fabricated APOLY-12 PU500 water pumping windmills. The rotor frame consists of 6-strokes (angle iron 40 mm x 40 mm x 4 mm) an inner and outer ring (flat 30 mm x 6 mm) and a hub (angle 40 mm x 40 mm x 4 mm) which clamps around the 50 mm main shaft. The tower is 6.5m high. The cut-in

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Feasibility of Wind Energy in India

From P. 9

speed of the windmill is 2.5 m/s.

Jyoti Ltd., Vadodara, has developed energy conversion systems ranging from a 40 W battery charger to a 1 kW machine for village water supply and rural lighting. These systems can also be used for irrigational needs of small and marginal farmers.

The 40 W system consists of a two bladed wooden rotor, which drives a DC generator directly, the output being used to charge a lead acid battery. The system also includes overspeed control, manual brake and over charging and overdraining protection for battery.

The 350 W and 1 kW systems consist of three bladed rotors, which are coupled to the dedicated electrical system. It involves an variable frequency AC alternator with an induction motor pump set, through a step-up gear box. Rectified DC output can be obtained and stored in batteries as an option.

Voltas Limited, Bombay, has fabricated two prototypes based on the designs of Intermediate Technology Development Group, London. These have horizontal axis with a driving reciprocating pump through a system of linkages and transmission assembly, which facilitates pumping water from deep open dug wells, a characteristic of India. The rotor diameter is six metres and is mounted on a tower 6m high. In wind velocities of 15 to 20 km/hr, the unit discharges approximately 10,000 to 18,000 l/hr against a head of 5-6 metres.

The Department of Non-Conventional Energy Sources (DNES), Ministry of Energy, Government of India, in cooperation with different State Electricity Boards has set up five wind farms at Okha and Mandvi in Gujarat; Tuticorin in Tamil Nadu; Puri in Orissa and Devgarh in Maharashtra. The capacity of the wind farms ranges from 0.55 MW to 1.1 MW.

A wind farm is also operating in Veraval, Gujarat. The target for the end of the century is 5,000 MW. There are over 1,500 water pumping windmills installed across the country with 10,000 more envisaged for the Seventh Plan.

There is still much to be done in tapping wind energy. The cost of generation at the five wind farms ranges from Rs. 1.14 to 1.50 but State electricity boards are reluctant to pay beyond Rs. 1.0 per kWh. Unless Rs. 1.50 is paid, there may not be wide participation by private industry in wind power generation.

The cost of water pumping windmills in the country is around Rs. 20,000 (US$1550) and the cut-in-speed is 9 km/hr. Though DNES and State nodal agencies grant subsidies, the price is still beyond the reach of an average farmer. On the other hand, some designs, available from Columbia operate in 5 km/hr wind and may cost Rs. 10,000 (US$770) if manufactured in India.

For sustained power supply, hybrid systems like wind-solar, wind-diesel-solar and wind-hydro-diesel should be introduced. In the West, for desalination and for production of nitrogen and hydrogen through reverse osmosis, wind has been used successfully.

Electricity can also be generated using a windpump to lift water to a storage reservoir from which it is subsequently released through a hydroelectric turbine. This type of system with a suitably sized storage reservoir can produce power continuously on demand and is independent of variations in wind speed.

(Contributed by: Dr. A. Jagadeesh, (President, Society of Science for the People, 2-210 Nawabpet Nellore-524002, India); Source: *The Hindu: Science, Engineering & Technology*, June 8, 1988).

RONAST as an INNERTAP Network Focal Point for Nepal

The various documentation and information centres which have been established so far in Nepal are attached to other institutes or departments and have developed gradually to meet the growing interests and needs of scientists, industrialists and planners in research activities. There are 30 of these information and documentation centres at present.

There is some awareness in the energy sector institutions of the benefits of collecting relevant information and documents but specialized documentation and information centres have not yet been established.

An International Network on New Energy Sources and Technologies for Asia and the Pacific (INNERTAP) was established by UNESCO in 1983.

A contract agreement was made between the Royal Nepal Academy of Science and Technology (RONAST) and UNESCO on 6 May 1986 appointing RONAST as INNERTAP's Information Network Focal

Waterpump Production in Nicaragua

The Nicaraguan National Energy Institute (INE) has started up production of two waterpump models in conjunction with the People's Metallurgical Industries (IMEP) of Managua. A three metre model follows the design concept of most traditional machines, while the second model, a five metre waterpump, is a faster running, direct drive design by Holland's Consultancy Services Wind Energy Developing Countries (CWD).

Six machines of the zero series are being installed in pilot projects at small communities and irrigation sites around Managua. A rehabilitation programme for damaged or worn machines and a resource assessment study are included in the project.

The use of windmills for water lifting has been accepted practice in Nicaragua for some time. Installation in substantial numbers started after World War II and it is estimated that at least 750 machines have been installed, mostly on cattle farms. Twenty per cent of these are no longer operational.

The American Aeromotor model dominated imports with a 2.4 metre machine. More recently, but on a limited scale, 12 and 14 foot Southern Cross models from Australia have taken their place. If INE gets its way, use of windpumps will be extended, also for remote community water supply and small-scale irrigation, and the bulk of machines will be locally manufactured.

More important to the Nicaraguans than abundant water supplies or energy conservation is a release from reliance on imports. Water lifting represents around 17 per cent of electricity consumption, 11 per cent of this alone for irrigation. But windpumps typically compete with diesel sets. The wind resource of the country is from fair to good, with the Caribbean coast representing the best source. Here the northeasterly winds average 5.6 m/s at Puerto Cabezas and 5.9 m/s during the dry months from December to April. Foreign consultancy, by CWD, is aid financed.

(Source: *Nicaragua Starts Production*, by Jos van Beek. *Wind Power Monthly*, Vol. 4, No. 5, 1988)

Point in Nepal. In the contract agreement it is mentioned that the network node will serve as a formal and informal mechanism for collecting, processing, analysing, repackaging and disseminating NRE information.

As a network focal point, RONAST has conducted the following activities:

Step 1: RONAST Library & Documentation Centre started to collect and store energy information from various sources and disseminate them through library services, inter-library loan facilities, a current awareness bulletin and a union list of periodicals etc. At the moment, these services are provided only inside the country. It is hoped that the dissemination service will be extended to other countries of this region in the near future.

Step 2: A report (Renewable Energy Resources in Nepal) has been prepared and it presents, in detail, the present energy situation in Nepal including the availability of energy resources.

Step 3: A national training workshop on Energy Information Handling within the framework of the INNERTAP programme and in collaboration with UNESCO was held from 26-29 January 1987.

The major objectives of the workshop were as follows:

1) To create greater awareness about energy information sources and services available in general and specifically in the Asia and Pacific Region.

2) To develop an information service system network for new and renewable energy sources at sub-national and national level in Nepal.

3) To ensure greater cooperation among information users, information generating agencies, libraries, and documentation centres in the INNERTAP Programme.

4) To establish effective two-way linkages with the INNERTAP for free flow of information on new and renewable energy resources.

In this training programme one resource person was drawn from UNESCO and three were locally available. Participants from 11 organizations in Nepal and from RONAST attended the workshop. These participants were from various energy related institutions.

(Source: Report of the National Workshop on Energy Information Handling, held during 26-29 January 1987, at Royal Nepal Academy of Science and Technology, Kathmandu, Nepal, prepared by B.K. SEN, UNESCO Resource Person.)

Rural Renewable Energy Project in Thailand

Brace Research Institute - Khon Kaen University Linkage Program

A linkage program on rural renewable energy research and development between the Brace Research Institute of McGill University, Canada, and Khon Kaen University, Thailand, was initiated in 1986. The specific objective of the project is to transfer educational, on-the-job training and research skills in the areas of rural renewable energy analysis and supply, and related natural resource development. The project is now being conducted and some of the expected results are as follows:

1) Linkage developed between McGill University and Khon Kaen University in the area of renewable energy development. A total of 17 staff exchanges are anticipated for training purposes and for joint work on the project. An outgrowth of this linkage is expected to be closer ties in the future between the two universities in the form of joint research and field implementation projects in rural energy development and related activities.

2) Improved collaboration among Khon Kaen University and other Thai universities and public and private sector institutions in the field of renewable energy technology by conducting training, joint seminars, conferences, research and field work activities, etc.

3) Transfer of educational and on-the-job training skills in the area of rural energy development. Skills will be transferred in such areas as system design, fabrication, installation and testing, trouble shooting, maintenance and repair. In addition, Khon Kaen University project members will develop educational and hands on skills necessary for effective technology transfer to audiences ranging from peasant farmers to owners and managers of agro-industries.

4) Transfer of analytical and research skills in the area of rural energy analysis. Skills to be transferred include the following: problem identification and assessment, resource survey and assessment, appropriate technology methodology of approach, matching of resource to end use.

5) Transfer of energy use monitoring capability. Selected Khon Kaen University staff will be trained in the various techniques of energy use monitoring ranging from general "rules of thumb" to more in-depth monitoring of either isolated energy systems or integrated rural energy systems using both instrumented and non-instrumented approaches. Skills will be transferred in such areas as use, operation and maintenance of monitoring equipment, application of energy audits and use of short-term, accelerated and long-term monitoring procedures.

6) Twenty to forty Khon Kaen University and other Thai institution technical staff will receive training in rural and community development activities related to the introduction and implementation of renewable energy technologies in Northeast Thailand.

7) Research and development at Khon Kaen University into a variety of renewable energy technologies including:

Solar drying - Several small and large-scale solar dryers will be fabricated at Khon Kaen University. These will be typical of designs found suitable in similar climatic zones, but will be adapted to suit availability of materials, produce to dry and the economic and skill level of the intended recipients.

Biogas - Prefeasibility studies will be conducted on at least one proposed farm size plant and one proposed larger agro-industry based unit. Practical research, including workshop fabrication, will be conducted on a minimum of one biogas plant to be installed at the Khon Kaen University campus. Design and development activities will be completed on a small biogas plant capable of mass production. A unit will be built and tested.

Charcoal/Wood stoves - A small laboratory will be set up for the testing of charcoal and wood stoves under controlled conditions. Thermodynamic and heat transfer studies will be undertaken to improve stove designs for a more effective use of heat by the cooking vessel. Materials research will be conducted into liner and insulation materials for use in both the charcoal and wood stoves.

Gasification - At least one site suitable for a rice husk gasification plant will be identified in Northeast Thailand. Prefeasibility and investment studies will be completed by project personnel for this site. Attempts will be made to coordinate the installation of a demonstration unit in the Northeast Region.

Comnt. P. 12

Metal Hydride Heat Pump Development: The Heat-Upgrading Experiment

The heat-upgrading experiment (HUGE) with a hydride heat pump was carried out by Studsvik Energiteknik AB, Sweden. It is intended to demonstrate the technical feasibility of an hydride heat-transformer working up to moderate steam temperatures and to identify the main problems that might arise at commercial plant scale.

This report is based on a lecture given by Derek Lewis at the 1983 Autumn-meeting of the Society of Chemical Engineers of Japan. It describes R & D work on metal hydride heat pumps in progress at Studsvik since 1977. The work has culminated in the construction of an installation of HUGE, that stimulates the generation of low-grade steam by a hydride heat pump driven with waste heat.

The results obtained so far indicate that a hydride heat-transformer, like that in HUGE, is likely to be technically and economically viable.

For further details please contact:
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Studsvik Energiteknik AB
S-611 82 Nykoping
Sweden

Proceedings Available at a Special Price !!

Proceedings of the FAO/FHI Regional Technical Consultation on Agricultural Wastes and Solar Technologies for Farm Energy Needs.
Suzhou, People's Republic of China, 23-26 June 1982, and Cabanatuan City, Republic of the Philippines, 28-30 June 1982.

A Regional Technical Consultation on Agricultural Wastes and Solar Technologies for Farm Energy Needs was held in China and the Philippines. The Consultation was held in Suzhou, Jiangsu Province, China, from 23 to 26 June 1982 and then moved to the Philippines for the second part of the Consultation in Cabanatuan City, Nueva Ecija, from 28 to 30 June 1982.

The Consultation was organized jointly by the Food and Agriculture Organization of the United Nations (FAO) and Food for the Hungry International (FHI) in cooperation with the Ministry of Commerce, People's Republic of China and the National Food Authority, Republic of the Philippines.

The participants included senior government officials from national food corporations and research institutions, university professors and directors of commercial enterprises from ten countries namely: Bangladesh, Burma, People's Republic of China, India, Japan, Malaysia, Philippines, Sri Lanka, Thailand and the United States of America. Various technical papers were presented. The emphasis was placed on agricultural waste utilization for energy conversion. Directors and engineers of the Bureau of Food and the National Research Institute of China (sixteen in number) also attended the Suzhou Consultation as observers.

The exchange of experiences at this Consultation resulted in 16 specific recommendations for follow-up activities in the area of new and renewable sources of energy, particularly on gasification from agricultural residues. Product processing in rice barn stabilization and oil extraction was also dealth with.

The proceedings is available at US$18.00 per copy including air-mailing cost for orders from outside Thailand; 150 Baht per copy for orders within Thailand. To obtain the proceedings please contact:

Food for the Hungry International
Thailand Office
G.P.O. Box 2830
Bangkok 10501
Thailand
Tel: 278-1826, 279-1320
Telex: 84638 STAR TH

Rural Renewable Energy Project in Thailand
Brace Research Institute - Khon Kaen University Linkage Program

From P. 11

Sterilizer for food processing - A minimum of one solar sterilizer will be designed and built at Khon Kaen University for research activities related to small-scale and home industry food processing.

Nocturnal cooler - A nocturnal cooler for use in food preservation, will be designed and built on campus. The unit will be used for research and development activities.

Solar cooker - Several solar cooking units will be fabricated and installed on campus. These units will be used to conduct research and development activities related to food processing and cooking for small-scale industry, home and rural restaurant use.

8) Field projects - All of the technologies considered suitable for field implementation will be disseminated through community/rural outreach and development projects. The number of units of each technology will depend on success in research and outreach programs.

9) Dissemination of relevant information to farmers, households, rural based industries, village artisans, community development and extension workers and local, regional and national authorities. Information generated in the project will be disseminated through workshops, do-it-yourself booklets, community meetings, seminars, reports and the services of participating community and rural development outreach organizations.

10) Improved facilities for the transfer of technologies. Library resources in the specific areas of project activities will be improved. A number of staff of Khon Kaen University will receive overseas training or in-country training in the areas of technology research, development and transfer.

(Source: Information provided by the Faculty of Engineering and the Secretary for Research Affairs, Rector's Office, Khon Kaen University, Thailand.)

Proceedings of the Regional Seminar on Alternative Energy Applications in Agriculture, Chiang Mai, Thailand, 27-29 October 1986.

The Regional Seminar on Alternative Energy Applications in Agriculture was organized by the Faculty of Engineering, Chiang Mai University under the sponsorship of UNESCO to promote research and other activities on alternative energy applications in agriculture in the region. Major topics discussed at the seminar were research and development activities and applications on biomass energy, solar energy, post-harvest technology, and geothermal energy in the region.

The proceedings published by the Faculty of Engineering, Chiang Mai University, contains thirty-three papers presented and discussed at the seminar.

It is available at US$35.00 per copy for orders from outside Asia, and US$25.00 per copy for orders from Asian countries. Both prices include air-mailing costs. The proceedings is available from:

Department of Mechanical Engineering
Faculty of Engineering
Chiang Mai University
Chiang Mai 50002, Thailand
(Attn: Mr. Teera Siratanapanta)

Biomass for Energy and Industry

4th E.C. Conference

Proceedings of the International Conference on Biomass Energy and Industry

Orleans, France, 11-15 May 1987

Edited by G. Grassi; B. Delmon; J. F. Molle and H. Zibetta
Elsevier Applied Science Publishers Ltd.
Crown House, Linton Road
Barking, Essex IG11 8JU
England
(ISBN 1 85166-164-6, 1987, xxvii+1391 p.)

This book presents the proceedings of the Fourth Conference "Biomass for Energy and Industry" held by the Commission of the European Communities in Orleans by kind invitation of the French authorities and with the cooperation of the City, UNESCO, AFME and the French Association for Biomass.

This Conference was attended by some 500 participants from Europe, Africa, United States, Asia and South America. The two main objectives of the Conference were: to review and discuss the biomass research programmes supported by the Commission, and to develop the agriculture/energy and agriculture/industry interfaces.

The conference sessions were organized on the basis of a number of common themes representing the different stages of production, conversion and utilisation of biomass for energy and industry.

Workshops were also conducted to present the state-of-the-art on topics/themes that included production, biochemical and thermochemical conversion, and biomass for energy in the developing countries.

Poster sessions with over 200 contributions on the same themes as the oral presentations formed an integral part of the programme.

Most participants agreed that biomass should be exploited by diversifying agricultural activities to non-food types of production. In this way farmers would be offered a realistic opportunity towards solving the growing problem of food over-production in Europe.

Two main lines of action are envisaged: in the short term, the production of ethanol from current agricultural crops (wheat, sugar beet, etc.) for use as a gasoline additive; on the medium term, short rotation forestry for energy and industry.

Promising products have been indentified, technologies have been adapted, and new processes are continually being developed. The conference contributed to progress in the field by diffusing the knowledge now available and by facilitating contact between the worlds of science and agriculture; it should also help to create openings in energy and industrial sectors.

This proceedings contains: the 6 presentations of the opening session; 16 papers on production and recovery of biomass; 6 papers on new outlets for European agriculture; 12 papers on biological conversion processes; 11 papers on thermochemical conversion processes, 7 papers on tests and trials, 5 papers on agroenergy and agroindustrial systems presented at the plenary session; 5 presentations of the workshops; and more than 150 presentations of the poster sessions.

Improved Wood, Waste and Charcoal Burning Stoves - A practitioners' manual

Bill Stewart, et. al.
Intermediate Technology Publications, London, UK
(ISBN 0 946688 65 6, 1987, ix+229 p.)

The book is based on the experience of the Intermediate Technology Development Group (ITDG) Stoves Project since 1979. The Group has been involved with a wide variety of grassroots, national and international stove activities. It concentrates on the practical operational aspects of a stove project—assessing users' needs; choosing, testing and adapting stove designs; producing stoves with local resources.

This book is designed as a reference manual for stove practitioners. It provides basic information on all aspects of running a stove project. Theories of stove design and testing in this manual are deliberately aimed at enabling people without high qualification in chemical engineering or combustion dynamics to be able to optimize a stove within their own capabilities.

This manual is divided into three sections: 1) the critical issues and steps involved in assessing the situation; 2) the basic components of 4 stove types—chimney, multi-pot chimneyless, one-pot chimneyless and the charcoal stoves; and 3) dissemination of chosen stoves.

Numerous publications which give more details are also cited in the manual.

Proceedings of the Sixth Canadian Bioenergy R & D Seminar Richmond, British Columbia, 16-18 February 1987

Edited by Zsa-Zsa Stiasny
Elsevier Applied Science Publishers Ltd.
Crown House, Linton Road
Barking, Essex IG11 8JU
England
(ISBN 1-85166-153-0, 1987, xvii+516p.)

The sixth Canadian Seminar on Research and Development on Bioenergy was held for the first time in British Columbia. Two hundred and twenty two participants, mostly from Canada and the United States, were in attendance, demonstrating a strong continuing interest in this event.

A major innovation of this seminar was the orientation of the plenary sessions towards technology transfer and industry participation. The content and stature of the oral presentations, and the active participation of the industrial sector in the plenary sessions, resulted in an ideal forum for an airing of the views of researchers, governments and industry. One hundred and three technical poster presentations permitted the detailed exchange of scientific information and informal discussions that are often difficult in the more formal conference atmosphere.

The proceedings contains: 19 papers of the plenary session; 20 papers on biomass production, 16 papers on material handling and preparation, 40 papers on biological process, and 26 papers on thermo-chemical processes presented at the poster sessions.

Publications Received

Energy

o Rural Energy Planning: Asian and Pacific Experiences, K.V. Ramani (Ed.), Asian and Pacific Development Centre, Kuala Lumpur (Pesiaran Duta, P.O. Box 12224, 50770 Kuala Lumpur, Malaysia), 1988, xix+464 p.

o World Bank/UNDP/Bilateral Aid Energy Sector Management Assistance Program, Information and Status Report April 1988, 58 p. (available from: Energy Strategy, Management and Assessment Division, Industry and Energy Department, the Workd Bank, 1818 H Street, NY, Washington, D.C. 20043, U.S.A.; or Division for Global and Interregional Projects, United Nations Development Program, One United Nations Plaza, New York, New York 10017, U.S.A.)

o Training Through Networks: A Case Study of APENPLAN, K.V. Ramani and Perter Hills (Eds.), Asian and Pacific Development Centre, Energy Programme, Kuala Lumpur (Pesiaran Duta, P.O. Box 12224, 50770 Kuala Lumpur, Malaysia), January 1988, xii+154 p.

o The First National Conference on Thermal Engineering, Proceedings, 4-6 April, 1988, Kuala Lumpur, Organized jointly by Faculty of Engineering, Universiti Malaya; the Institution of Engineers Malaysia; and Malaysian Working Group on Non-Conventional Energy Research, 1988, xvi+284p.

Biomass Energy

o Biogas Research and Development in Mauritius, African Energy Programme, Research Report Series No. 1, Commonwealth Science Council (Commonwealth Secretariat, Marlborough House, Pall Mall, London SW1Y 5HX), CSC Technical Publication Series No. 237, 1987, x+95p.

o Preliminary Investigations on a Vortex Furnace and Gasifier for the Continuous Production of Heat and Amorphous Rice Husk Ash, S. Joseph and D. Baweja, National Building Technology Centre (P.O. Box 30, Chatswood, NSW2057, Australia), November 1987, 21 p.

o Training Course on Biogas Reactor Design and Development, Lecture Notes, 11 May - 5 June 1987, Bangkok, Thailand, Organized by ASEAN Working Group on Food Waste Materials and ASEAN Working Group on Nonconventional Energy Research, King Mongkut's Institute of Technology Thonburi, Bangkok, 1987, 2 volumes.

o Review of Rural Application of Biogas Technology in China, India, Nepal and Thailand, Regional Network on Biomass, Solar and Wind Energy, Natural Resources Division, Economic and Social Commission for Asia and the Pacific, United Nations, Bangkok, 1987, xi+60p.

o Regional Training Workshop on Energy from Biomass, Proceedings, 3-7 March 1986, Bangkok, Thailand, King Mongkut's Institute of Technology Thonburi, Bangkok, 1986, ii+550p.

Solar Energy

o Potential Use and Performance Studies of Solar Crop Driers in Mauritius, African Energy Programme, Research Report Series No. 2, Commonwealth Science Council (Commonwealth Secretariat, Marlborough House, Pall Mall, London SW1Y 5HX), CSC Technical Publication Series No. 238, July 1987, x+62p.

o Natural Convection Solar Crop Dryers in Kenya: Theory and Practical Application, African Energy Programme, Research Report Series No. 3, Commonwealth Science Council, London, CSC Technical Publication Series No. 241, 1987, ix+107p.

o Small-Scale Desalination Seminar, 10-14 August 1987, Kanye, Botswana, Rural Industries Innovation Centre (Private Bag 11, Kanye, Botswana), September 1987, 89 p.

o Photovoltaic Development and Support Program for Medical Systems in Developing Countries, Final Report, NASA CR-180876, Solarex Corporation and Development Sciences, Inc. (1335 Piccard Drive, Rockville, MD20850, U.S.A.), Prepared for National Aeronautics and Space Administration, Lewis Research Center, and for U.S. Agency for International Development, Science and Technology Bureau, Office of Energy, April 1988, 84p.+Appendices.

o Calculation of Effective Solar Radiation on Hourly and Daily Bases Incident on Concentrating Solar Collectors in Turkey, Ersoy Tasdemiroglu and Faruk Arinc, Turkish Scientific and Technical Research Council, Engineering Research Groups, Ankara, 1988, vi+250p.

Certificate Programs 1988-89

Energy Technology Division
Asian Institute of Technology (AIT)
Bangkok, Thailand

ABOUT THE DIVISION

The Energy Technology Division was founded in 1979. It offers programs in Energy Planning, Rational Use of Energy and Renewable Sources of Energy, Solar Energy and Biomass

Currently the Division offers a Ph.D. program, a five-term Master's degree program, a post-graduate Diploma program in Energy Technology, and Certificate programs in Energy Planning, Rational Use of Energy, Renewable Sources of Energy and Energy Technology.

THE CERTIFICATE PROGRAMS

These programs are aimed at middle-level professionals with knowledge and experience who require renewal or reorientation in the field of energy. Each course lasts 3 months and comprises three compulsory courses plus either another optional course from among the many offered by AIT or a special study on a subject of the student's choice under the individual supervision of a faculty member. The starting dates of the programs and their composition are:

Energy Planning: May

- Economics of Energy Projects
- Sectoral Energy Planning
- Foundations of Macro-Economic Energy Modelling
- Special study or optional course

Rational Use of Energy: September

- Energy Conservation
- Rational Use of Energy in Industry
- Design of Energy Systems
- Special study or optional course

Renewable Sources of Energy : May

- Solar Thermal Processes
- Photovoltaic Systems Engineering
- Biomass Conversion
- Special study or optional course

Energy Technology: January

- Thermal Processes
- Renewable Sources of Energy
- Economics of Energy Projects
- Combustion and Mass Transfer
- Special study or optional course

No financial aid for these courses is available from AIT. The fee for tuition is US$2,700 per term, accommodation is US$40 per month. Subsistence is at the student's own expense estimated minimum is US$130 per month. Air fare and book expenses are to be paid by students.

ADMISSION

To be eligible for admission to the Certificate Programs an applicant must:

i) hold a Bachelor's degree (normally with a four-year program) from an institution of recognized standing;

ii) have undergraduate grades significantly above average;

iii) possess an acceptable level of English proficiency; and

iv) have satisfactory physical and mental health to pursue academic studies at the graduate level.

The normal closing date for receipt of applications for admission to the Certificate Programs is March 15 for students applying for Energy Planning and Renewable Sources of Energy, July 15 for Rational Use of Energy, November 15 for Energy Technology.

The AIT prospectus, application forms and other information can be obtained from:

Registry
Asian Institute of Technology
G.P.O. Box 2754
Bangkok 10501
Thailand

Diary of Events

♦ **June 12-17, 1988, Kiryat Anavim, Israel**

International Workshop on Renewable Energy in Developing Countries

The Workshop is organized by the Ministry of Energy and Infrastructure, Israel, and sponsored by the United Nations Development Programme.

The aim of this Workshop is twofold: to present a summary of the state-of-the-art in those aspects of solar, biomass and wind energy conversion which are relevant to developing countries; and to provide a forum in which participants may share their experiences gained and lessons learned in actual projects.

THE PROGRAM

The Workshop Program consists of 5 sessions:

1) Policy and Financial Issues
2) Solar Energy
   Low temperature applications;
   Passive solar; solar power for developing-areas, technology, economic and social impact; solar energy utilization in selected countries.
3) Wind Energy
   Commercial wind power department; early experience with commercial wind power.
4) Biomass Energy
   Basic Processes; State-of-the-Art; Experience.
5) Discussion on Experience gained.

For more information contact:
Dr. H. Avraham Arbib
Director, Division of R & D
Ministry of Energy and Infrastructure
P.O.Box 13106
91130 Jerusalem, Israel
Tel: (02) 551293
Telex: 26362
Facsimile: (02) 534828

♦ **September 12-30, 1988, Rugby, UK**

ITDG Stoves Training Course 1988

The course is organized by the Intermediate Technology Development Group. This three-week training course is designed for stove practitioners and managers and focuses on stove technology and application.

Cont P. 16

Diary of Events

From P. 15

The participants should:
(a) have experience of field work;
(b) be familiar with assessment of biomass; and
(c) be involved in implementing/managing stove programmes.

For further details please contact:
Ms. J. Pepper
ITDG Stoves
Myson House, Railway Terrace
Rugby CV21 3HT
UK
Tel: Rugby 60631
Telex: 317466 ITDG G

The Regional Energy Resources Information Center (RERIC) is one of the four specialized Information Centers of the Library and Regional Documentation Center, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The "RERIC News" is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership along with the other four regular publications namely: RERIC International Energy Journal (formerly: Renewable Energy Review Journal); RERIC Holdings List; Abstracts of AIT Reports and Publications on Energy; and RERIC Membership Directory. For further details contact:

Regional Energy Resources
Information Center
Asian Institute of Technology
G.P.O. Box 2754, Bangkok 10501,
Thailand
Tel: 5290100-13 Ext. 2873
Telex: 84276 TH
Fax: (66-2) 5290374

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Somchart Paisarnrat
Yuva Raja Upadhyaya

♦ September 18-24, 1988, Honolulu, Hawaii, USA
International Renewable Energy Conference (IREC)

The conference is hosted by the State of Hawaii and co-sponsored by the U.S. Department of Energy, U.S. Overseas Private Investment Corporation, U.S. Trade and Development Program, East-West Center, etc. and will be held in conjunction with Windpower'88. The theme of the conference is "Developing Indigenous Energy Resources: the Path to Economic Security and Growth."

The conference will: (1) provide an overview of the status of worldwide accomplishments and opportunities for renewable energy development, (2) provide a one-stop look at Hawaii's unique state-of-the-art installations demonstrating the viability of renewable energy in a tropical setting, and (3) facilitate the transfer of renewable energy technology among participating nations.

For registration please contact:
Mary Charles & Associates
2334 South King Street
Suite 205
Honolulu, HI 96826, USA
Tel: (808) 942-9655
Fax: (808) 949-1273
Telex: 743-1705

♦ October 16-18, 1988, Toronto, Ontario, Canada
Canadian Wind Energy Conference & Exhibition'88

Topics of the Canadian Wind Energy Association's fourth annual wind energy conference and exhibition are: commercial market, project financing, utilities and regulatory issues, international affairs, technology developments, mechanical and pumping applications, case studies, hybrid systems, government programs and policies.

For more information contact:
Nancy Phillips
Conference Coordinator
Passmore Associates International
209-135 York Street
Ottawa, ON K1N 5T4
Canada
Tel: (613) 234-3602

♦ November 1988, Luxembourg
International Conference on Pyrolysis and Gasification

The themes of the conference are utilization of wastes, various forms of biomass and other low-grade solid fuels.

For more details contact:
Prof. A. Buekins
Vrije Universiteit Brussel
Pleinlaan, 2
B-1050 Brussel
Tel: (02) 641 32 50

♦ November 6-10, 1988, Baghdad, Iraq
Symposium on Utilization of Industrial Wastes

The symposium is sponsored by Federation of Arab Biologists and Biological Research Center.

For more information contact:
Dr. Suhair A. Musa
Biological Research Center
Environmental Pollution Dept.
P.O. Box 2371
Jadiriya, Baghdad, Iraq
Telex: 213976 SRC IK
Tel: 7765116/1593

♦ November 13-16, 1988, Tokyo, Japan
VIII International Symposium on Alcohol Fuels

Clean fuels as the key fuels that serve to diversify energy sources and the new technology related to alcohol fuels are the themes of the symposium.

For more details contact:
New Energy Development Organization (NEDO)
29F, Sunshine 60 Bldg.
1-1 Higashi Ikebukuro
3-chome
Toshima-ku, Tokyo 170
Japan

♦ December 1-3, 1988, Madras, India
Seminar on Integrated Energy Systems

This Seminar is organized by Regional Centre for Energy, Heat and Mass Transfer for Asia and the Pacific and sponsored by UNESCO and COSTED. The topics of the seminar cover:

- Role of integrated energy systems in the conservation of energy,
- Cogeneration systems,
- Urban applications,
- Rural applications, and
- System analysis and optimization.

For information contact:
Dr. V.M. Krishna Sastri
Scientific Secretary
Regional Centre for Energy
Heat and Mass Transfer for
Asia and the Pacific
Madras-600 036, India

RERIC news

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ISSN 0125 - 1775 VOL. 11, NO. 3, SEPTEMBER 1988

AIT Charcoal-Methanol Solar Refrigerator

An intermittent solar charcoal-methanol adsorption refrigerator has been designed, constructed and tested at the Division of Energy Technology, Asian Institute of Technology, Bangkok. A schematic diagram of the system is shown in Fig. 1.

The solar collector of the system consists of 15 copper tubes 54mm in diameter and 1.2m long; it has an effective collection area of about 1 m^2. The collector tubes contain 17.8 kg of activated charcoal (207E3, Sutcliffe Speaksman Carbons Ltd., UK). The top ends of the collector tubes are sealed and the bottom ends are connected to a common header. The collector tubes, which are coated with a black selective surface, are housed in a galvanised iron sheet box with a single glass cover. The back and sides of the collector box are insulated with polyurethane foam, and the back insulation of the collector can be lowered. The solar collector is tilted at an angle of 14° facing due south. The condenser of the system is fabricated from copper tubes and is cooled in a tank of static water. The receiver and the evaporator have been designed as a single unit housed in a well insulated box. The receiver/evaporator of the system is charged with 4 litres of methanol, all of which was initially adsorbed by the charcoal. The actual system is shown in Fig. 2.

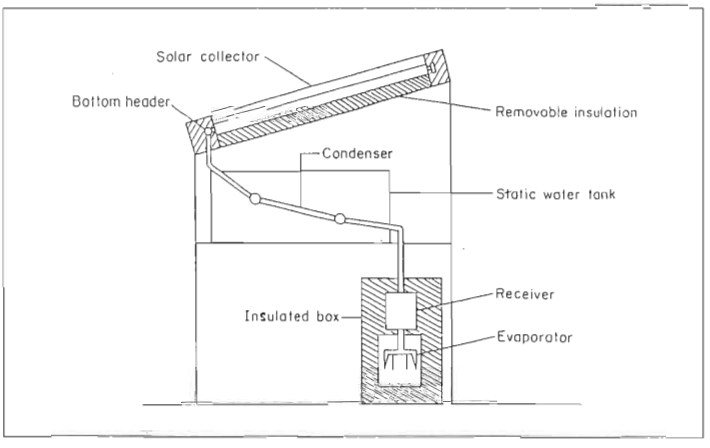

Fig. 1 A cross-sectional view of the solar refrigerator.

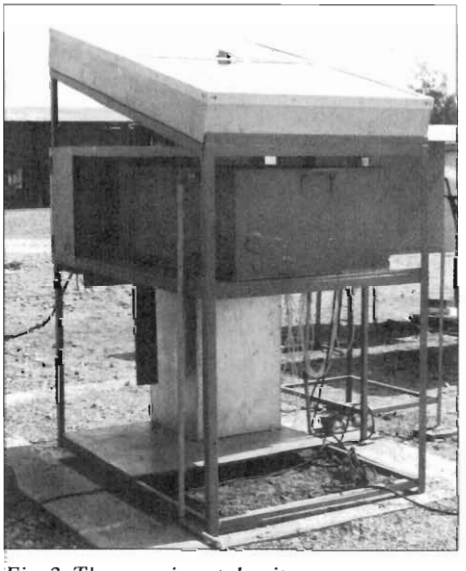

Fig. 2 The experimental unit.

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Operating Principle

Solar radiation incident on the solar collector heats it and causes methanol to vaporise from the charcoal. This vapour condenses in the water-cooled condenser and collects in the receiver/evaporator. The generation of methanol continues until late afternoon. Once the generation stops, the back insulation of the collector is lowered by the operator to let the collector cool. As the collector cools, the charcoal starts to readsorb methanol vapour from the receiver/evaporator. This results in the evaporation of methanol at low temperature and the formation of the ice from the water placed in thermal contact with the evaporator. The heat of adsorption of methanol in

Cont. P. 2

wind and sun compendium
Development of wind and solar energy for water pumping
CWD
Consultancy Services
Wind Energy
Developing Countries

Energy Information Service, CSIRO
Incorporates news from the Energy Information Service, CSIRO and Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).
INNERTAP

AIT Charcoal-Methanol Solar Refrigerator

From P. 1

the charcoal is dissipated by the collector. Thus, this system has a daily cycle in which methanol generation takes place during the day time and cooling is produced at night.

Operation and Performance

The performance of the system was monitored during the month of October 1987. During this month, there were some clear days, some clouded and some rainy days. The efficiency of the collector was found to vary between 33% and 44% and the collector reached a temperature of 122°C during clear days. The net solar coefficient of performance of the system (net cooling produced at night divided by total solar radiation incident on the collector) was above 10% and sometimes reached 12.3%. The minimum evaporator temperature during most nights was below -7°C, but during some nights it was as low as -12°C. This system was able to produce up to 4 kg of ice after a clear day. The system is being further monitored to evaluate the long-term performance.

Cost and Applications

The total cost of this experimental unit was about US$ 1,000 (1987). The fabrication costs of commercial systems could be lower than the above value due to economy of scale, and could be reduced further if suitable activated charcoal and methanol are available locally. The possible areas of application of such refrigerators are numerous. The refrigerator can be used without major modifications for vaccine storage and freezing icepacks needed for the Expanded Programme of Immunization, WHO for remote rural areas. The system is quite cheap compared with the photovoltaic systems (producing 1.2 to 2 kg of ice) whose prices range from US$ 4,000 to 8,000.

The above project was sponsored by USAID through the Illinois Institute of Technology, Chicago, and conducted by Mr. Y. R. Upadhyaya under the guidance of Prof. R.H.B. Exell and Dr. S. C. Bhattacharya.

Further information about this project can be obtained from RERIC, Asian Institute of Technology, G.P.O. Box 2754, Bangkok 10501, Thailand.

Mapping of the Global Solar Radiation over Southeast Asia using Satellite Data

Solar radiation falling on the earth's surface is normally measured on the ground by means of pyranometers. A detailed knowledge of the variation of the solar radiation on the earth's surface requires a closely spaced network of pyranometers measuring solar radiation over each area of interest. Unfortunately, solar radiation data are limited by lack of measuring sites; pyranometric data from most of the areas of the developing countries remain sparse or non-existent.

An alternative solution to the above problem is to derive solar radiation data through the analysis of images from meteorological satellites, which provide extensive and frequent observations in the visible and infra-red wavelengths. A method was developed at the Asian Institute of Technology (AIT), Bangkok, by Dr. Chumnong Sorapipatana to determine the global solar radiation on the earth's surface using visible and infra-red observations from the GMS-3 satellite from Japan.

This satellite is located above the equator at longitude 140°E and is equipped with a visible and infra-red spin-scan radiometer (VISSR) which scans the field of view in two wavelength bands: visible(0.55-0.75 μm) and infra-red (10.5-12.5 μm). The resolution of the satellite is 2.5 km for the visible data and 5 km for the infra-red data at the sub-satellite point. Both the visible and infra-red radiances measured simultaneously by the satellite sensors are transmitted to the satellite center in Japan where they are pre-processed. The processed data are transmitted through the satellite to users.

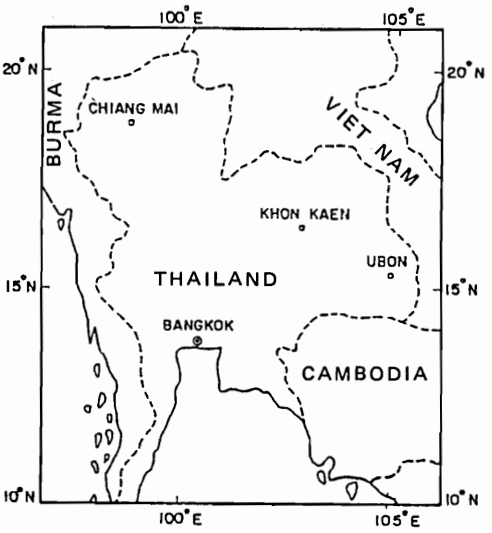


Fig. 1 Location of radiation stations and the study area (13°N-19°N and 98°E- 105°E).

The amount of solar radiation reaching the earth's surface depends on cloudiness. In the AIT study the cloud effects were calculated in terms of the cloud cover over a given area and cloud optical thickness from the infra-red and visible brightness satellite data respectively. Both of these parameters were used to derive a single cloud parameter called cloud effectiveness to be used in the statistical model developed to calculate daily solar radiation. Computer software was designed and developed to provide

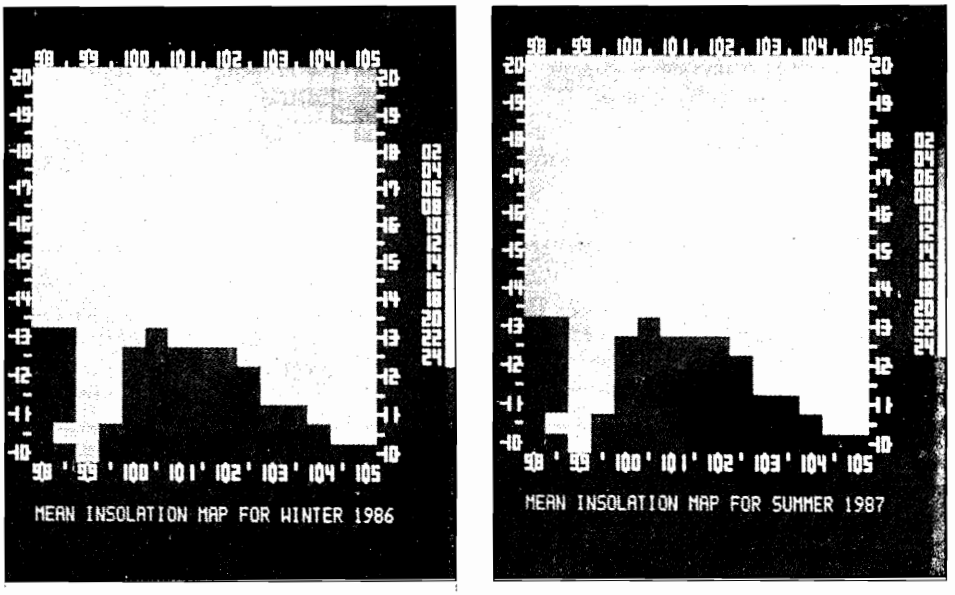


Fig. 2 Mean insolation map for winter 1986 and summer 1987.

information on the mesoscale distribution of insolation. It has been used for producing mesoscale maps of surface insolation on an image processor of the IBM 3083 mainframe at the Regional Computer Center (RCC) at AIT, Bangkok.

The study area is located between the latitudes 13°N - 19°N and longitudes 98°E - 105°E, which is strategically situated over the central land mass of Southeast Asia. It covers most of the land mass of Thailand, the southern part of Burma, the lower part of Laos, the western part of Kampuchea and some small parts of Vietnam. The results obtained were tested against ground measurements taken at four meteorological stations: Bangkok, Chiang Mai, Ubon and Khon Kaen as shown in Fig. 1.

Using this method maps were plotted of the daily global solar radiation on a horizontal surface for the study area every half degree of latitude and longitude. The periods covered were November 1986 to January 1987 (winter 1986) and mid May 1987 to mid August 1987 (summer 1987). Figure 2 shows the mean daily insolation for the two periods.

The results have shown that it is possible to use GMS-3 imagery to estimate global solar radiation within 12% of the mean as measured by pyranometers, and daily global solar radiation within 14% of the mean.

The mapping of global solar radiation by methods such as this has many potential applications. In agriculture, solar radiation is used for modelling crop growth and evapotranspiration for determining irrigation needs. In marine biology a knowledge of insolation over the sea would contribute to the understanding of the growth of plankton and fish. Finally, as solar energy technology matures, detailed descriptions of the solar energy resources obtained from satellites will help engineers to optimize the use of solar thermal and photovoltaic appliances and to select the best sites for solar power generating systems.

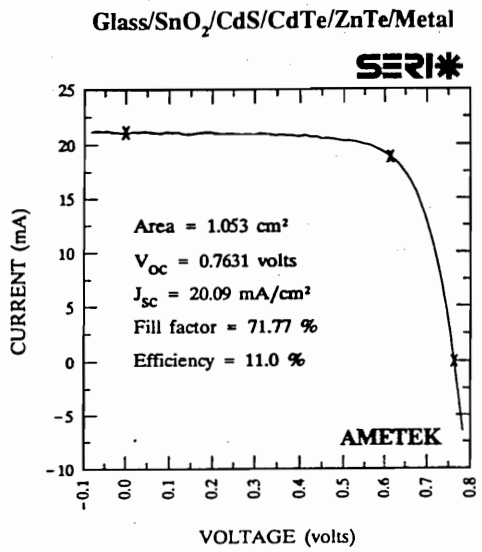
Further details about the methodology and results are available in *Mapping Solar Radiation Over Southeast Asia by Meteorological Satellite Images*, Dissertation No. ET-88-01 for the Doctor of Engineering by Chumnong Sorapipatana (1987), Asian Institute of Technology, Bangkok.

Polycrystalline Thin Film CdTe Solar Cells

The Solar Energy Research Institute (SERI) in partnership with polycrystalline thin film CdTe solar cell companies in the US has launched the fabrication of CdTe cells and large area modules with great efficiencies.

A cell made by Ametek, Inc. (Harleysville, PA) achieved 11% efficiency, the highest SERI-verified efficiency of any polycrystalline thin film CdTe cell in the world. The CdTe was made by electrodeposition, an innovative low-cost method for which Ametek holds several patents. The design of the cell was Ametek's new 'n-i-p' structure in which CdTe acts as an undoped intrinsic layer sandwiched between n-type CdS and p-type ZnTe layers that induce a drift field across the CdTe. The purpose of the 'n-i-p' design is to stabilize the CdTe cells against contact degradation. Ametek has reported testing the cells for 3000 hours under illumination with no degradation, the first CdTe cells to pass this difficult test. Ametek is designing a square-foot-sized CdTe module which it expects to demonstrate within the year. SERI is funding Ametek for two years with a total contract value of US$1,408,000; of which 50% is Ametek's cost-shared contribution. Dr. Peter Meyers is the principal investigator at Ametek and can be contacted at (215) 256-6505.

A second company funded by SERI, Photon Energy of El Paso, Texas, has made the most efficient near-square-foot CdTe module to date. Their module was recently measured at SERI under standard conditions. It was 6% efficient (aperture area) and produced 4.75 W. Although the world record for CdTe modules lags behind those for some competing thin films such as $CuInSe_2$ and amorphous silicon, scale-up to larger sizes is more recent for CdTe. Continued progress should allow CdTe to meet or surpass the others. Photon Energy makes its CdTe using a potentially very low cost, wet chemical method. Thus, if the company can continue to improve the efficiencies, the modules should be among the most competitive. Photon Energy is designing larger area modules (4 square feet). SERI is funding them for two years



at a total contract value of US$702,000, of which 26% is provided by Photon Energy as their cost-shared contribution. Dr. John Jordan is the President of Photon Energy and can be reached at (915)778-5247.

Both Ametek and Photon Energy joined the SERI program in 1987 as a result of an open competition. They represent the US leaders among those with intentions to commercialize polycrystalline thin film CdTe solar cells. Within the SERI program, they are supported by important collaborations with other research groups at universities and institutes, including Southern Methodist University, Colorado State University, Institute of Energy Conversion (University of Delaware), Georgia Tech, Jet Propulsion Laboratory, and SERI itself. Along with $CuInSe_2$ and amorphous silicon, CdTe is regarded by SERI as one of the thin films most likely to achieve the Department of Energy's goals for providing competitive electricity (6 cents/kWh) for large-scale applications.

For more technical information, contact Ken Zweibel or Harin Ullal, Solar Energy Research Institute (SERI), 1617 Cole Boulevard, Golden, Colorado, USA 80401.

(Source: World Record CdTe Solar Cells Founded by SERI, Solar Energy Research Institute Fact Sheet, 11 May 1988.)

Zig Zag Collector
A Solar Water Heater

The Zig Zag Collector is a hot water system which was developed as a result of the experience gained from a small-scale solar energy project entitled "Hot Water for Wamena" carried out in Irian Jaya, Indonesia, from November 1985 through April 1986.

The hot water system is manufactured from locally available materials. The zig zag pipe collector has an absorber of 1/2" galvanized iron pipe fastened to a galvanized steel sheet. The housing is made of hardwood. Sawdust is used for insulation and the cover is made of glass.

The storage tank is made of a 200 litre drum. For the upper and lower conduit flexible conduits resistant to high temperatures were used (Fig. 1).

The details of construction and installation, with a large number of photographs and drawings, of this solar water heater are presented in *"Zig Zag Collector: Manual on the Construction of a Solar Water Heater"*. This manual of 94 pages was published by TOOL Publications. It is available at the price of dfl. 15- (postage excluded) from TOOL, Entrepotdok 682/692, 1018 AD Amsterdam, Netherlands.

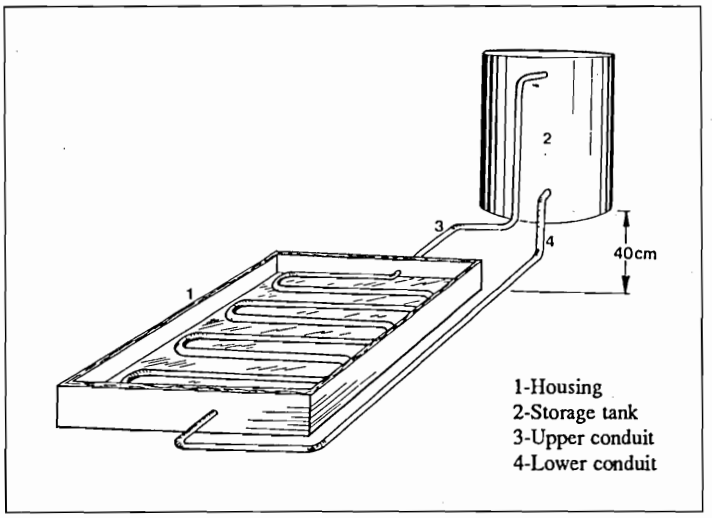


Fig. 1 Hot water system.

Solar One - 10 MWe
Solar Thermal Pilot Plant

Solar energy has the potential to provide a significant portion of our energy needs. A pilot plant generating 10 MWe in the Mojave desert, about 12 miles east of Barstow in California, is a major example of the large-scale harnessing of solar energy. This pilot plant is a model of the 100 MWe generating plant which is planned for the future. This cooperative project of US Department of Energy and the Southern California Edison Company, is one of the biggest solar thermal central receiver project ever conceived. This project which can supply electricity requirements for a community of 6000 was commissioned in 1981. The major purpose of this project was to gather data and information useful for building similar power plants in the future.

Solar One consists of an array of 1,818 heliostats each having 12 slightly concave mirror panels totaling 39.13 m^2 of reflective area. The heliostatic field, which has a total reflecting area of 71,140 m^2, surrounds the central receiver tower and occupies 72 acres of the 130-acre plant site (Fig. 1).

The working principle of the system is shown in Fig. 2. In this system the computer controlled heliostats reflect and concentrate the incident solar radiation to the stationary receiver or boiler on the top of the tower. The receiver is designed to produce 112,000 lb/hr of steam at 960°F(516°C) and 1,465 psia (10.1 MPa). The steam is used to run a turbine-generator to produce electricity. The steam in excess of the energy required for generation of 10 MWe net power

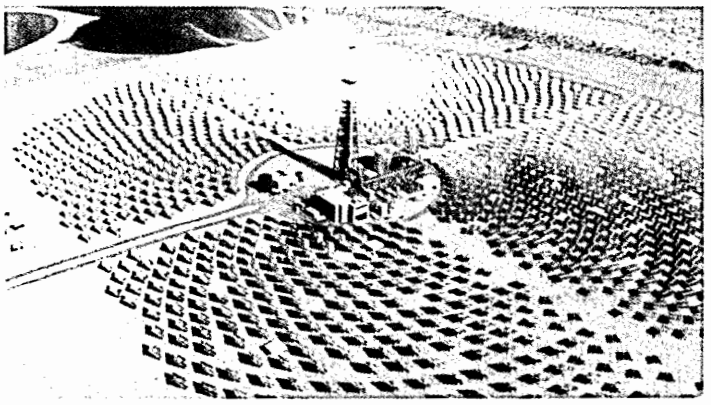


Fig. 1 Solar One, the 10 MWe solar power plant.

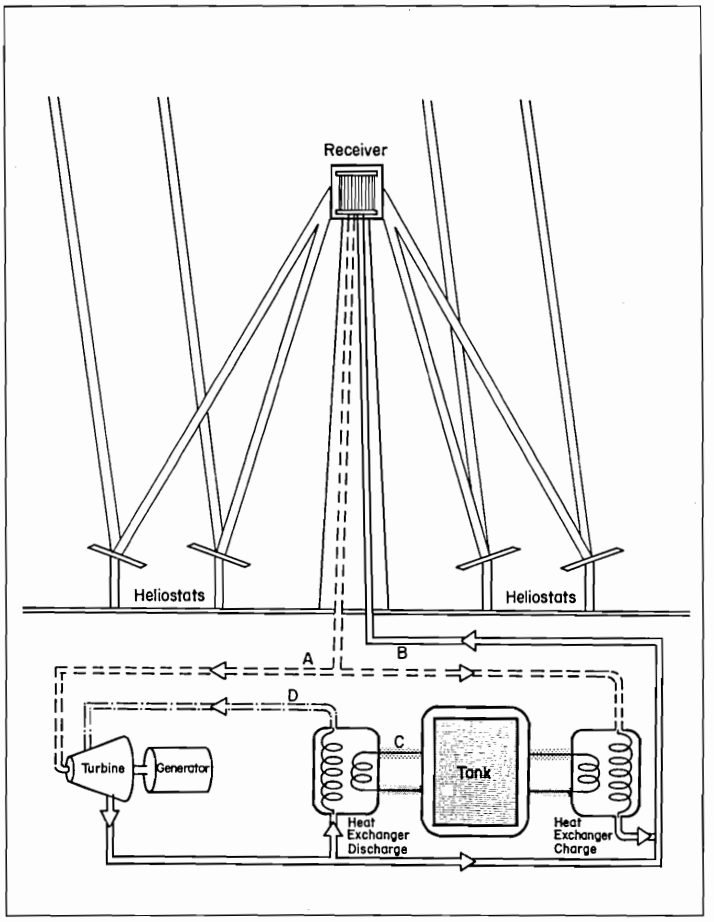


Fig. 2 The working principle of Solar One.

to utility grid, is directed to the thermal storage for use when the output of the receiver is less than that needed for electric power. The thermal storage tank contains gravel, sand, and heat transfer oil. When the system is discharging, hot oil is pumped from the top of the tank through a heat exchanger to generate steam. The maximum operating temperature of the storage system is 300°C.

The experimental test and evaluation phase of this project began in mid 1982 and was completed in mid 1984. During this phase the plant demonstrated its technical feasibility. The power production phase which started in 1984, demonstrated the operating capability of the pilot plant to supply electric power on a reliable basis. The power production goals of generating 10 MWe net from receiver steam and 7 MWe from thermal storage steam were both met. The pilot plant operation also showed that such a system could be operated by utility personnel with skills similar to those needed to operate conventional power plants. The experience gained from operating the power plant is expected to be a valuable aid in design and development of similar power plants in the future.

(Source: Extracted from *Final Report on the Power Production Phase of the 10 MWe Solar Thermal Central Receiver Pilot Plant*, L. G. Radosevich, National Technical Information Service, Springfield, VA, March 1988. The Report was provided by Sandia National Laboratories).

Solar Ponds in Israel

Work on solar ponds is probably one of the most significant areas of research and development being conducted in Israel. The research work which began during 1958 was interrupted between 1966 and 1974 due to the availability of cheap petroleum. But it was revived during 1975 when the Israeli Government declared the development of solar ponds of national importance and allocated a budget of US$ 20 million to this work. This lead to the development of a 150 kWe power station which was inaugurated in December 1979. This power station is located on the shore of the Dead sea at Ein Boqeq and is shown in Fig. 1.

In a solar pond, density gradient is created by the differential dissolution of salts in water. The concentration in the pond gradually increases from the top to the bottom.

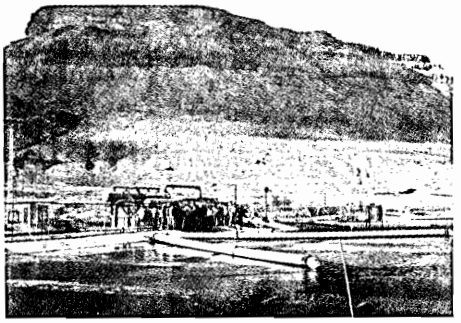


Fig. 1 The Ein Boqeq 150 kWe solar pond power station.

During day time the pond is heated by solar radiation and hot water is accumulated at the bottom while the top layer acts as an insulator. With this process a temperature close to the boiling point of water can be reached. A schematic diagram showing the working cycle of a low temperature turbine using the heat from the solar pond is shown in Fig. 2. Hot water from the bottom of the solar pond is pumped and used to evaporate a low-boiling point organic fluid. The heated vapour is used to run a turbine-generator to produce electricity. The vapour coming out of the turbine is cooled in a water cooled condenser and sent to the evaporator which completes the cycle.

The above project demonstrated that a solar pond having a large collector and built-in-storage is capable of supplying energy day and night during both summer and winter months. Encouraged by this project another 5 MWe power station was initiated in 1983 at Betha Arava, the north end of the Dead sea. This unit will be followed by a series of modules of 20 to 50 MWe capacity which is planned to be erected, over the next 10 to 20 years, in the Dead sea using the new technology of floating ponds. The programme represents a potential of about 2000 MWe, enough to meet about 20% of the national demand during the year 2000. This will be accomplished by converting the Israeli part of the Dead sea - 400 square kilometres - into a giant solar lake. Inland solar pond projects are possible in Negev where brackish water available from aquifers can be employed.

According to Harry Tabor, one of the researchers, the use of solar ponds as a source of low-grade heat and power, particular in areas not connected by the national grid, is extremely encouraging. For thermal applications such as district heating, central air-conditioning, desalination, heat for industrial and agriculture processes, the solar pond appears to be the cheapest source of energy.

An economic analysis from the Solmat and Ormat companies, which are jointly developing the programme, indicates that the cost of solar electricity which can supply peak demand, can compete with conventional fuels even from the early stage of solar ponds programme implementation.

Further research is being carried out to develop a saltless solar pond which consists of a solar pond with a flat-plate honeycomb collector for the production of low-cost heat for industry and other applications. A pilot plant tested reached a temperature up to 95 °C and the first industrial unit having 4000 m² collection area has been planned.

(Source: Extracted from *Solar Energy in Israel*, Grouses, D. and I. Segal (1984), Ministry of Energy and Infrastructure, Jerusalem, Israel, 93 p.).

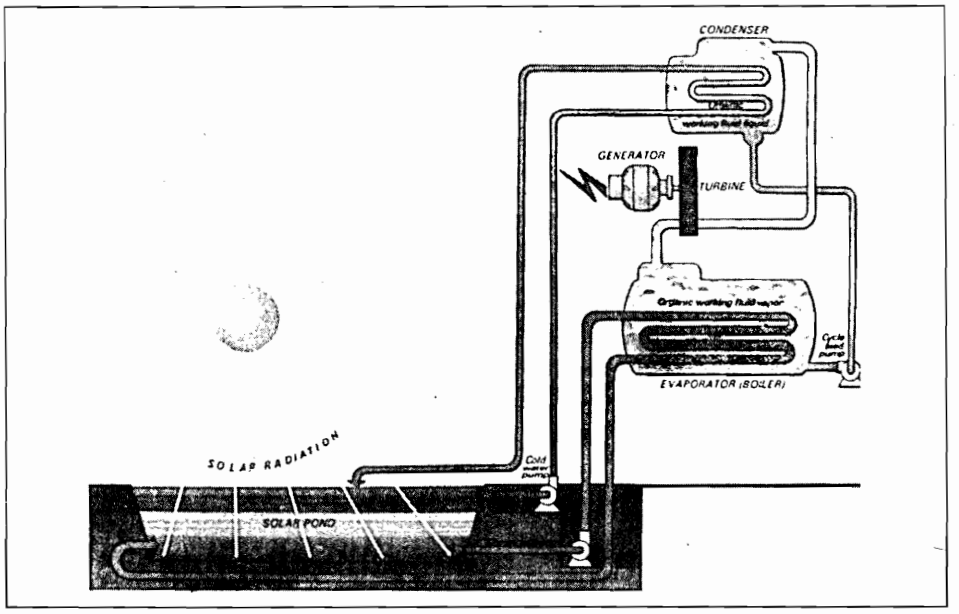


Fig. 2 Schematic diagram of the solar pond and low-temperature turbine operation.

Swedish Municipality Initiates World's Largest Fuelwood Project

The world's largest fuel-forest project with an area of 5,000 hectares to be planted in Örebro county, central Sweden, should reach maturity in the early 1990s, according to the Federation of Swedish Farmers, LRF. By that time, the municipality should have a solid fuel boiler fired with wood-chips, coal and peat in operation.

These fuel forests consist of fast-growing, specially developed types of willow and osier (of the Salix family), with particular resistance to infestation and climatic changes. After three years the trees are 5-6 metres high and ready for felling. The average annual yield is 12 tons/hectare. The stubs produce new saplings, and, as each plantation is estimated to be productive for some 20 years, this means 6-7 harvests.

Costs and the lack of demand on the market have previously inhibited this kind of experiment, but times are changing, the participating farmers hope. Grain growing is becoming less and less lucrative and viable alternatives are required. The Örebro municipality, the local LRF and other authorities and organizations have decided to back the experiment. Grants originally allocated for grain cultivation, as well as grants for assistance when changing from grain to other crops, will be made available. The planned solid fuel boiler also forms part of the scheme.

The cost of wood-chip produced power is estimated at Kr. 0.11-0.13 (US$0.02) per kWh, which is slightly higher than that of coal, excluding environmental costs. Wood-chip burning is certainly less polluting, it is stated; the amounts of carbon dioxide and other acidifying substances are reduced and the ash can be recycled.

So far, there is not much practical experience gathered from fuel forests, according to the report. Earlier small experimental plantations will soon be ready for the first harvest, but the Örebro project is the first on a large-scale for cultivation and distribution. The lessons learnt will be vital for future developments, LRF states.

(Source: *SIP The Swedish-International Press Bureau,* Stockholm, 22 August 1988.)

Low Cost Residue-Fuelled Food Driers for Developing Countries

Over the past four years Biomass Energy Services & Technology Pty Limited (BEST), in collaboration with researchers, entrepreneurs and extension officers in developing countries, and the Department of Food Science and Technology at the University of New South Wales, has developed a range of furnaces to provide the heat for drying. These furnaces have been designed to meet the needs of agricultural processing industries and to overcome the deficiencies of existing furnaces. The designs derive from extensive theoretical and experimental research at Reading University and at the BEST research station at Wamberal, Australia.

Computer models were used to determine the performance of different designs, and test rigs were used to determine their operating characteristics when using different fuels with a range of moisture contents.

Most of the research has been focused on developing a range of driers that can be fuelled by residues such as rice husks, coconut shells or wood residues. One of these driers using rice husk as fuel (Fig. 1) consists of two components; a furnace and a drying chamber that contains an air heat exchanger, and the trays to hold the product.

The rice husk/sawdust furnace consists of a drum that is divided into two sections, an outer annular section for holding the fuel and an inner cylinder to burn the volatile gases. Air is brought in underneath the furnace and passed through a grate. The fuel is poured in from the top or bottom into a space between the outer wall of the furnace and an inner cylinder. The drum and cylinder can be made from steel, bricks or ceramic. The inner cylinder is punctured with holes. There are a number of variations of this design. Small furnaces that use sawdust do not have a permanent inner cylinder. The inner cylinder is used to pack the fuel in and is then removed. Some furnaces have a number of cylindrical holes placed throughout the fuel bed.

The furnace is operated as follows:

1. Rice husks, sawdust, or charcoal fines are loaded into the furnace.
2. A wood fire is started in the bottom of the drum under the fuel.
3. The hot gases from the wood fire pass through the inner cylinder to strike the heat exchanger.
4. The heat from the fire and from the hot gases flowing in the inner cylinder is also transferred into the fuel. This causes the fuel to pyrolize. The volatile gases then migrate to the inner cylinder (through the holes in the wall) where they meet the hot gases from the wood fire. These hot gases contain oxygen and thus the volatiles are

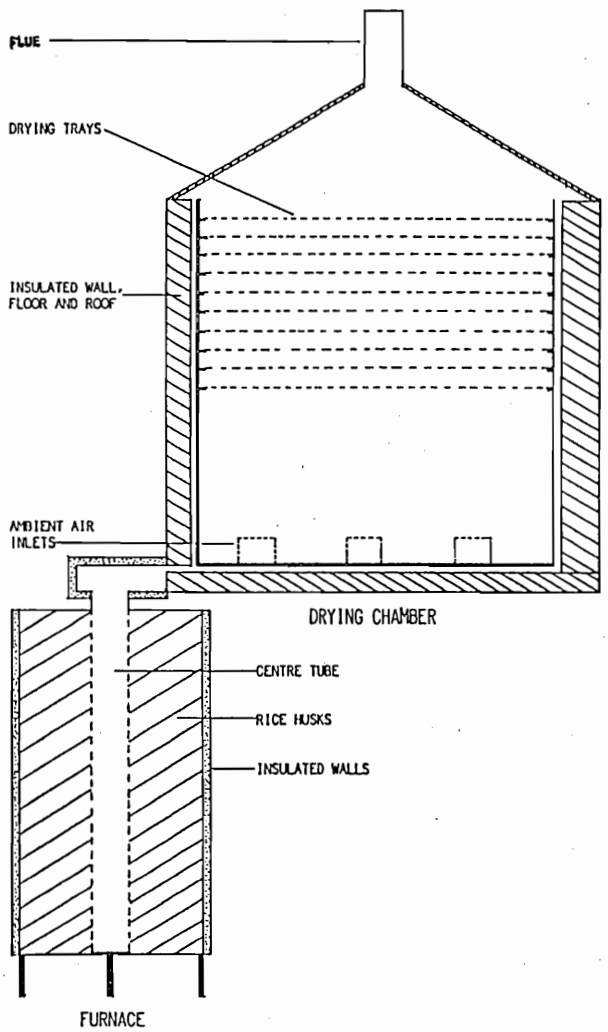


Fig. 1 A multi-purpose drier using rice husk as fuel constructed at Gosford, NSW, Australia.

ignited.

5. As the inner cylinder heats up, the reaction becomes self-sustaining and the wood fire is stopped.

The furnace can be operated continuously for up to eight hours. It has a maximum output of 20 kW and an average flue gas temperature of 800 °C.

Operation of the drier is as follows:

The hot gases (approximately 800 °C) pass through a series of tunnels underneath the bottom of the drier before flowing between the inner drying cabinet and the outer wall of the drier. Some of the gas also passes up the nearest wall. The distribution depends on the difference in pipe diameter between the inner and outer walls. Heat is transferred through the walls to the inner drying cabinet. The hot gases then pass up to the chimney at a temperature of 400 °C. At this temperature there is a reasonable difference in pressure between the outer air and the inner air inside the tray drier (approximately 7 pascals per metre of chimney). This pressure difference causes the air outside to enter the inner drying cabinet and flow through the product at the desired velocity of 0.05 m/sec. As the air passes over the hot slab it is heated. The conditions in terms of heat and flow can be changed by varying the output of the furnace, by altering the height of the chimney and by opening or closing the cold air inlet dampers.

To reduce the capital cost, the drier is constructed mainly from mud blocks and the roof made from corrugated iron. The outer walls are made from a mixture of rice husk ash mud and a little cement so that they have a high insulating value. The inner walls are made from steel sheet. The product is placed on a series of trays. This drier uses indirect heat to dry and the stack gases are used to draw the air into the drying cabinet.

Extensive testing of the furnace has been undertaken and it will be field tested in Indonesia. Testing of the drier is still being carried out at the Fisheries Research Institute in Djakarta.

For further details please contact:
BEST Pty Limited
5 Kenneth Ave.
Saratoga, NSW 2250
Australia
Tel: (043) 69 5108, Telex: AA 021822.

The Coiled Tube Pump - A New Design

The coiled tube pump concept has been around for some years now but has not been manufactured widely because early designs were both difficult to make and inefficient. Recent work by Dr. D.J. Hilton (A Visiting Faculty at the Asian Institute of Technology, Bangkok on secondment from Darling Downs Institute of Advanced Education, Toowoomba, Queensland, 4350, Australia) has, however, resulted in a design which is simple to manufacture, requires almost no maintenance, and has improved efficiency.

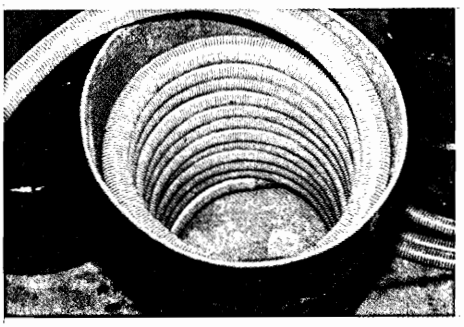


Fig. 2 A coil of reinforced plastic tube being installed in the drum.

Application

The pump is ideally suited for low-lift irrigation from a canal or river, where the water has to be lifted between 0.5 m and 3 m onto the irrigated land.

It is a slow-speed pump (normal range 10-60 rev/minute) and is therefore ideally suitable for being driven by hand, bicycle mechanism, windmill or animals. Features of the design are shown in Fig. 1.

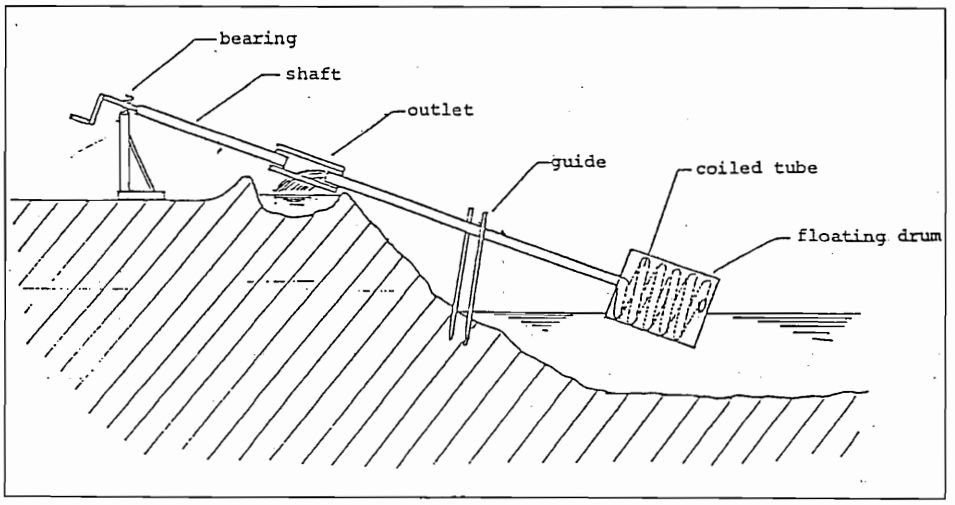


Fig. 1 Diagram showing features of the design.

Construction

The pump consists of a cylindrical drum connected to a steel water pipe. Inside the drum is a coil of reinforced plastic tube (Fig. 2). One end of this tube is connected to the steel pipe and the other end is connected to a short piece of steel pipe welded to the side of the drum at the entry hole.

The drum is designed to float so that it is approximately 50% submerged at the point where the water enters the coil. It therefore ensures that the correct entry conditions are maintained, since the drum follows the water level as it varies up and down.

The steel water pipe is used as a shaft to turn the drum around and is also used to convey the water. At the upper end there is a bearing support, and this is the only bearing required (Fig. 3). This bearing is of the self-aligning type. Two bamboo sticks are employed to control the shaft direction,

Fig. 3 The hand-operated pump.

Fig. 4 Installation of a hand-operated pump at Wat Sa Geow.

Fig. 5 Operation demonstration of the pump at Wat Sa Geow.

while still allowing the drum to rise and fall with the varying water level.

Figs. 4 and 5 show the installation and operation of the hand operated pump at Wat Sa Geow respectively (students assisting in the assembly and operation).

How the pump works

As the drum rotates, it collects a quantity of water and then a quantity of air repeatedly until all the coils are approximately half full of water. Small pressure differences are produced between each pocket of air. When all these small pressure differences are added together, enough pressure is developed to push the water in the last coil to the top of the delivery pipe. The flow is not continuous, but consists of a quantity of water being delivered for each revolution of the drum, followed by a small quantity of compressed air being released.

Efficiency

With this new design an overall efficiency of between 50% and 58% has been measured at the lower end of the speed range. This compares favourably with other low-power, low-lift pumps and various other types of lifting device.

Maintenance

The only maintenance required is occasional lubrication of the bearing at the top end of the shaft, and painting the drum to prevent corrosion. Since the coiled tube is inside the drum, the plastic material will be protected from degradation by ultra-violet light, and should have a long life.

The pump should therefore give many years of service with very little maintenance indeed.

Pump output for various pipe and coil sizes

The table below shows the output flow per revolution, and the flow rate at a rotational speed of 40 rev/minute for two sizes of drum and various sizes of pipe.

	Pump Output			
Diameter of floating drum	22.5" (57 cm) (Standard 2001 oil drum)		75 cm	
Diameter of coiled pipe	2" (5 cm)	2.5" (6.3 cm)	2.5" (6.3 cm)	3" (7.5 cm)
Output for one revolution	1.5 litres	2.3 litres	3.3 litres	4.8 litres
Output, litres/hour (rotating at 40 rev/minute)	3600	5500	7900	11500
Recommended pump lift for hand-operation	2-3 m	1.25-2 m	1-1.75 m	0.5-1.25 m
Recommended size of delivery pipe (drive shaft)	2" (5 cm)	2.5" (6.3 cm)		

Energy Policies in Asia: A Comparative Study*

The Energy Technology Division of AIT has recently completed a study of the energy policies of twelve Asian countries, namely, Bangladesh, China, Hong Kong, India, Indonesia, Korea, Malaysia, Nepal, Pakistan, Philippines, Sri Lanka and Thailand. Using data for the period 1973-1985, the study documents and analyses the changes in the institutional arrangements, planning processes and supply, consumption and price structures in the energy sector. The evolution of both large-scale and rural energy systems are traced and compared through nearly 210 tables, 240 figures and 25 charts.

The study concludes that the Asian countries have in general followed a policy of energy self-sufficiency, accelerating the depletion of their limited resource endowments and contributing to the overall energy intensification of their economies. Widening of the energy supply options through non-oil energy imports has been attempted only by Korea and Hong Kong.

The study shows that in 1972, the prices of petroleum products in Asian countries were significantly higher than those in international markets. Hence the countries have responded by not passing on the international price increases. This policy has helped the evolution of more homogenous price regimes by 1985, thereby reducing allocative inefficiencies.

As part of a programme to strengthen cooperation between Asian countries through shared experiences, the study was commissioned by the Regional Energy Development Program (REDP) of the United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP) with funding from the United Nations Development Program (UNDP) and the Commission of the European Communities (CEC).

The study was carried out in close cooperation with national governments and several international organizations which has helped the creation of a regional energy database at AIT. The database is being further strengthened with funding from CEC and in conjunction with REDP. More detailed studies are envisaged. Interested persons may contact Dr. Dang Van Giap,

Energy Sector Management Assistance Program - ESMAP

The Energy Sector Management Assistance Program (ESMAP) was started jointly by the World Bank and the United Nations Development Programme in 1983 as a companion to the Energy Assessment Program which was established three years earlier. The Assessment Program was originally designed to identify, analyze, and propose actions to address the most serious energy problems in developing countries. As a direct consequence, ESMAP was conceived in part to act as a preinvestment facility to assist in the implementation of the actions recommended in the assessments.

Today, ESMAP is carrying out energy-related preinvestment activities in over 50 countries and provides a wide range of institutional and policy advice to developing country decision makers. The program is an integral partner in the overall international effort to provide technical assistance in the energy sector to developing countries. It attempts to supplement, advance, and strengthen the impact of bilateral and multilateral resources and private sector investment available to the energy sector. The findings and recommendations garnered from individual ESMAP country activities are summarized in reports which provide governments, donors and potential investors with information needed to identify sound energy sector projects and to accelerate their preparation and implementation. ESMAP's policy and research work analyzing cross-country trends and issues in specific energy subsectors is emerging as an important tool for highlighting critical problems and suggesting solutions for dealing with them.

The program's activities are organized into two major groupings, each managed by a unit of the Energy Strategy, Management and Assessment Division of the Industry and Energy Department at the World Bank. The Energy Efficiency and Strategy Unit addresses institutional, financial and policy issues in the energy sector, including design of sector strategies, facilitating energy delivery, improving energy end-use, defining investment programs, and strengthening sector enterprises. The Household Energy Unit focusses on the technical, economic, financial, institutional, and social issues affecting energy use and energy provision in lower income urban and rural households as well as in rural industries. It addresses both traditional and modern fuel sources including renewable energy resources.

The supporters of the program for the first four months of the calendar year 1988 are the World Bank, the UNDP Interregional Programs, United Kingdom, Sweden, The Netherlands, Denmark, UNSO, and Canada.

The current ESMAP program and a list of on-going projects appear in ESMAP's information and status reports which are issued three times a year.

For further information on the program or to obtain copies of selected ESMAP reports, please contact:

Robert J. Saunders
Chief
Energy Strategy, Management and Assessment Division
Industry and Energy Department
The World Bank
1818 H Street, N.W.
Washington, D.C., USA 20433.

or

Timothy Rothermel
Director
Division for Global and Interregional Projects
United Nations Development Programme
One United Nation Plaza
New York, NY 10017.

Asian Energy Review Project, AIT, P.O. Box 2754, Bangkok 10501, Thailand.

*Lucas, N.J.D., J. Ambali, E. Chang, M.S. Forbes-Ricarte, and R.M. Shrestha (1988), *Energy Policies in Asia: A Comparative Study*, McGraw Hill Book Co., Singapore.

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EUROWIN - European Wind Turbine Database

The European Wind Turbine Database (EUROWIN) has been sponsored by the Commission of the European Communities (CEC) under the directorate general responsible for renewable energy R&D and carried out by the German Fraunhofer Institute for Solar Energy. The database is accessible to anyone and questions to it are welcomed by the operators. Anyone with an IBM compatible computer can also link up to the system after a one day training course at Fraunhofer in Freiberg.

Information is stored in three categories:

- a database supplying information on manufacturers, operators, components and institutions;
- statistics on wind turbine production divided into annual, quarterly, general and individual categories;
- calculation of specific values such as specific annual energy and energy coefficient.

The database is in turn split into three and can provide technical data on individual WECs, local data on installed individual WECs and calculated analysis of production, failures, and so on throughout a specific country.

As yet the system has no foreign users and is untried by the wind industry. Its usefulness therefore remains an unanswered question and as yet data collection is incomplete, explains Hans-Peter Klein of the Fraunhofer Institute. In particular it has been difficult to get a regular flow of data from Germany, Spain and the United Kingdom. But Denmark and Holland are well represented.

The data stored in the system is from January 1986 and it is continually updated. A total of 570 types of European machine are represented, including some battery charging machines down to 500 W in size.

Individual machine makes are not identified in the various analyses, neither are the addresses of operators revealed so there is no question of the system being used for industrial espionage.

But standard research can be carried out on a month by month basis for interested parties wanting a regular flow of particular information.

The project was due for closure this year but it has recently been granted a two year extension by the CEC. It is hoped that it will eventually be taken over by a commercial database company; interest in EUROWIN has been shown by the German Centre of Databases which might consider taking it over when it is complete.

(Source: Extracted from "A Wind Database for Everybody", by Lyn Harrison. *Windpower Monthly*, Vol.4, No.7,1988).

The 8th International Training Course on Biogas Technology Chengdu, China

April 8 - May 20, 1989

So far over 4 million biogas plants for family use have been operating successfully in the rural areas of China. More than 20 million farmers are utilizing biogas for cooking and lighting. China's technology and experience in biogas development have been followed with great interest by many countries, developing countries in particular.

In order to popularize and encourage extensive utilization of biogas technology and to strengthen regional co-operation in the field of research and development in-line with the technical co-operation advocated by the United Nations, the Asia-Pacific Regional Biogas Research and Training Center in Chengdu, China (BRTC) was set up in 1981 as agreed upon between the Government of China and the United Nations Development Programme (UNDP). Since its inception, the center has held 7 International Training Courses on Biogas Technology, jointly with UNDP and FAO, and 169 biogas technicians from 59 countries have been trained. Encouraged by the success of these courses BRTC is going to hold another International Training Course on Biogas Technology. The 8th Course will be funded by the Government of China and UNDP.

Purpose of Training

1. To further strengthen co-operation among various countries in the field of biogas research and development according to the spirit of technical co-operation among developing countries advocated by the United Nations.
2. To transfer the experience and expertise acquired in China in biogas research and development at the small-scale and individual household level.

Outcome of Training

It is expected that, within 6 weeks, all the trainees will be able to understand the current biogas developments in China and the basic fermentation process, and master the basic techniques of design and construction of Chinese hydraulic type plants. After the training course all the trainees are expected to be able to develop and extend the Chinese biogas technology in their countries.

Content of Training

1. Biogas microbes and their biochemical process.
2. Fermentation technology and control in biogas digester.
3. Analysis and determination in biogas fermentation.
4. Stirring units in biogas digester.
5. Design and construction of fermentor.
6. The systems of feeding and withdrawing.
7. Cleaning and preserving of biogas.
8. Gas burners and gas-supply systems.
9. Utilization of biogas for power.
10. Disposal of waste water with high concentration of organic materials after anaerobic fermentation.
11. Economic analysis of biogas projects.
12. Biogas septic tank for urban human stool.

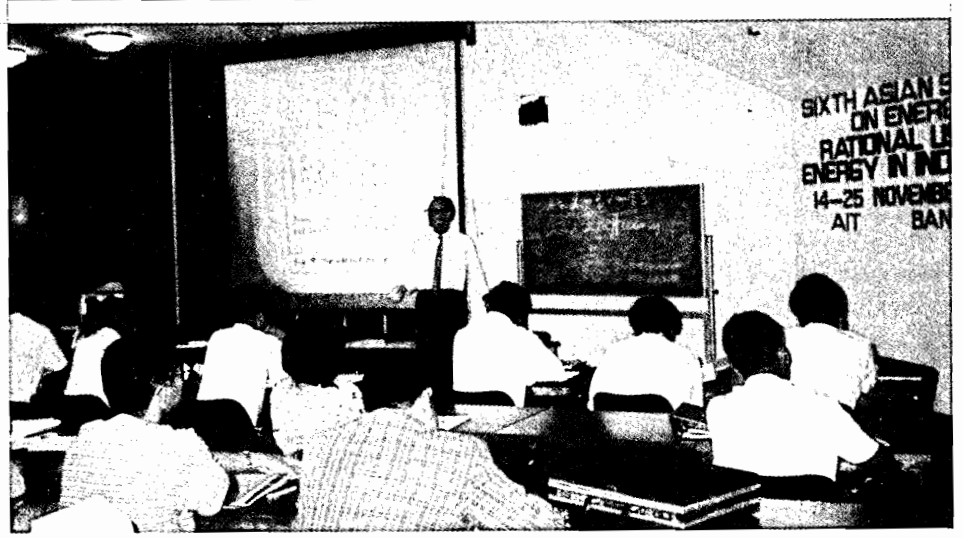
Location and Date

The Course will be held at Chengdu

Sixth Asian School on Energy

Rational Use of Energy in Industry

The Asian Institute of Technology (AIT) in cooperation with King Mongkut's Institute of Technology Thonburi (KMITT) organized the Sixth Asian School on Energy during 14 to 25 November 1988 at the Division of Energy Technology of AIT. The theme of the School was Rational Use of Energy in Industry. The School was sponsored by the French Agency for Energy Management (AFME) and the United Nations Educational, Scientific and Cultural Organization (UNESCO) and co-sponsored by the French Embassy in Thailand, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, the United States Agency for International Development (USAID) and the ASEAN Working Group on Non-Conventional Energy Research, Thailand (AWGNCER).



Prof. Exell of the Energy Technology Division, AIT during one of the lectures.

The 2-week School was designed for:

1. Industry engineers concerned with energy management;
2. Scientists, researchers and trainers in the field of rational use of energy; and
3. Government officers involved in formulating or implementing policies for energy conservation in industry.

The School was divided into two parts. The objective of the first part of the School, Rational Use of Energy, was to update the participants' knowledge of technical solutions of how to reduce energy costs and to provide a background for understanding the latest developments and progress in the applications of methanisation, cogeneration, membrane processes and use of ozone in the industrial sectors.

The second part, Pollution Abatement and Energy Recovery, included lectures and discussions by experts on specific industrial energy problems.

This School was attended by 25 full-time participants. Additional 9 and 5 participants attended first and second parts of the course respectively. The school drew participants from academic and research institutions, Government agencies and industries from different countries, like China, India, Indonesia, Philippines, Pakistan, and Thailand.

Resource persons were from academic and research institutions, and industries of USA, Thailand, France, India, Hong Kong and Tunisia.

city, Sichuan province, China during 8 April until 20 May, 1989. The theoretical part of the course will be conducted in the lecture-hall of the Training Center. The practical sessions for digester construction, material-feeding and operation will be conducted at the Center's experimental pilot plant. Accommodations will be at the Jin Jiang Hotel in central Chengdu.

Financing

The tuition fee for the training course, lasting 42 days, will be US$ 3,200 excluding air tickets. The above expenses (US$ 3,200 and air tickets) will be paid by the participants themselves. The expenses in the People's Republic of China will be paid by the Chinese Government.

Contact Address:
Ms. Cao Cheng-Zhao
Training Department of BRTC
13, Block 4, People's South Street
Chengdu, Sichuan
The People's Republic of China
Tel: 51571, Cable: 3049.

Training Course on Energy Management in Small and Medium Scale Industries

Course objectives: Analysis of the role of energy in production processes; availability and acquisition of energy, and the consequences of the choice of sources; efficient use of energy; the formulation of policy options and strategies.

Programmes: Lectures, discussions, case studies, exercises and excursions related to technology options in production processes; energy utilisation and need assessment; energy control and conservation techniques; energy planning and supply options; energy auditing; economic aspects of energy; management dimensions; policy aspects of energy in small and medium scale industries.

Language: English.

Type of diploma: Certificate of Attendance.

Duration: 5 weeks.

Next course: Begins October 1989; Ends November 1989.

Deadline for application: 1 July 1989.

Educational requirements: B.Sc. or equivalent in a relevant subject.

Professional experience: At least 2 years.

Fees: D.fl. 10,000 (for local sponsors in developing countries D.fl. 7,500). Estimated costs for living expenses (5 weeks): D.fl. 3,500.

Scholarships: a) International organisations (conditional); and b) Restricted number out of Netherlands Fellowships Programme (via RVB).

The Training Course is conducted by the Technology and Development Group of

Cont. P. 12

Biogas from Human Waste, Workshop Proceedings, Delhi, 22-23 August 1986

Biogas plants have been widely accepted in India as an appropriate means of recycling cattle wastes and producing both fuel and manure from the same quantity of dung. At present it is believed that there are over 3 million family-owned biogas plants in the country.

The majority of these biogas plants use cattle dung as the feedstock. At the same time there are also efforts to use alternative feedstocks like human excreta and other agricultural wastes.

Some of the community biogas plants directly fed on human excreta are at Masoodpur village near Delhi; Sewagram, Wardha; Midnapur, West Bengal; and Puri in Orissa.

Considering various problems regarding social, health and operational aspects associated with biogas plants fed fully or partially with human excreta, the Consortium on Rural Technology in collaboration with Action for Food Production (AFPRO) conducted a workshop on biogas from human waste during 22-23 August 1986. The workshop drew about 75 participants from Government Departments, Research Institutions and Voluntary Organisations. Discussions focussed on the following aspects:

- social aspect
- health aspect
- design and R&D aspects
- treatment of slurry and its use
- strategy for promotion and integration with other development programmes.

The Proceedings of the workshop is available from the Consortium on Rural Technology (D-320, Laxmi Nagar, Delhi 110092, India). The Proceedings contains recommendations of the workshop; prologue; keynote address; epilogue; 5 papers on social aspect; 7 papers on health aspect, 8 papers on design and R&D aspect; 3 papers on treatment of slurry and its use and 3 papers on strategy for promotion and integration with other development programmes. A list of participants is also included.

Technical Information Package on Solar Drying of Lumber

Technical Assistance and Energy Unit
Caribbean Development Bank
P.O. Box 408
Wildey St. Michael
Barbados, W.I.
June 1987, 18p. + Figs.

This information package summarizes the findings of numerous publications on solar drying of lumber and the experiences gained with solar lumber dryers in the Caribbean region. Dryers were inspected in Dominica, Guyana, Jamaica, Puerto Rico and Trinidad and Tobago. It also provides information on suppliers of materials and equipment required to build and operate solar lumber dryers.

Addresses of resource institutions and persons with special knowledge and experience in the operation of solar lumber dryers inside and outside the Region are appended.

Three different methods of lumber drying are described: open air drying, use of conventional kilns and use of solar kiln-dryers. The latter is recommended for use in the Caribbean Region.

The construction of these solar dryers is outlined as well as the practical procedures for operating solar kilns.

Humidity standards applicable to dried lumber in northern countries and potential export customers are mentioned.

Training Course on Energy Management in Small and Medium Scale Industries

From P. 11

University of Twente in cooperation with the Netherlands International Institute for Management (RVB), Delft.

For further details contact:
Technology and Development Group
University of Twente
P.O. Box 217
7500 AE ENSCHEDE
The Netherlands
Tel. 31-53-893539
Telex 44200 thtes nl
Fax 31-53-356490

Demand for Electricity in the Philippines Implications for Alternative Electricity Pricing Policies

Clodualdo R. Francisco
The Philippine Institute for Development Studies
4th floor, NEDA sa Makati Building,
106 Amorsolo St., Legaspi Village
Makati, Metro Manila, Philippines
(ISBN 971-128-014-0, 1988, xvii+194 p.)

The Philippine Institute for Development Studies is a non-stock, non-profit, government research institution engaged in long-term, policy-oriented research. The Institute in cooperation with the United Nations Development Programme have supported the study on Demand for Electricity in the Philippines. This study attempts to es-

Power from the People Innovation, User Participation, and Forest Energy Development

Matthew S. Gamser
Intermediate Technology Publications
9 King Street, London WC2E 8HW, U.K.
(ISBN 0 946 688 94 x, 1988, vii + 159p., Price: £9.95)

This book is a discussion of the management of technical change. It looks at many examples of this change, ranging from work on the most sophisticated, 'high-tech' products and processes for industrial cultures, to aspects of basic struggles for survival in rural areas in developing nations. Its heart lies in the detailed analysis of the introduction of forest energy technologies in Sudan.

The technologies themselves are not

timate the demand elasticities of electricity in the Philippines with focus on the Manila Electric Company (MERALCO) franchise area. The results of the analysis are used to derive some broad implications for alternative electricity pricing policies.

This report provides a brief theoretical discussion of the electricity demand model used. The two related components of electricity, power and energy, the two-part tariff and multi-block pricing of electricity, and the derived nature of demand for electricity are considered.

The residential consumer demand function for electricity is specified. Two models are tested. Both monthly and annual data were used to test the model.

Specification of the commercial consumer demand model is also provided. As in the residential model, there are two models specified and tested due to two different specifications of the inframarginal prices. Under the commercial consumer category, there are four types of consumers based on MERALCO classification. These are X-1, SMD, primary account, and secondary account commercial consumers. An additional feature of the commercial consumer demand function is the introduction of the peakload and demand charge variables. The results are then analyzed and explained.

For the industrial consumer demand function, there are two models tested due to the different specifications of the inframarginal price variables. Under the industrial category, there are three types of consumers based on MERALCO classification. These are XMD, primary account, and secondary account industrial consumers. The consumer demand function specified is tested for each type of consumer and the results are explained. Except for the specification of the explanatory variable for industrial activities, the specification of both the commercial and industrial demand functions are similar.

The results for each of the five sets of explanatory variables are analyzed across various types of consumers. Also, the results of the peakload elasticity coefficients and some added explanatory variables are discussed. The implications of the short- and long-run estimates of the coefficients of price, income and other variables to include the results on stock adjustments are presented using a dynamic reformulation of the demand model. Thereafter, the implications for alternative electricity pricing policies are derived.

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the focus of this study. Its central concern is the players who participate in their innovation, and the manner in which that participation can be organized.

Forest energy technologies are especially dependent on local social and environmental conditions. User participation in forest energy technology development is essential to innovation in this technology area. Promoting an approach that facilitates user participation in this process, therefore, is integral to change management, and to development assistance in this field. This work provides an empirical illustration of user importance through the analysis of forest energy technology development in Sudan.

This book consists of two parts. The first part examines developments in the theoretical understanding of the innovation process and the role of users within that process. It also reviews the reassessment of research and development strategy that has been undertaken in many development fields, and is now beginning in the renewable energy field. This reassessment demonstrates that much common ground exists between technical change in industrialized, and in the developing nations. The second part looks in detail at the experience of a user-oriented technology development effort in the forest energy work of the Sudan Energy Research Council (SERC) under Sudan Renewable Energy Project (SREP). The results obtained in this effort substantiate the importance of the user role in innovation established in the previous section.

Chapter 2 looks at users and innovation in both industrial and development contexts. Chapter 3 discusses problems that have beset project implementation in the renewable energy technology area, focusing on work in forest energy and on the relative isolation from user involvement of technology development work in this field. Chapters 4 to 7 contain the detailed study of forest energy development in Sudan, with one chapter on each of the three technologies examined, and an introductory chapter concerning energy and institutions in that nation. Chapter 8 discusses how technology development strategy, R&D institutional management, and development assistance programmes can be restructured to better attract and utilize user contributions.

New Proceedings available from RERIC

Energy Conservation in Buildings, Proceedings of the 5th Asian School, AIT, Bangkok, 15-23 June 1987

B. Mohanty & P. Bouix (Eds.)
Asian Institute of Technology
Bangkok, Thailand
(June 1988, 254 p.)

The Fifth Asian School on Energy Conservation in Buildings was a deviation from the earlier schools organized jointly by the Asian Institute of Technology (AIT) and the King Mongkut's Institute of Technology in the field of solar energy harnessing and applications. However, it follows and caters to the present demand of "rational use of energy" in all the economic sectors of the region.

The Proceedings published by the Energy Technology Division of AIT contains the following 19 papers presented by lecturers during the school:

- A National Training Policy for Energy Conservation in Residential and Commercial Buildings (Anne DUPORT)
- Economic Appraisal of Energy Conservation: Micro and Macro Perspectives (Bertrand CHATEAU)
- Policy of the French Agency for Energy Management for Residential and Commercial Buildings (Thierry MERAUD and Jean-Pierre TRAISNEL)
- Analysis of Energy Consumption Trends and Patterns of Buildings in ASEAN Countries (Thierry MERAUD)
- Atmospheric Radiation (Robert H. B. EXELL)
- Lighting and Daylighting in Buildings (Surapong JIRARATANANON)
- Nocturnal Cooling (Piyawat BOON-LONG)
- The Basics of Energy Management and Control systems (Pierre F. PARENT)
- Management of Electrical Energy (Surapong JIRARATANANON)
- Building Energy Performance Prediction (S.K. CHOU)
- Computer Codes for the Energy Analysis of Buildings (S.K. CHOU, Y.K. LEE and M.N.A. HAWLADER)

Cont. P. 14

New Proceedings Available from RERIC

From P. 13

- Adaptation and Use of CASAMO-CLIM, a Microcomputer Program (L. LEJEMBLE, P. BREJON and D. CAMPANA)
- TECHNICAL NOTE: Basic Algorithms of Simulation of CASAMO-CLIM (Jean-Pierre TRAISNEL and Brahmanand MOHANTY)
- Controlling Heat Gains of Traditional Style Houses in Hot Humid Climates (Truengijai BURANASOMPHOB)
- Design of Air-Conditioning System for Large Buildings (Pibool HUNGSPREUGS)
- Building Design with Energy Factor: Practical Experience (Sumet JUMSAI, Philippe BOUIX and Brahmanand MOHANTY)
- Thermal Energy Analysis in Hospitals and Hotels (Prida WIBULSWAS)
- Fundamentals of Absorption Cycles: Heat Pumps (Jean-Claude MORA and Arshad UL HAQUE)
- Absorption Heat Pumps in Residential Sector (Brahmanand MOHANTY).

An overview of the Fifth Asian School and ten selected papers presented by the participants are also included.

The Proceedings is available from the Regional Energy Resources Information Center (RERIC). The prices are:

Developed countries US$30.00/copy
Developing countries US$22.50/copy.

Order and pre-payment should be made to:

The Director
RERIC/AIT
G.P.O. Box 2754
Bangkok 10501
Thailand.

PUMPING SYSTEM
Photovoltaic Tests and Instrumentation

This handbook by France Lasnier et al. provides a detailed procedure to evaluate the performance of photovoltaic water pumping systems under natural environmental conditions. The publication is available at US$10.00 per copy from:

Dr. France Lasnier
Energy Technology Division
Asian Institute of Technology
G.P.O. Box 2754, Bangkok 10501
Thailand.

Diary of Events

♦ **September 20-23, 1988, Beijing, China**

International Conference on Energy Sources Management and Energy Saving Technology

The conference will include energy conservation, particularly as it relates to heavy and light industry and power plant technology; energy conservation in the building and construction sectors involving air-conditioning and refrigeration; and training and education in energy management.

For more information contact:
Dr. Jayant A. Sathaye
Bldg. 90, Room 3120
Lawrence Berkeley Laboratory
University of California
Berkeley, CA 94720, USA
Tel: (415) 486-6294
Telex: 910-366-2037 LBL BERK
or
Prof. Zhu Ya Jie
President of China Energy Research Society
P.O. Box 902, Beijing
People's Republic of China
Tel: 2017869 Beijing
Telex: 22349 SSTCC CN

♦ **September 29-October 2, 1988, Hull, Canada**

Recovery and Re-Utilization of Waste Biomass

An international conference on food and animal feed, fuels, fabricating materials, fibre/chemical stock, fertilizers and soil conditioners will be held in the Palais des Congrès, Hull, Canada. The conference is sponsored by the Planetary Association for Clean Energy, The World Bank, International Bank for Reconstruction and Development, International Development Association and the International Development Research Centre of Canada.

For more information or to submit a paper contact:
The Planetary Association for Clean Energy, Inc.
191 Promenade du Portage / 600
Hull, Québec J8X 2K6
Canada
Tel: (819)777-9696

♦ **October 18-21, 1988, Atlanta, GA, USA**

11th Annual World Energy Engineering Congress and Conference

The topics of the Congress and Conference are new building control strategies, electricity and natural gas purchasing strategies, and cogeneration project development. The latest products and services for efficiency improvements on combined energy management, lighting, HVAC and cogeneration will be presented.

For more information contact:
Alma McFarland
Tel: (404)447-5083

♦ **October 24-28, 1988, Saarbrücken, West Germany**

Euroforum New Energies

For more details contact:
Conference Organisers
H.S. Stephens and Associates
Agriculture House 55, Goldington Road
Bedford MK 40 3LS
United Kingdom

♦ **October 25-27, 1988, Oslo, Norway**

1st Wokshop on Charcoal Production Technologies

For more details contact:
K. Kocsis
FAO (F.411)
Via delle Terme di Caracalla
00100 Rome
Italy

♦ **October 26-28, 1988, Niza, France**

Conference of the European Wind Energy Association (EWEA)

For more details contact:
Conference - EWEA
European Wind Energy Association
Rutherford Appleton Lab., Chilton
Didcot OX11 OQX
United Kingdom

- **November 13-16, 1988, Tokyo, Japan**

8th International Symposium on Alcohol Fuels

For further details contact:
New Energy Development Organisation
29F Sunshine 60 Building
1-1 Higashi Ikebukuro
3-chrome Toshimaku
Tokyo 170
Japan

- **November 14-19, 1988, Antalya, Turkey**

International Mediterranean Congress on Solar and Other Renewable Energy Resources

This International Congress is sponsored by the Turkish Ministry of Energy and Natural Resources in affiliation with related associations and organizations. Topics of discussion at the technical program include resources assessment, potential and exploration; technologies and developments; applications; economic considerations; policies plans, programs and cooperation; and environmental, social and legal factors. The official languages of the congress are English and Turkish, with simultaneous translations.

For more information contact:
International Mediterranean Energy Congress
Organizing Committee
Toros Sakak, Baris Apt. 33/18
06430 Sihhiye - Ankara
Turkey
Tel: (4)229-47-01

- **November 17-19, 1988, Nanyang Technological Institute, Singapore**

1st Singapore Conference on Industrial Energy Management and Conservation

The conference is organized by the School of Mechanical & Production Engineering, Nanyang Technological Institute, Singapore and co-sponsored by the Institution of Engineers Singapore and the Singapore Manufacturers' Association.

The theme of the conference is "efficient utilization of energy in industries".

The following topics will be discussed:

- Energy conservation in industrial processes,
- Computer applications in industrial energy management,
- Heat pump and refrigeration technology,
- Energy conservation of combustion engines, and
- Waste heat recovery.

Abstracts (300 words) and enquiries should be addressed to :

Dr. Tay Seow Ngie
School of Mechanical & Production Engineering
Nanyang Technological Institute
Nanyang Avenue
Singapore 2263
Telex :RS 38851 NTI
Telegram:SINNTI
Telefax :2641859
Tel: 6605593/6605486

- **November 17-19, 1988, Parkville, Victoria, Australia**

Solar'88

Solar'88, a Conference & Exhibition on Environmental Improvement through Solar Energy, will be held at University of Melbourne, Parkville, Victoria, Australia. The topics of the Conference are energy policy and planning; biomass energy; renewable energy promotion; solar energy research & development and its applications; wind energy.

Two 90 minute workshops will also be provided namely: energy education workshop and solar vehicle workshop.

For more details contact:
Solar'88 Conference Secretariat
c/o Victorian Solar Energy Council
10th Floor, 270 Flinders Street
Melbourne, Victoria 3000
Australia
Tel: (03) 654 4533
Fax: (03) 650 5063

- **November 21-24, 1988, Amsterdam, The Netherlands**

Energy Economy'88

For more details contact:
Energy Conference
RAI Gebouw B.V.
Europaplein 8
NL - 1078 GZ, Amsterdam
The Netherlands

- **November 25-30, 1988, Tripoli, Libya**

Energex'88

Energex'88, an International Energy Conference will be held during 25-30 November, 1988 at Al-Fateh University, Tripoli. Topics of discussion will include oil and gas, solar energy, wind energy and nuclear energy.

For information contact:
Dr. M.A. Muntasser
Chairman of Energex'88
Al-Fateh University
P.O. Box 12348
Tripoli
Libya

- **December 4-6, 1988, Madras, India**

Seminar on Integrated Energy Systems

This Seminar will be held on December 4-6 instead of December 1-3 as mentioned in RERIC News, June 1988.

For more details contact:
Dr. V.M. Krishna Sastri
Scientific Secretary
Regional Centre for Energy Heat and Mass Transfer for Asia and the Pacific
Madras 600 036
India

- **December 12-20, 1988, Madras, India**

Training Workshop on Energy Auditing and Conservation in Buildings

The Training Workshop will be organized by Regional Centre for Energy Heat and Mass Transfer for Asia and the Pacific, Madras, India and sponsored by United Nations Centre for Human Settlements (Habitat), Nairobi, Kenya.

The topics of the Training Workshop will be:

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Diary of Events

From P. 15

- energy conservation potential,
- energy auditing methodologies in buildings,
- energy conservation measures, and
- energy conservation devices and their economics.

For more details contact:
The Scientific Secretary
Regional Centre for Energy Heat and Mass Transfer for Asia and the Pacific
Madras 600 036
India

♦ **January 26-28, 1989, Manila, Philippines**

International Symposium on the Development and Management of Energy Resources

The Symposium will be sponsored by the Philippine Association for the Advancement of Science, Inc. (PhilAAS) in cooperation with the Office of Energy Affairs (OEA), the Industrial Technology Development Institute (ITDI), and Philippine Council for Industry and Energy Research and Development (PCIERD).

For more details contact:
Office of Energy Affairs
Nonconventional Resource Division
PNOC Complex, Merritt Road
Fort Bonifacio, Makati
Metro Manila
Philippines
Tel: 818-8614 (DL), 85-10-21 to 31 (loc. 245, 290 & 291)
Telex: 22259 PNO PH, 63667 PNOC PN

♦ **July 10-13, 1989, Scotland**

European Wind Energy Association's 1989 Conference

The Conference will be held in Scotland instead of France.

For further details contact:
Norman Lipman
Rutherford Appleton Laboratory
108 R63, Chilton, Didcot
Oxfordshire OX11 0QX
United Kingdom
Tel: 44-1-235-21900 Ext. 5302
Telex: 83414 RUTHLB G
Telefax: 44-1-235-446863

♦ **September 4-8, 1989, International Conference Center Kobe, Kobe City, Japan**

ISES Solar World Congress

The 1989 Congress of the International Solar Energy Society (ISES) will be held in Kobe during September 4-8, 1989. The co-sponsors of the Congress are New Energy Development Organization (NEDO) and Foundation for Advancement of International Science (FAIS).

The Congress will cover all aspects of solar energy and renewable energy. The main theme is Clean and Safe Energy Forever. The topics are classified in the following categories:

- Solar photovoltaic materials and devices
- Solar photovoltaic system technology and components
- Advanced technology for the future (superconducting energy storage system using high-temperature SC materials, etc.)
- Solar space heating, cooling and hot water supply systems
- Passive and low energy architecture
- Solar industrial process heat and solar thermal applications
- Biomass and agricultural applications
- Wind, photochemical energy conversion, OTEC and other renewable energy sources
- Heat pump and energy storage
- Socio-economic aspects, policy, standardization and national section reports
- Solar energy for developing countries
- Solar radiation and natural energy resources
- Solar materials

The Congress will consist of invited review sessions and technical sessions (oral sessions and poster sessions). Workshops will be planned in some categories. Deadline for abstract is December 1, 1988.

For more details please contact:
ISES Solar World Congress 1989 Kobe
c/o International Communications, Inc. (ICS)
Kasho Bldg. 2F
2-14-9 Nihombashi, Chuo-ku
Tokyo 103
Japan

The Regional Energy Resources Information Center (RERIC) is one of the four specialized Information Centers of the Library and Regional Documentation Center, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The "RERIC News" is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership along with the other four regular publications namely: RERIC International Energy Journal (formerly: Renewable Energy Review Journal); RERIC Holdings List; Abstracts of AIT Reports and Publications on Energy; and RERIC Membership Directory. For further details contact:

Regional Energy Resources Information Center
Asian Institute of Technology
G.P.O. Box 2754, Bangkok 10501, Thailand
Tel: 5290100-13 Ext. 2873
Telex: 84276 TH
Fax: (66-2) 5290374

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Villagers and visitors at a stand pipe.

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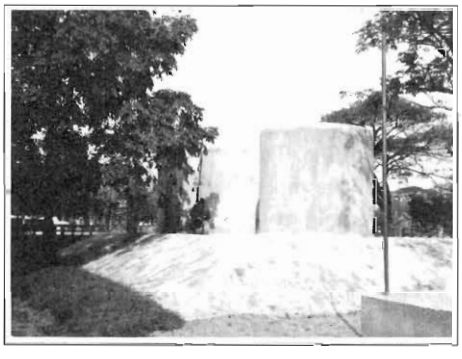
Solar Photovoltaic Pump for Village Water Supply

A solar photovoltaic pumping system was installed in March 1988 in Khon Kaen Province, Thailand by the Department of Health (DOH) and the Thai-Australian Northeast Village Water Resource Project (NEVWRP) as part of the Northeast Rural Water Supply Program. The 630 peak watt system has 14 single crystal silicon modules and was designed to supply drinking water for two neighboring villages, Phra Yuen and Hua Bung, located about 30 km from Khon Kaen. Although both the villages are now supplied by grid electricity, the artesian well itself is located in an unpopulated area about 2 km from Phra Yuen with no electrical supply.



Ferrocement water storage tanks.

This pumping system is suitable for remote locations as it runs on its own and does not need an operator on-site. The submersible multistage centrifugal pump with a 3-phase AC motor automatically starts up in the morning when the irradiation level reaches 100 W/m^2 and switches off at a little below 100 W/m^2, thus averaging about 6 hours of pumping time a day. The initial high investment in the system, due largely to the photovoltaic panels which make up more than 70% of total system cost, is partly off-set by the lack of operation and maintenance cost, unlike a conventional electric or diesel-powered pump. The cost of solar panels is expected to drop to at least US$ 1/W_p from the present cost of US$ 9/W_p which will make such systems cost-effective for rural water supply projects in the future.

The artesian well with the water table located at a depth of 20 m has good quality drinking water though with a limited yield of 12-14 m^3/day. The well is therefore suitable for a small capacity pump designed for supplementary drinking water for a rural community with other traditional water supplies. Drinking and domestic water have traditionally been obtained from household rainwater jars and shallow wells located in the two villages. As these sources dry out or become depleted during a long dry season, the villagers have often had to buy water from neighboring villages at a high price.

The management of the solar pumping

Cont P. 2

wind and sun compendium

Development of wind and solar energy for water pumping

CWD

Consultancy Services
Wind Energy
Developing Countries

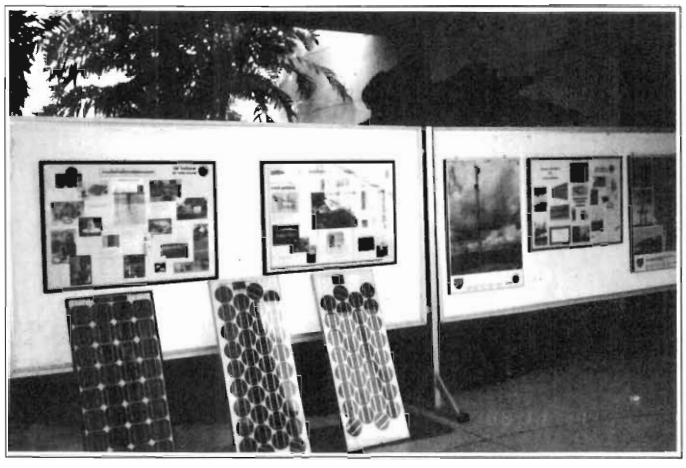
Energy Information Service, CSIRO

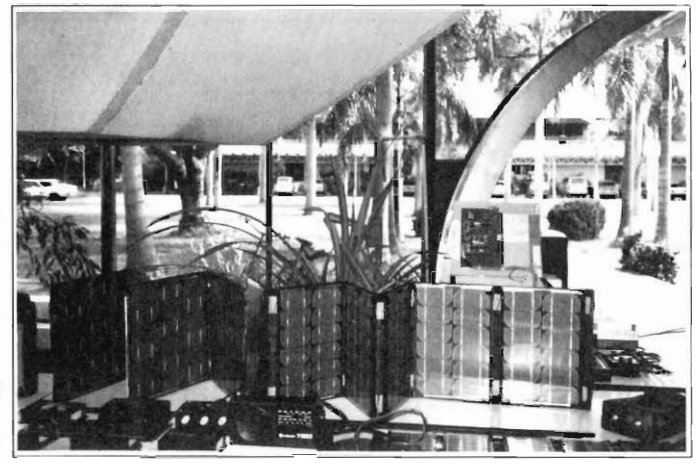
Incorporates news from the Energy Information Service, CSIRO and Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

INNERTAP

Photovoltaic Seminar

The Energy Technology Division of Asian Institute of Technology (AIT) together with BP Thai Solar Corp. Ltd. and the Thai-Australian Water Resource Project jointly organized a seminar for Thai Government officials on the role of photovoltaics in rural development. The seminar was held on 1 November 1988 at the Asian Institute of Technology, Bangkok. This seminar also featured posters of the ongoing and completed projects carried out by the company and an exhibition of photovoltaic products and technology. The main applications featured were for lighting, water pumping, refrigeration, etc., for remote rural areas. The following photographs show some of the exhibited equipments and posters.





Solar Photovoltaic Pump for Village Water Supply

From P. 1

facility designed and installed jointly by DOH and NEVWRP has been put entirely under the management of a village committee. The committee takes charge of the sale and distribution of the piped water stored in 3 ferrocement storage tanks. The water is sold from public stand pipes at a price of 1 baht (≈US$ 0.04) per cartload (120 litres) and revenue collected from the sale is kept for necessary maintenance and repair of the system.

A monitoring program is being conducted for a period of one year to evaluate system performance and assess the suitability of the technology for adaptation in other rural settings. An AIT team headed by Dr. France Lasnier of the Energy Technology Division is responsible for the technical monitoring of the system while the social evaluation is being carried out by social scientists of the Research and Development Institute (RDI) of Khon Kaen University.

The actual daily technical data is recorded by two village committee members from Phra Yuen who are paid minimal salaries to carry out routine care of the facility and to ensure responsible data recording.

The social monitoring program proposes to monitor patterns and changes in water use with change in water supply technology; the effectiveness of the management and distribution system; the appropriateness of the technology to a small rural community and the replicability of the project in other socio-economic settings.

In addition to the daily global monitoring, specific tests are carried out during AIT missions to Phra Yuen to evaluate dynamic performance of the system. During the tests, array voltage, current and temperature; irradiation; motor current, voltage and speed; total head; and flow rate are recorded at 5 second intervals using a Cambel datalogger.

Photovoltaic pumping system at Phra Yuen Village, Khon Kaen.

The water pumped by the system during the wet season has so far averaged about 13.5 m^3/day with a maximum recorded amount being 21 m^3/day while the average water consumption was found to be 8.8 m^3/day. The storage of rainwater practiced by nearly all rural households satisfies much of the drinking and domestic water needs which results in reduced consumption of well water during the rainy season. Other ways of productively using the pumped water in times of excess supply, possibly as a means of supplementary income for the villagers are being studied.

The pilot project has so far been successful in supplying more than an adequate amount of water to the community during the wet season. Whether this solar pump would be able to provide enough drinking water during crucial dry months when water supplied from other sources become scarce, is still to be seen.

AIT - GTZ Biocoal Project

Biocoal, which is charcoal produced from organic wastes, presents tremendous potential as a substitute for wood-derived charcoal. However, biocoal, until recently, has been the subject of minimal research and development activity.

These considerations are central to a biocoal project being carried out by Asian Institute of Technology (AIT), under the sponsorship of the German Agency for Technical Cooperation (GTZ). The project concerns the production of biocoal from agricultural and forestry residues.

Most of the project activities have been carried out since August 1987. Some important achievements of the project so far are presented in the following reports :

A Report of the State-of-the-Art for Biocoal Technology

This report consists of a review of the technological aspects of biocoal i.e., technology and raw material options for biocoal production, biomass densification, charcoal briquetting and pyrolysis, along with a review of industrial biocoal making including techno-economic data on some existing commercial ventures and a review of R & D activities currently being carried out by various institutes.

A Report of Biocoal Technology : A Comparison of Options and Recommendations

This report contains the comparative study of two technological routes for production of biocoal :

(i) Briquetting-Carbonization Option, and

(ii) Carbonization-Briquetting Option.

Briquetting-carbonization technology generally gives a high density product of large size and variable quality. The process gives a higher yield of biocoal compared to carbonization-briquetting option. Proven hardware for small-scale biocoal production is also available for this technology.

The main advantage of carbonization-briquetting technology is its ability to produce a product of uniform quality, less environmental pollution and lower electricity requirement.

This report also points out the major shortcomings of briquetting-carbonization process and recommendations for overcoming these.

A Report of Economics of Biocoal Production in Thailand

This report presents the financial analysis of biocoal making and sensitivity analysis of existing biocoal technology in Thailand. The basic objective of the economic evaluation is to determine the present economic returns at the existing sales price of biocoal in the market and also the effects of variations in the capital and operating cost as well as variations in the sales price of biocoal on the plant's financial returns. The market sales price, will of course, have a considerable influence on the outcome of efforts to promote biocoal as an alternative clean fuel for domestic and industrial use. A low price would facilitate market penetration yet at the same time the sales price has to be high enough to yield an adequate return on the capital investment.

A Report of Test Run of a Biocoal Kiln in Thailand

This report presents the result of a test run of a biocoal kiln. The objective of this study was to carry out a mass and energy balance for one run of kiln of Kit Wattana Import-Export biocoal plant. The plant has six brick beehive kilns each of 8 cubic metres capacity (Fig. 1). Sawdust briquettes are bought from a local briquetting plant.

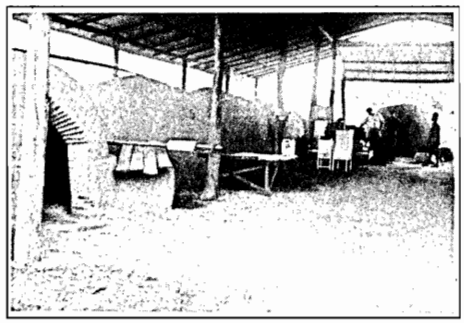


Fig. 1. The beehive kilns, each of 8 m³ capacity, at Kit Wattana Import-Export biocoal plant.

A Report of Cost and Availability of Selected Residues in Thailand

An assessment of biocoal technology calls for an estimation of the availability of suitable raw materials. This report presents the annual generation of nine agricultural residues i.e., paddy husk, paddy straw, sawdust, bagasse, cotton stalk, corn cob, groundnut shell, cassava stalk, coconut husk and shell, and one forestry residue, sawdust, in different agro-economic zones and regions of Thailand along with the local cost of each residue.

Of the ten residues studied, the largest amount of residue production comes from paddy straw. Five residues i.e., bagasse, cotton stalk, corn cob, groundnut shell and cassava stalk are costlier than the rest. The cost of these five residues are higher by 150 to above 200% when compared to the other residues. The observations on traditional uses for different residues have also been presented in the report.

A Report of Market Opportunities and Requirements in Thailand

This report presents the results of a study of biocoal market opportunities and requirements. The report involves a profile of the biocoal industry in Thailand, a survey of rice husk and sawdust briquettes in Thailand, market opportunities and requirements of biocoal, identification of the existing and potential uncarbonized briquette and biocoal users in addition to economics of traditional fuel substitution.

Most of the results presented in this report were obtained through M. Eng. research work of Mr. Prasong Wongvicha under the supervision of Dr. S. C. Bhattacharya and Dr. Ram M. Shrestha.

The major remaining activities of the project are:

1. Characterization of major residues based on their physical properties, availability and cost.
2. Laboratory scale pyrolysis of residues.
3. Organization of an international workshop on biocoal technology.

For further details about the AIT-GTZ Biocoal Project please contact: Dr. S.C. Bhattacharya, Energy Technology Division, Asian Institute of Technology, G.P.O. Box 2754, Bangkok 10501, Thailand.

Biocoal Utilization in Thailand

Charcoal produced from wood is a popular household fuel in Thailand. With the increase in population and high economic growth, the demand of charcoal is going to rise which in turn will increase pressure on limited forest stocks. A search for an alternative fuel to substitute for charcoal is therefore very appropriate. Biocoal, which is charcoal produced from organic wastes, such as agricultural wastes and forest residues, is one of the likely options to replace wood based charcoal.

The biocoal industry has been in existence in Thailand since 1982. Presently, there are three commercial biocoal plants in Thailand, two of them are in Ayuttaya Province and the other one is in Chiang Mai Province. At present, most of their products are exported to Korea, Hong Kong and Taiwan. Biocoal, in excess of export, is sold locally through middlemen and department stores.

Biocoal making is a well-defined process in Thailand. It consists of two steps : briquetting of biomass and carbonization of briquettes. Generally, the briquetting machines used are extrusion type devices which use a screw to force feedstock into a heated die forming large hollow cylindrical logs having an outside diameter of about 5 cm and inside diameter of 2.5 cm, length of about 50 cm, and average weight of 1.3 kg. The output of such machines is about 100 kg/hr. A cross-sectional view of an extrusion type briquetting machine is shown in Fig. 1.

Rice husk and sawdust are two popular biomass residues used for briquetting. Presently, 9 machines use rice husk and 44 machines use sawdust as their feedstock. The uncarbonized briquettes are sold through middlemen to refugee camps, temples, and biocoal producers. The briquettes are carbonized in metal or brick kilns to produce biocoal.

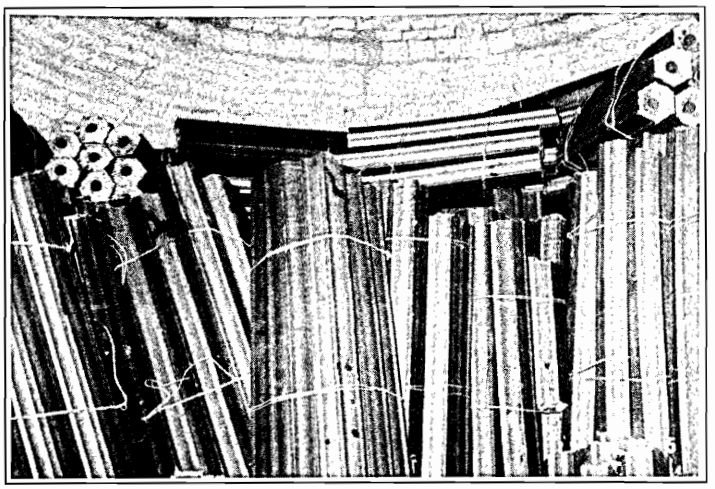


Fig. 2. Uncarbonized briquettes.

Biocoal packed in plastic bags weighing 2.5 kg is sold in local markets at a price ranging from 10-13 baht/bag (≈US$0.5). Biocoal, sold at the six Central Department Stores in Bangkok, is packed in kraft paper boxes and priced at 18 baht/kg (≈US$0.7). Biocoal for export is also packed in kraft paper boxes and weighs 12 kg. In this study, it was revealed that most of the biocoal used was for cooking. Further more it was also found that the majority of consumers were food vendors. The cost of biocoal was cheaper compared to charcoal purchased in small quantities. Despite cost advantages of wood charcoal purchased in large quantities and LPG, food vendors preferred biocoal available in small bags as it was easier to transport in their food vending carts. Moreover, the preference was due to some other advantages of using biocoal, such as, uniformity in size, strong and steady fire generated by biocoal, non-sparking fire, no variation in properties, low smoke generation, low content of ash, longer lasting fire, etc. One of its defects is its difficulty to ignite.

At present, the use of biocoal is not significant. But due to its properties, it has proved to be a close substitute for wood based charcoal. In addition to its household use, it has a high potential for use in industries, especially those using charcoal, which include blacksmithy, foundry, iron smelting, forging, etc.

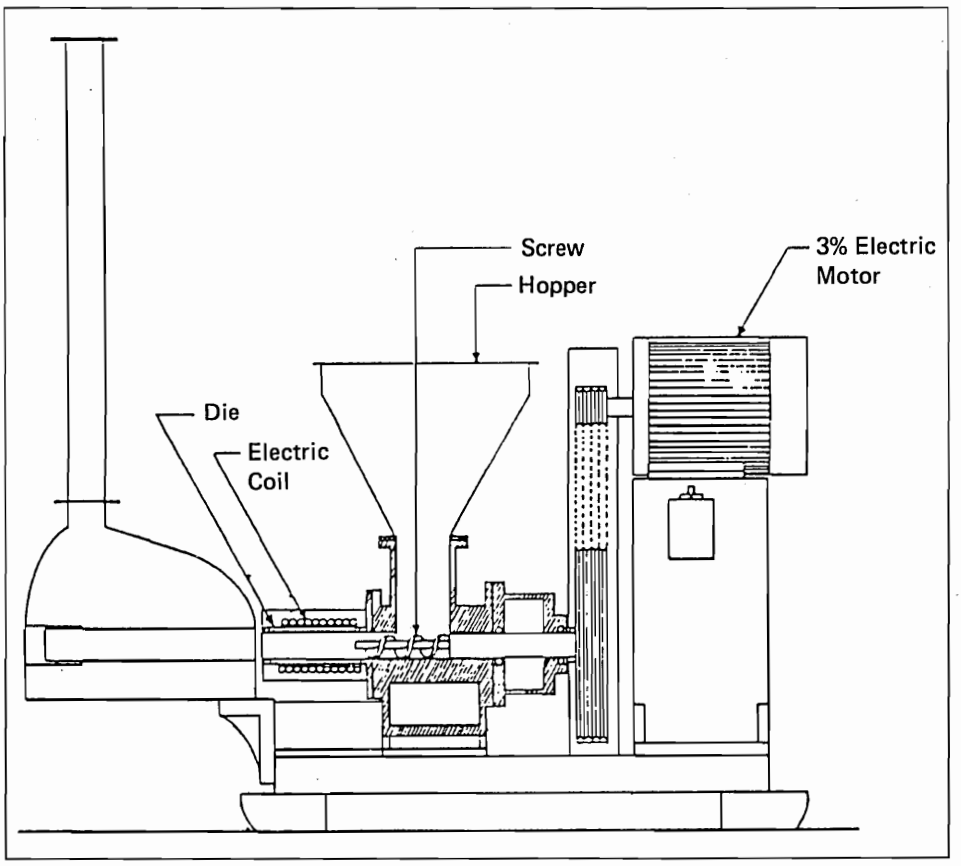


Fig. 1. Cross-sectional view of the extrusion type densification machine.

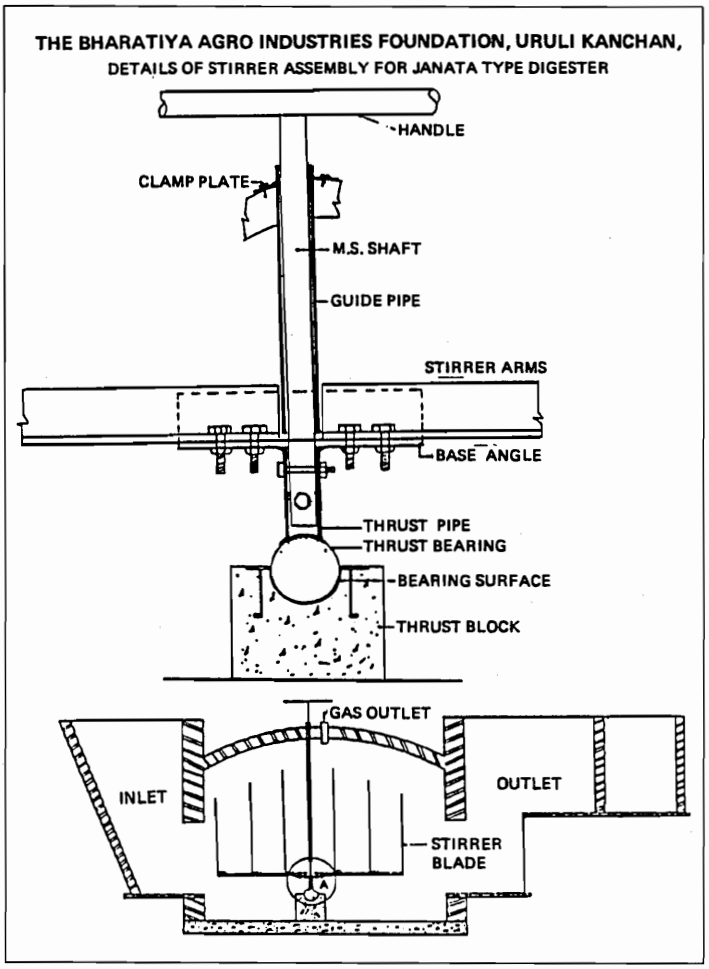
(Source : Extracted from *Biocoal : A Report on Market Opportunities and Requirements in Thailand* (Draft Report). AIT-GTZ Biocoal Project being conducted by Division of Energy Technology, Asian Institute of Technology (AIT), Bangkok, 1988.)

Field Trials on Utilization of Agricultural Wastes for Biogas Production - India

A two-year study on utilization of agricultural wastes for biogas production was undertaken by the Bharatiya Agro-Industries Foundation (BAIF), Pune, India. The study was conducted at BAIF's Central Research Station at Urulikanchan near Poona and was sponsored by the Department of Non-Conventional Energy Sources (DNES), Government of India.

Pilot scale studies were conducted in two types of plants : a) floating drum (KVIC) model, and b) fixed dome (Janata model). Two plants of each type (digester volumes 4.75 m^3 and 5.6 m^3 respectively) were constructed. A stirring mechanism was developed and installed on the fixed dome plants (Fig. 1). Substrates used were Palas extractions (a non-edible oilseed meal), sugar cane trash and sunflower stalks mixed with cattle dung. Promising results were obtained which indicated increased gas production ranging from 15% to 80%. Guidelines for using these substrates for biogas production have been prepared. Details of the study and experimental results are available in a research report entitled" Field Trials on Utilisation of Agricultural Wastes for Biogas Production" by G. G. Sohani and A. L. Joshi.

The report is available from Bharatiya Agro-Industries Foundation, Urulikanchan, Kamdhenu; Senapati Bapat Marg, Pune 411016, India.



Rice Hull Fuels 2.1 MW Power Plant - Philippines

A rice hull-fired power plant of 2.1 MW capacity, of the National Food Authority (NFA), is now in operation in Jaro, Iloilo, the Philippines.

Generating 2.1 MW of electricity, the Iloilo NFA plant supplies the power requirements of milling operations and all buildings and facilities at the NFA regional office compound. It also sells excess electricity to the local electric cooperative.

The Iloilo rice hull-fueled power plant was proposed in 1982 to utilize the waste material of NFA milling, according to Engr. Nemesio Peneda, Head of the Facility Installment and Maintenance Division of the NFA Technical Services Directorate. Designed and built by the British firm Northern Engineering Industries Projects (NEIP) Ltd., the plant was turned over to NFA in August 1986 after test-runs and revisions. For 12 months it was operated by local personnel until an acceptance test was run September to October 1987 by NEIP engineers. The plant was accepted by NFA in March 1988.

The plant burns about three tons of rice hull per hour to give a gross output of two megawatts. Rice hull comes from the nearby NFA mill and private mills in the area, which are received in a husk storage building or a hopper.

The hopper is made of mild steel and has a rotary valve and a fan to blow rice hull into a cyclonic combustor. Inside this combustor are three burners which burn diesel fuel to start up operations.

The NFA combustor is lined with brick to be able to absorb heat as high as 1080°C, the temperature at which it must be maintained. At 740°C the rice hull is gradually introduced to the combustor. As the temperature goes up, more hull is allowed even as the burners are switched off one by one. The plant is run purely by rice hull when the temperature is above 900°C.

At the bottom of the combustor, ash falls down to a Redler chain conveyor where it is collected. Hot flue gas goes through a duct into a super-heater and boiler where steam is generated at a temperature of 330°C and a pressure of 210 pounds per square inch gauge.

This superheated steam drives a multistage condensing turbine which has its own impeller blades. The turbine is coupled to an electric generator in turn. The spent steam is condensed and pumped back to the boiler.

From the boiler, the flue gas passes through a grit arrestor which eliminates fly ash to control pollution. It then goes through the economizer. Here, its residual heat is absorbed by feed-water. The gas next passes through the boiler and exits through the chimney.

Without considering depreciation, the unit cost of energy from the hull-fueled plant is 0.68 peso per kWh (≈US$ 0.032 per kWh). This is at an average gross output of 1.330 MW. When this is increased to 1.736 MW, the unit cost goes down to 0.49 peso per kWh (≈US$ 0.023) for a profit margin of 0.37 peso per kWh (≈US$ 0.017).

(Source : Rice Hull Fuels 2.1 MW Power Plant, *Energy Alternatives*, Quarterly Newsletter of NCRD, Office of Energy Affairs, the Philippines, Vol. IV, No.2, April - June 1988, p.2)

Geothermal Energy Projects - Thailand

A number of geothermal energy projects have been conducted in the North of Thailand by the Faculty of Engineering and the Faculty of Science, Chiang Mai University, in cooperation with a number of government organizations, namely the Electricity Generating Authority of Thailand (EGAT) and Thailand Department of Mineral Resources, and with some foreign agencies such as the French Bureau de Recherches Géologigues et Minères and Geowatt, France.

Some of these geothermal projects are as follows :

Development of San Kamphaeng Geothermal Energy Project

San Kamphaeng geothermal field is located in the northeastern part of Chiang Mai city. Systematic studies to assess its energy resources started in late 1977, with the cooperation of personnel from the Thailand Department of Mineral Resources, Chiang Mai University, and Electricity Generating Authority of Thailand (EGAT).

San Kamphaeng Geothermal Field has been selected as a case study for an exploration drilling programme. The first geothermal exploration well in Thailand, GTE-1, was commenced at the end of 1981. Up to the present time, six geothermal exploration

Improved Stoves in China

Like other developing countries, biomass energy is the main source of energy for cooking and also for heating during the cold winter season in rural China. During the year 1987 , 270 million tons of straw and 276 million tons of firewood were directly consumed. Prior to the introduction of improved stoves in China, most households used old-fashioned wood stoves having a thermal efficiency of less than 10%. This led to massive deforestation and the forest coverage of the country has dwindled to 12% and to only 3.4% in Jiangsu Province. To alleviate the shortage of fuelwood, to improve cooking conditions, and to shorten cooking time, improved stoves were introduced in China in the year 1982. By the end of 1987, 80 million households in the countryside, or 45% of the nation's total, were using efficient energy-saving stoves.

The old-fashioned stoves used by the peasants (Fig. 1) had a thermal efficiency of only 10 to 12%. The combustion chamber

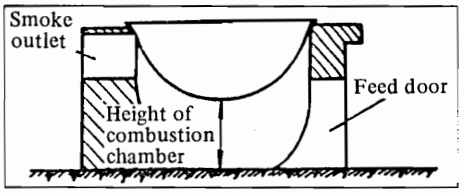


Fig. 1. The old type stove.

and stove part of this stove are big and the stove does not have any chimney. Therefore, during the research and development work, special attention was paid to improving the combustion chamber and firebox structure which affected the thermal efficiency. The improved stove (Fig 2) is equipped with a grate and chimney. The

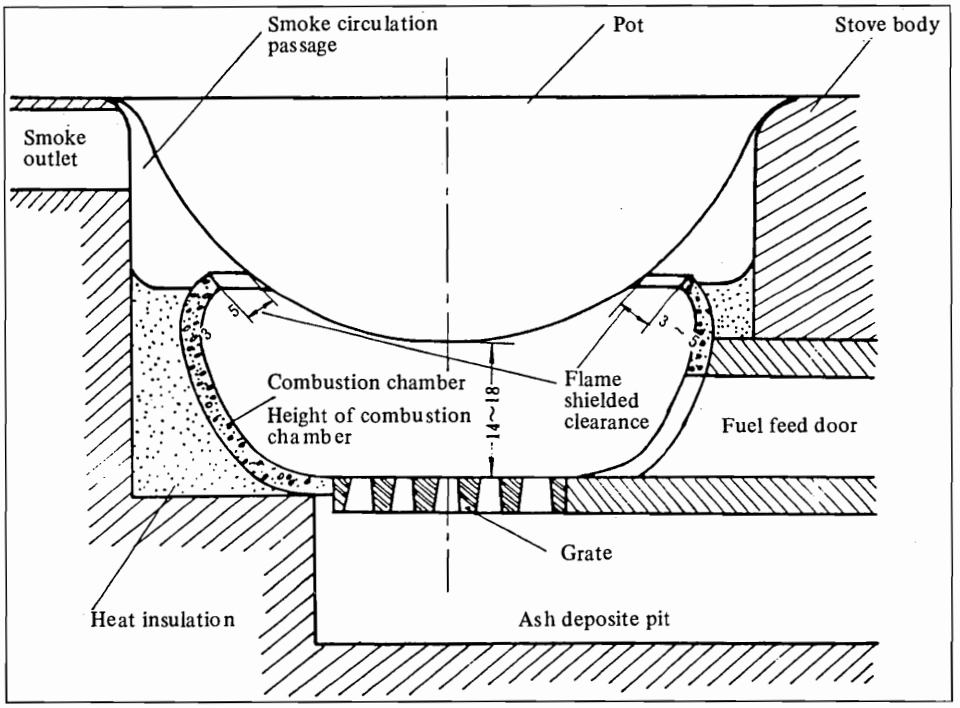


Fig. 2. The structure of the energy-efficient stove.

thermal efficiency of the improved stove is in the range of 25 to 30%, or twice as high as the old-fashioned one. In addition to the advantage of firewood saving, this stove is easy to operate, burns better, shortens cooking time and can be easily kept clean and tidy. A view of the assembled firewood saving stove is shown in Fig. 3. One of the features of this stove is that it can be made locally using brick and grate. It can also be made of cast iron. These stoves have been well received by the peasants. It has been targeted that 90% of the peasant households should use such stoves by the end of year 1990.

(Extracted from : Liang Baofen and Gu Shuhua (1988), Popularization of Firewood/Coal-saving Stoves and Energy Conservation. In : *Proceedings International Conference on Energy Sources Management and Energy Saving Technology*, Zhu Yajie (Ed.), 20-23 September 1988, Beijing, China.)

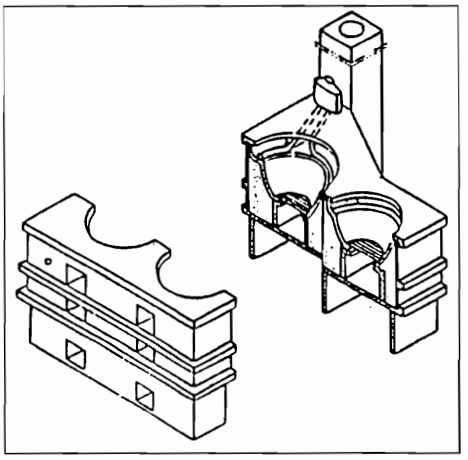


Fig. 3. The overall assembled firewood-saving stove.

wells, GTE-1 to GTE-6, with an average maximum depth of 500 m, have been drilled. Two wells encountered hot water while the rest are dry. GTE-2 is now discharging hot water at 85°C with a very small discharge. GTE-6 encountered hot water of 120°C at the depth of 489 m and is now discharging hot water of 104°C, 3.6 bar pressure and approximately 4 litres/sec at the well head. A number of shallow wells, less than 50 m depth, were drilled in the thermal manifestation area and where a resistivity survey showed relatively low values at shallow depth, suggesting possible zones of thermal water accumulation. Five shallow wells encountered hot water with temperatures ranging from 100-130°C. A reservoir model of San Kamphaeng geothermal system was proposed. Under the joint technical programme between the governments of Thailand and Japan, a deep exploration well, to the depth of at least 1,500 m, was commenced in 1984.

Further details about the San Kamphaeng Geothermal Energy Project are available in "Development of San Kamphaeng Geothermal Energy Project, Thailand", GEOSEA V Proceedings, Vol. I Geol. Soc. Malaysia, Bulletin 19, April 1986, pp. 627-641.

Fang 300 kW Geothermal Power Plant Demonstration Project

A feasibility study of geothermal power resources in Fang District of Chiang Mai was conducted during 1981-1984 by the Electricity Generating Authority of Thailand (EGAT) in cooperation with the French Bureau de Recherches Géologigues et Minères (BRGM) and Geowatt, France. It was found that a binary-cycle geothermal power plant of 120 kW for demonstration purposes could be developed.

An exploration drilling programme was conducted by EGAT and AFME (Agence Française pour la Maîtrise de l'Energie) in 1985. It was found that a binary-cycle geothermal powerplant of 300 kW could be developed using the FGTE-14 and FGTE-15 geothermal wells in Fang District. The total discharge rate of the two wells is 22 litres/sec with an average temperature of 117°C, 1 bar pressure.

The demonstration power plant is now being constructed and is expected to be operated in 1989.

A Cool Storage for Onions and Potatoes Using Geothermal Hot Water

The objective of this project is to develop a cool storage using geothermal hot water as a heat source for an absorption refrigeration system to store onions and potatoes.

Onions, after harvesting, can be stored at room temperature up to 4 months and a loss of about 35% due to sprouting is anticipated. In the case of potatoes, storage at room temperature is possible for up to 2 months before sprouting occurs. However, onions and potatoes can be stored at 4°C for more than 6 months. Currently, part of the onion and potato harvest in Chiang Mai is transported to Bangkok for the cool storage. Electricity cost for a conventional refrigerator amounts to approximately 1 baht/kg per month (≈US$ 0.04). This affects the high selling price of onions and potatoes during the off-season. Furthermore, due to the limited cool storage and the cost of electricity, Thailand has to import a large amount of onions and potatoes annually.

The Fang Geothermal Multi-purpose Project, with the collaboration of Chiang Mai University, Electricity Generating Authority of Thailand (EGAT) and Department of Agriculture, aims to build a geothermal power plant and utilize hot water from the plant for agricultural applications, especially cool storage by an absorption refrigeration system. With the existing flow rate of hot water, approximately 10 cool storage rooms with a loading capacity of more than 1000 tons is anticipated. Since the absorption refrigeration system requires much less electricity, there is a great potential for the private sector to implement the cool storage using geothermal hot water for cool storage of onion and potatoes.

In this project a prototype 10 m x 10m x 2.5 m cool storage using geothermal hot water as a heat source for the absorption refrigeration system is being designed and constructed. Onions and potatoes will be pretreated and kept in the cool storage. Qualities of the stored products will be periodically checked and analyzed. The performance of the system will be evaluated for further improvement. Final design drawings will be documented for the private sector.

(Source: Information provided by Faculty of Engineering and Faculty of Science, Chiang Mai University).

Industrial Energy Conservation in Thailand

Energy Consumption in Thai Industry

In 1986, energy consumption in industry in the form of oil, electricity and natural gas was 1,676; 1,007 and 101 MMLCOE respectively. Other fuels used were coal and agricultural wastes, i.e. firewood, sugarcane waste and paddy husk equivalent to 3,400 MMLCOE. Therefore, total energy consumption of industry was 6,184 MMLCOE or 27% of national energy consumption. The rate of energy consumption in industry compared to production was about 28 litres of crude oil to Baht 10,000 of production, a decrease from 1985 which was 29 litres of crude oil to Baht 10,000 of production. The consumption of energy in industry increased at a rate of about 4.3% per year.

The Sixth Five-Year National Economic and Social Development (NESD) Plan has set the target of increased economic growth by about 5% per annum with a rate of expansion of GDP in industry of 6.6% per year. One factor which caused a decrease in industrial growth was the increase in energy cost. On average the cost of production has increased. Therefore, one of the major targets is to support improvements in industrial efficiency, especially efficiency in energy consumption in order to reduce energy expenses and the cost of production.

There are at present about 45,000 legally registered factories in Thailand and only about 8,000 factories out of the total consume 90% of the energy in the industrial sector. These factories are, according to the Thai Standard Industrial Classification (TSIC), divided into 9 categories, i.e. food/beverage, textiles, wood products, paper, chemicals, nonmetallic minerals, basic metals, fabricated metals and others.

As a result of a series of energy audits of Thai industry conducted by and for the National Energy Administration (NEA), the average energy intensities of each of the above 9 categories were determined.

Group 1 : Energy intensities higher than the Thai average.

Group 2 : Energy intensities below the Thai average but higher than the combined Thai/World average.

Group 3 : Energy intensities below

Cont. P. 8

Industrial Energy Conservation in Thailand

From P. 7

the Thai/World average but higher than the World average.

Taking sample results of the 300 energy audits in the 8,000 factories for proportion distribution into the above 3 groups, it was estimated that the percentages of Group 1, Group 2 and Group 3 are 50%, 24% and 26% respectively.

Energy Conservation Situation

Thailand's energy conservation programme was first introduced as part of the Energy Development Plan in the Fifth NESD Plan (1982-1986) and a second conservation programme has already been prepared for the Sixth Plan. The first programme mainly concentrated on the industrial sector, while the second programme, although a continuation in part of the first one, is more extensive and covers transportation and commercial/service buildings. The on-going activities and plans for energy conservation can be summarized as follows:

Energy Conservation Unit

As recommended in the Fifth Five-Year Plan, a governmental Energy Conservation Unit was set up within the National Energy Administration (NEA) to provide factories with free-of-charge services for the examination and analysis of the potential for energy conservation, the determination of the amount of investment required and the amount of savings which could be made. For this service, two energy auditing teams with measuring equipment and technical advisors have been visiting factories on a request basis to investigate energy utilization and to recommend ways and means to conserve energy. Since 1982 to the present 285 factories have used the service, with a combined potential to conserve fuel oil as much as 63.15 MMLCOE and electricity as much as 279.15 million kilowatt hours annually, amounting to a saving of 681.18 million baht.

Moreover, the Government and private enterprises have held meetings, seminars and exhibitions and trained factory managers, engineers and technicians of industrial plants and increased the knowledge of those concerned by preparing documents giving recommendations on energy conservation. Information for distribution to factories and individuals concerned with energy conservation has also been prepared. Three training courses on energy conservation, i.e. Energy Management, Thermal Energy Saving and Electrical Energy Saving, have regularly been conducted at the Energy Training Center of NEA since 1983. Up until now, more than 1,000 persons from both government and private sectors have enrolled in these courses.

Energy Conservation Information Service

NEA has distributed technical information to all industries, academics, governmental offices, the private sector and other interested persons: about 50,000 items have been distributed. The following technical information booklets have been produced:

- Electricity Saving in the Home,
- Electricity Saving in Industries,
- Power Factor Improvement,
- Economic Use of Oil Fired Boiler,
- Energy Utilization and Conservation,
- Evolution of Energy,
- Condensate and Flash Steam Utilization,
- Steam Trap,
- Factory Energy Management,
- Energy Saving in the Buildings, and
- Energy Saving in Industries (pamphlet).

NEA also publicizes information about progress in the energy field and successful energy technology, both foreign and domestic, through the bi-monthly "Energy Conservation News".

Establishment of an Energy Conservation Center of Thailand (ECCT)

The Energy Conservation Center of Thailand (ECCT), managed by the private sector under the NEA's supervision, has been established and has been operating since the beginning of the Sixth Five-Year Plan. The drafting of Energy Management Law, to support the establishment of the ECCT and to promote and strengthen other efficient energy activities, has been completed and submitted by NEA to the government for a decision.

Fiscal and Financial Incentives for Energy Conservation

Reduction of Import Duty on Machinery, Materials and Equipment for Energy Saving

The Ministry of Finance has reduced import duties on machinery, materials and equipment for energy saving from 30% to only 10% as a fiscal incentive for investment. Since December 1983, there have been requests for 154 items from 104 factories for this incentive, and 64 items of 31 pieces of energy conservation equipment from 48 factories have been approved. The total amount of duty reduced by the state was 57.1 million baht with the total investment of 571.4 million baht, conserving energy equivalent to 216.67 million baht. Some of the approved equipment are: lignite fired boiler; developing steamer; DC converter SCR drive for DC motor; high efficiency chiller; automatic combustion controller; economiser; and ceramic fibre insulator.

Energy Conservation Demonstration Programme

This programme aims at encouraging implementation of energy conservation technologies in industries. As an example to encourage widespread adoption of technologies which lead to the efficient use of energy in other factories, NEA has provided loans to selected factories at an interest rate of 10% per annum since 1984. Until now eight factories have applied for this financial incentive amounting to over 6 million baht with estimated conservation of 7.84 million litres of fuel oil and 0.85 million kilowatt hour of electricity annually. Details of energy conservation measures in this programmes are shown in Table 1. Moreover, NEA has received approval from the Cabinet in October 1986, to expand the scope of this programme to include other types of energy conservation such as energy substitution by domestic energy sources, energy conservation in commercial buildings and production of high energy efficiency equipment and NEA is also in the process of considering the reduction of interest rate to below 10%. In addition, the Industrial Finance Corporation of Thailand

Table 1. NEA's Demonstration Projects.

Type	Energy conservation measures	Estimated annual energy saving	Money saving (Baht/year)
Food	Process improvement and increasing efficiency by installing Ogden pump, pressure reducing valve, pressure and temperature controller	oil 756,000 l	3,229,000
Paper	Reduce waste energy by improvement of steam pipes, pressure adjusting valve, steam trap, electric system and insulation of equipment	oil 174,000 l	783,000
Food	Improvement by using CO from fuelwood instead of oil	oil 317,000 l	1,296,000
Paper	Using lignite in producing steam instead of oil	oil 187,000 l	764,000
Fabricated metals	Using LPG instead of electricity	electricity 575,000 kWh	1,000,000
Textile	Fuel oil substituted by fuel wood in producing steam	oil 72,000 l; electricity 271,000 kWh	693,000
Food	Improvement by using CO gas from fuelwood	oil 2,880,000 l	8,064,000
Paper	Using lignite in producing steam instead of oil	oil 3,456,000 l	8,999,000
Total		oil 7,842,000 l; electricity 846,000 kWh	24,828,000

(IFCT) also has a loan programme for modifications leading to energy conservation at an interest rate below that of other financial institutes.

Efficient Electricity Consumption in Industry

The Government has also provided the incentive for efficient use of electricity, with the grant of a bonus to factories operating at a power factor greater than 0.85, and will impose a higher tariff for those having power factor below 0.85. The measures have been enforced since December 1985.

Technical Potential for Energy Savings in Industrial Sector

A study on the technical potential for energy savings that NEA completed in collaboration with an expert team from Hagler Bailly & Company recommended that technical potential will be achieved by implementing three types of measures:

Type 1 - Housekeeping, the potential saving is 517.5 MMLCOE, or 8.14% of fuel consumption in industry in 1986.

Type 2 - Process improvement, the potential saving is 716 MMLCOE, or 11.26% of fuel consumption in industry in 1986.

Type 3 - Major equipment changes, the potential saving is 288 MMLCOE, or 4.53% of fuel consumption in industry in 1986.

The total potential saving of these three types of measures is 1,521.5 MMLCOE, which represents 23.9% of total fuel consumption in industry in 1986, equivalent to the money savings of 4,306 million baht.

Further Implementation Plans

In order to achieve the energy targets of the Sixth Five-Year Plan, the following principal activities have been identified for inplementation :

Energy Auditing

This activity should be conducted regularly in every factory. The government may assist medium- and small-scale factories by offering financial support or by providing a free service, including staff training to conduct this activity.

Training

Energy conservation training courses and technical seminars, at different levels such as basic knowledge, project evaluation, specific technology and advanced technology, will be conducted for different personnel levels, i.e. executives, energy managers, energy auditors, consulting engineers, and training staff.

Energy Conservation Demonstration

Demonstration projects will be selected from those projects arising from the energy audits as well as from those proposed by the factories themselves.

Public Ralations

This activity will include distribution of energy news, technical information, energy conservation competitions, movies, stickers, energy conservation project contests and an Energy Day event. These can be operated continuously for several years.

Assignment of Incentives for Energy Conservation Investment

The assigned incentives will include financial support, leasing of energy conservation and auditing equipment, improvement of import duty exemption criteria for energy conservation equipment and the study on other appropriate incentives.

Other Supporting Activities

A law approving the establishment of the Energy Conservation Institution of Thailand will be proposed in order to change the status of ECCT to be a legal corporation and enable it to undertake its tasks freely. Moreover an Energy Management Law will also be proposed. Another activity concerns with a study on the potential for energy conservation in industry.

(Source: Industrial Energy Conservation in Thailand, P. Teetakeaw, National Energy Administration, Thailand, paper presented at the *ASEAN-EC Energy Conservation Seminar in Industries, Buildings and Transportation*, 14-18 December 1987, Bangkok, Thailand.)

New Directions for A. I. D. Renewable Energy Activities

A final report on New Directions for A.I.D. Renewable Energy Activities has been brought out by the Office of Energy, Bureau for Science and Technology, U. S. Agency for International Development (A. I. D.) in February 1988.

Overview

This report responds to the A. I. D. Administrator's call for a critical reassessment of the Agency's experience with renewable energy technology in the light of lower and unstable world oil prices, declining fuelwood resources, and the present commercial status of various renewable technologies. General lessons learned in developing and applying renewable technology are also described, as well as priority applications and the appropriate role of the private sector. The report then sets out the proposed "New Directions" for A.I.D. renewable energy activities.

A.I.D.'s focus is on self-sustained economic development. Rural and agricultural development are essential prerequisites to achieving overall economic growth, and special attention is needed to address the energy requirements.

This report shows that while new renewable energy technologies have not had the far-reaching impact many had hoped in contributing to rural development, specific renewable technologies have demonstrated that they have a valuable role to play. A number of renewable energy technologies are now becoming economically and financially attractive in developing countries. Commercialization of these technologies offers considerable economic benefit to developing countries.

A major finding of this reassessment is that, to mount successful renewable projects, A. I. D. should rely on market forces to select which technology is best for which development application. This represents a significant shift away from past experience, which was too often technology driven and where governments played a large role in renewable energy technology selection and

Design Tools for Building Energy Conservation in Singapore

Office and commercial buildings account for an estimated 25% of the total electrical energy consumed in Singapore. This represents an electrical energy cost of about S$300 million per year and energy cost savings of S$30 million per year for every 10% reduction in energy use. From an energy study conducted by the Public Utilities Board between 1982 and 1985, it was found that, of the total energy consumed by air-conditioned buildings, refrigeration and ventilation equipment accounted for about 50%. The remaining half was shared by lights (about 30%), and miscellaneous equipment and electrical appliances (about 20%). This distribution of energy use is generally true for all present-day commercial buildings except for some hotels, where air-conditioning may account for up to 60% of the total.

Undoubtedly, major energy-saving opportunities in buildings lie in the use of energy-efficient refrigeration and heat recovery equipment, and the proper selection of air-conditioning systems and control strategies.

Computer Aided Building Design

In recent years, several computer codes of varying complexity and accuracy have been developed to model the energy interactions of a building due to systems, plants and weather conditions. These codes are capable of making hour-by-hour computations, thus allowing the dynamic behaviour of a building to be simulated over an entire year.

At the Department of Mechanical and Production Engineering, National University of Singapore, two such codes, BUNYIP and DOE-2, are currently used for the energy analysis of buildings. BUNYIP, the acronym for Building Energy Investigation Package, was developed at the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia. The program is capable of providing energy performance information of a building from a set of input data on the building description, occupancy and operating schedules, and specifications of space conditions, systems, and plants. The computer calculations, proceed from estimating the energy demand of secondary systems to the energy supply required from primary equipment.

The DOE-2 computer code was commissioned by the U. S. Department of Energy and developed at the Lawrence Berkeley Laboratory of the University of California. The DOE-2 program can calculate the performance and response of a building whose description has been provided by the user. The computer analysis proceeds by first calculating the building and systems loads and, subsequently, determining the energy requirements of primary equipment. The two computer codes model the heat transfer processes of a building differently. While DOE-2 utilizes the transfer function method, BUNYIP uses the finite-difference technique. Another major difference lies in the hour-by-hour computations of the annual energy performance. DOE-2 computes through 8760 hours of a year using a whole year's weather data while BUNYIP executes the computations for pre-selected "characteristic days" of the year. In this respect, BUNYIP is capable of saving much computation time but it requires great care in preparing the reduced weather data set. A final major difference between the two codes relates to the choice of air-conditioning systems. DOE-2 users may specify from a host of pre-programmed systems with associated control options. On the other hand, BUNYIP allows users to build air-conditioning systems component by component and specify the required control strategies.

Recent Developments

In response to the long-term objective of arriving at an energy performance standard for buildings in Singapore, development work has been concentrated in improving the BUNYIP program for implementation on a micro-computer. To-date, modifications have been made to enhance the accuracy of energy estimation and the design capability of the BUNYIP software.

The modified program can calculate the hourly temperature variation of any given

development. A.I.D.'s new direction for renewable energy emphasizes private sector development and assistance programs to stimulate market-driven applications of these energy sources.

Lessons Learned

The main lessons learned in this reassessment are as follows:

- Large-scale introduction of new renewable energy sources through the efforts of A.I.D. or others has not been achieved. This is due primarily to two factors. First, most renewable energy projects were R&D projects and were intended to develop technologies (and institutions), not to directly disseminate commercially mature technologies; and second, institutional weaknesses and unfavorable policy conditions constrained renewable energy implementation.

- While many R&D efforts have not succeeded, a significant number of technical approaches have been demonstrated to be reliable. Several renewable energy technologies such as small hydro, some biomass applications, remote solar applications, and others, have now matured sufficiently for commercial applications to proceed.

- Projects should avoid technology options that are commercially unproven, unless projects are explicitly designed to support technology development as part of an overall commercialization plan.

- Only renewables able to compete in the marketplace with conventional technology in terms of cost, convenience, quality, service delivered, and reliability, will normally be successful.

- Local user or "market" acceptance determines whether a new renewable technology succeeds or fails. User involvement or market testing in project design, implementation, and evaluation should be a project requirement.

- Renewables' market penetration is seriously impeded when other fuels are subsidized or other unfavorable policy conditions exist. Policy conditions require up-front attention in A.I.D. efforts to support renewables introduction,

- Project ideas and designs cannot simply be transplanted from place to place. Applications must be tailored to local market, physical, material, institutional, and economic conditions.

- Lack of attention to "after-sales" service, including maintenance, spare parts, and local skills development, has often proved fatal to both demonstrations and attempts to commercialize a technology.

- Local private sector marketing of technology for commercial purposes is the best way, where possible, to ensure successful dissemination.

- Learning from past experience is severely handicapped by lack of adequate documentation of successes and failures. Improved interchange of results and methods of application could make a major difference in the rate of future success.

Elements of A.I.D. Renewable Energy Strategy

Based on the lessons learned above, it is appropriate for A.I.D. to establish New Directions for its renewable energy strategy. These directions should recognize today's economic and technical realities, and integrate renewable options, where appropriate, as components of rural, agricultural, and other development programs. Long-term energy price expectations should be used as a basis for decision making, and a diversified fuel mix that includes renewables should be encouraged. This strategy must be applied within the resource, social, environmental, and institutional situation of particular countries and even sites. Thus, no predetermined technology choice is possible; rather, a better informed judgement and case by case comparative evaluation is called for.

The overall objectives of A.I.D.'s New Directions are as follows :

First, to ensure the supply of appropriate "least-cost" sources of energy to strengthen rural development efforts, enhance agricultural productivity, and create rural employment opportunities.

Second, to support local and U. S. private sector initiatives to supply necessary energy services, technology, and capital in order to achieve self-sustaining solutions to energy problems.

Third, to place special focus on household energy problems through expanded biomass supply and improved utilization.

Fourth, to create the policy and institutional conditions required for sound energy sector development.

A.I.D.'s renewable energy program will be directed to support the following New Directions:

Private Sector Collaboration

Expanded cooperation between A.I.D., and U.S. and developing country renewable energy firms and developers to merge A.I.D. knowledge of country constraints and conditions and A.I.D. technical and financial support with private sector skills in design, manufacturing, and marketing.

Rural Development and Private Enterprise Support

Technical assistance to mission private enterprise and rural development programs will be increased to ensure provision of adequate renewable and other sources of energy for projects requiring new energy sources, to identify energy business opportunities and to provide information and training for A.I.D. staff on energy options

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zone within a building. The time period covered by the hourly zone temperature computation is one week.

Applications

The DOE-2 and BUNYIP codes are being used as major analytical and design tools in the upgrading of existing energy standards. Four major areas of application, namely, energy standard review, energy analysis, energy management, and lighting and daylighting have been identified by the Development and Building Control Division Committee on Energy Conservation in Buildings. Computerised techniques are being used to verify key parameters in the OTTV handbook, to evaluate the OTTV calculation, to develop simple-to-use energy estimating methodologies, and to investigate daylighting strategies. Experiments and energy surveys are also being conducted to validate the computer analyses and design methodologies.

Further details regarding the research and development of design tools for building energy conservation at the Department of Mechanical and Production Engineering, National University of Singapore, are available in " Design Tools for Building Energy Conservation in Singapore" by S. K. Chou, paper presented at the ASEAN-EC Energy Conservation Seminar in Industries, Buildings, and Transportation, 14-18 December 1987, Bangkok, Thailand.

R & D Activities at Renewable Energy Research Centre University of Dhaka, Bangladesh

The Renewable Energy Research Centre (RERC) was set up at the University of Dhaka in 1981 to promote and co-ordinate activities in the field of renewable energy. The objectives of the centre are: (i) to organize research activities in the fields of solar and other alternative sources of energy; (ii) to encourage research projects for utilisation of solar energy in Bangladesh; (iii) to help establish multidisciplinary research activities in this field; (iv) to look for international assistance and collaborations in this field; (v) to co-ordinate and establish liaison with scientists and engineers working in other institutions inside and outside the country; and(vi) to collect information and literature on researches in the fields of solar and other alternative energy sources and to disseminate them among the research workers.

RERC has boosted up research in the field of renewable energy in different departments of the University and several projects were started by RERC in which teachers and students of the Faculty of Science and Biological Sciences participated. The research and development activities carried out so far are as follows:

In place of a semiconductor pyranometer, an Eppley type precision pyranometer and a pyrheliometer have been set up to measure global, diffuse and direct irradiance. Studies on the estimation of solar radiation from sunshine duration, cloud cover and precipitation data have been made.

Flat-plate thermal collectors have been built using copper as well as corrugated galvanised iron sheets as absorbers. Work on storage type collectors is being carried out. Intermittently adjusted linear solar collectors using Fresnel mirrors and mirror strips in CPC configuration have been fabricated and tested. They were found feasible in Bangladesh. A box-type solar cooker has been fabricated and is to be tested soon. A programme to develop selective coatings to improve efficiencies of thermal collectors using chemical techniques has progressed.

Schottky type solar cells have been prepared. Diffusion type cells have been fabricated by direct painting of the dopant compound and subsequent heat treatment. A diffusion furnance is being installed to use modern techniques for fabricating high efficiency silicon cells. To develop silicon technology a Research Centre has recently been exclusively started by Dhaka University.

A battery charger for photovoltaic panels has been built and operated. Pyranometers have been built using semiconductor sensors and their characteristics have been investigated. Circuitry for studying solar panel characteristics is being developed. A microprocessor based solar tracker is under construction. Performances of photovoltaic panels for lighting are being investigated for studying their suitability for rural electrification.

Encouraging results have been obtained in a study on photobiological production of hydrogen from water using solar radiation with green leaves of water hyacinth as the photosynthetic membrane. Work on biogas production from water hyacinth has been successfully carried out with cooperation from the Commonwealth Science Council and Building Research Institute, Dhaka.

New strains of anaerobic bacteria capable of producing alcohol have been isolated from mud and soil samples. The biology of the genus *Zymomonas* is being studied with a special emphasis on the production of ethanol by the saw-organism. An experiment in bacterial fermentation of water hyacinth, rice straw inoculated with cow dung in laboratory digesters showed that a better yield comes from water hyacinth.

A survey is being carried on to find suitable fast growing local trees which are preferred and used as fuel by the villagers. Two cultivars of *Sesbania bispinosa* for fallow lands and *Trewia polycarpa* for water logged areas have been found to satisfy the criteria. Seedlings of *Sesbania grandiflora* have been planted in an experimental plot to study their growth.

Studies on genetic manipulation of rain tree (*Samanea saman*) and ipil-ipil (*Leucaena leucocephala*) through tissue culture have been undertaken with the ultimate objective of producing plant types capable of a faster growth rate and to look for possible variants of ipil-ipil capable of growing successfully in the acidic soil of Bangladesh. For both rain tree and ipil-ipil, plantlets with well developed roots were obtained. But tissue culture costs are now high for supplying plantlets for field growing.

Studies made on the windspeed throughout Bangladesh using data recorded by the Meteorological Department show that for Chittagong coast the distribution of available wind energy is fairly high. A sail-type horizontal axis wind machine was built and used to pump water. However, experience showed that the windmill made of garjan timber creates maintenance problems and is susceptible to cyclones.

Some of the ongoing/completed projects on renewable energy carried out by RERC are as follows:

1. Solar Water Heater for Domestic Use. (Project Supervisor: Dr. K. S. Rabbani)
2. Biomass Energy: Survey, Assessment and Growth. (Project Supervisor: Dr. A. K. M. Nazrul Islam)
3. Photobiological Production of Hydrogen. (Project Supervisors: Prof. S. Z. Haider and Prof. A. J. Mahmood)
4. Studies on Performances of Water Heaters. (Project Supervisor: Prof. Muhtasham Hussain)
5. Studies on Micropropagation of Fuelwood Plants. (Project Supervisor: Prof. A. S. Islam)
6. Preparation of Selective Surfaces for Solar Collectors. (Project Supervisor: Mr. A. H. M. Mahbubar Rahman)
7. Solar Radiation Data Recording and Analysis. (Project Supervisor: Prof. Muhtasham Hussain)
8. Fabrication of Solar Cells. (Project Supervisors: Prof. S. Ahmed and Dr. M. Ibrahim)
9. Solar Lighting for Rural Application. (Project Supervisor : Dr. Jalalur Rahman)
10. Bio-energy from Agriculture Wastes. (Project Supervisor : Dr. M. R. Khan.)

Further details regarding activities of RERC are available from:

Prof. Muhtasham Hussain
Director
Renewable Energy Research Centre
Faculty of Science
University of Dhaka
Bangladesh

(Source : *Renewable Energy Research Centre Projects Report*, June 1986, University of Dhaka, Bangladesh).

Energy Development in South East Asia and Cooperation with the European Community

International Seminar on Energy Policy
Pattaya, Thailand
February 27 - March 3, 1989

The Centre International de Formation en Politique Energétique, Paris (CIFOPE) and the Energy Technology Division of the Asian Institute of Technology (AIT) in cooperation with the Commission of European Communities will organize an international seminar on energy issues in the ASEAN region and the scope for cooperation with Europe.

The seminar, entitled Energy Development in South East Asia and Cooperation with the European Community, will be held from February 27 to March 3, 1989 at the Asia Pattaya Hotel, Pattaya, Thailand.

The main topic of this seminar will be energy policy in ASEAN countries. The prospects for cooperation between South East Asia and Europe in technology transfer and training will also be considered. The seminar participants will be experts from energy companies, institutions and universities in South East Asia and Europe.

For more information please contact:
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Energy Tech/Instrumex'89

An international exhibition of engineering technology and know-how related to the efficient utilization of energy, instrumentation and industrial control technology is going to be held, during 16-20 August 1989, at Bangkok International Exposition Center, Central Plaza Hotel, Bangkok, Thailand. The Energy Conservation Center of Thailand and Sitra Co., Ltd. are the joint co-organizers of this exhibition. This exhibition is supported by the Ministry of Science, Technology and Energy; National Energy Adminstration; Asian Institute of Technology; and King Mongkut's Institute of Technology Thonburi, Thailand. Exhibitions from manufacturers of energy efficient equipment as well as measuring, testing, and control instrument are expected.

For further details please contact:
Mr. Sakchai Thampreechatavorn
Sitra Co., Ltd.,
158 Emmanuel Bldg.
Rachadapisek Rd.
Bangkok 10310, Thailand
Tel. 2460-0871

New Directions for A. I. D. Renewable Energy Activities

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for health, agriculture, and other rural development activities.

Training in Support of Renewables Commercialization

Renewable energy training sponsored by A.I.D. and related initiatives, will be expanded to support the Less Developed Country (LDC) private sector and stimulate the commercial use of renewables in water pumping, health, rural commercial-industrial, and decentralized electric power supply, among other rural development applications.

Emphasis on Implementation

Development of innovative financing schemes to assist in the commercial penetration of renewables into rural and dispersed private markets. Expansion of risk-sharing via feasibility study and other explicit support, such as targeted use of the A.I.D. commodity import program to facilitate U.S. and LDC private sector ventures to transfer, adapt, and market cost-effective rural energy systems.

Further development and adaptation of energy production and utilization technology for selected high priority rural development applications, including adaptation of United States renewable energy equipments.

Coordinated Action

Reliance on greater donor coordination will be pursued to more effectively utilize and leverage A.I.D. resources and help develop the policy conditions necessary for the introduction of new energy sources.

Implementation Activities

Implementation Vehicles

The major implementing vehicles for the New Directions proposed above include the Renewable Energy Applications and Training Project (REAT), the Bioenergy Systems and Technology Project (BST), and centrally funded activities in the areas of household fuels, and energy and irrigation. All are ongoing projects or activities.

The Bioenergy Systems and Technology (BST) Project is intended to design, develop, and implement field projects using bioenergy systems. The Renewable Energy Applications and Training Project (REAT) has been responsible for the assessment of A.I.D.'s past experience with renewables and proposals for new initiatives to support rural and agricultural development.

Household fuel activities are another area of emphasis. Current work includes investigation of markets for briquette fuel substitutes made from coal and/or biomass residues, especially in countries experiencing increasing wood scarcities. Household fuel strategy development work, and a review of charcoal stove programs in East Africa are also being pursued.

The energy and irrigation activity is designed to promote the economic utilization of water for irrigation in A.I.D.-assisted countries.

(Sources: *New Directions for A.I.D. Renewable Energy Activities*, Final Report, Office of Energy, Bureau for Science and Technology, U.S. Agency for International Development, Washington, D.C., February 1988, iv+65p.)

Book Reviews

Energy Issues and Prospects in the Asia and Pacific Region

Energy Resources Development Services No.31

Economic and Social Commission for Asia and the Pacific
United Nations
New York
(1988, vi+130p.)

This report, which is one of a series of reports on Energy Resources Development Problems in the ESCAP Region, contains information and issue papers on energy presented to the Committee on Natural Resources at its 14th session in Bangkok, Thailand. The main issues dealt with include current energy situation and demand management achievements; prospects for production and utilization of coal, natural gas and electricity; human resource development, and strategies required for the development of new and renewable sources of energy.

The first chapter of the report contains a summary of the deliberations of the committee in the fields of energy and natural resources. A list of conclusions and recommendations forwarded by the committee are also included in this chapter. Several key papers presented to the committee are included in chapter two and are arranged under three sub-chapters as follows: (i) current energy situation and demand management achievements, (ii) energy issues, and (iii) strategies required in accelerated development of new and renewable sources of energy. A list of documents presented during the 14th session of the committee is also included in an annex.

Microbiological Aspects of Anaerobic Digestion Laboratory Manual

Edited by D. R. Ranade and R .V. Gadre with contributions from T. Y. Yeole and Nazifa N. Nagarwala
Maharashtra Association for the Cultivation of Science, Research Institute
Pune 411004, India
(1988, 112p.)

Maharashtra Association for the Cultivation of Science (MACS), is one of the pioneering research institutes whose efforts were made to develop a family-size biogas plant. Presently, activities at MACS are focussed mainly on microbiological and applied aspects of anaerobic digestion. The *Laboratory Manual on Microbiological Aspects of Anaerobic Digestion*, recently brought out by MACS, provides details of the following:

- Microbiology of Anaerobic Digestion (historical background and role of bacteria);
- Principles of Anaerobic Techniques;
- Culture Methods (preparation of pre-reduced media, collection of samples, enrichment and isolation);
- Methanogens (isolation and identification);
- Anaerobic Cellulolytic Bacteria (isolation and identification);
- Dissimilatory Sulphate Reducing Bacteria (isolation and identification);
- Most Probable Number of Anaerobic Bacteria (MPN of methanogens, MPN of anaerobic cellulolytic bacteria, and MPN of sulphate reducing bacteria);
- Media;
- Chemical Analysis;
- Gas Chromatography; and
- Reagents for Chemical Analysis.

Consultancy Services Wind Energy Developing Countries - New Publications

- *Comparative Testing of Wind Measuring Equipment, Part II : Test-results*, Hans Schotte, Wind Energy Group, Faculty of Physics, Laboratory of Fluid Dynamics and Heat Transfer, Technical University Eindhoven, The Netherlands, April 1987, 32p.
- *Low Head/High Volume Wind Pumps for the Fleuve Region in Senegal*, J. A. de Jongh, Wind Energy Group, Technical University Eindhoven, The Netherlands, June 1988, 36p.+App.
- *Measurements Executed on the CWD 49D Pump Provided with a PVC Tube Around the Raising Main to Limit Shockforces*, A. Kragten and J. Diepens, Wind Energy Group, Technical University Eindhoven, April 1988, 11p.+Annexes.
- *Design Report CWD 81D Deepwell Pump*, Jan Diepens, Wind Energy Group, Technical University Eindhoven, June 1988, 24p.
- *An Experimental Facility to Simulate the Unsteady Flow in Piston Pumps due to Valve Closure*, W. T. G. M. Janssen, Wind Energy Group, Technical University Eindhoven, August 1988, 80p.
- *Two Methods for Dynamic Measurement of the Valve Height in a Piston Pump*, Report of the traineeship, accomplished between December 1987 and July 1988, B. J. van der Ceelen, Wind Energy Group, Technical University Eindhoven, September 1988.

The above publications are available from Consultancy Services Wind Energy Developing Countries, P. O. Box 85, 3800 AB Amersfoort, Holland.

Proceedings of International Conference on Energy Sources Management and Energy Saving Technology, Beijing, China, 20 - 23 September 1988

Zhee Yajie (Ed)
Chemical Industry Press
Beijing, China
(1988, xx + 633p.)

The international conference on energy sources management and energy saving held during 20-23 September 1988 in China drew several experts from countries such as France, USA, India, Japan, Canada, Finland, Thailand, Yugoslavia, Denmark and

the host country China.

This proceedings of the above conference consists of 11 papers on energy conservation in general and energy management; 7 papers on status of national and regional energy conservation, 6 papers on control systems in energy conservation; 10 papers on energy saving technologies in various industrial sectors; 5 papers on energy saving technologies in power plants, industrial furnaces and kilns ; 9 papers on specific technologies in energy conservation ; and 3 papers on energy conservation and its environmental impact.

Proceedings of Second International Conference on Small Engines and Their Fuels in Developing Countries, Reading, UK, 23 - 24 September, 1987

Institute of Energy
London, United Kingdom
(1987, iii + 209p.)

The proceedings of the Second International Conference on Small Engines and their Fuels in Developing Countries consists of papers on research and development aspects of small engines, such as diesel, Stirling and steam engines, using alternate fuels (such as vegetable oil, alcohols, producer gas and solar energy) for water pumping, generating electricity for lighting and power supplies for light industries, and communications in rural areas of developing countries. The conference, jointly organized by the Energy Group of Engineering Department of University of Reading, Intermediate Technology Power Limited, and Institute of Energy, U. K., drew experts from several developing and developed countries. The subject coverage is very wide and includes : I. C. engines and their fuels (6 papers), externally heated engines (6 papers), fuels (6 papers), 12 papers presented during sessions 1 and 2, and 6 case studies.

Publications Received

Biomass Energy

- *Catalogue of Wood Energy Institutions,* S. C. Bhattacharya, Regional Wood Energy Development Programme in Asia (GCP/RAS/111/NET), Food and Agriculture Organization of the United Nations, Bangkok, July 1988, v+80 p.

- *The Use of Wood Fuels in Rural Industries in Asia and Pacific Region,* prepared by Biomass Energy Services and Technology, Regional Wood Energy Development Programme in Asia (GCP/RAS/111/NET), Food and Agriculture Organization of the United Nations, Bangkok, May 1988, ii+83p.

- *Charcoal Production Information Package,* Caribbean Development Bank, Technology and Energy Unit, June 1983, 7p.+Appendices.

- *Cookstove Information Package,* Caribbean Development Bank, Technology and Energy Unit, March 1983.

- *Biocoal Technology: A Comparison of Options and Recommendations,* AIT-GTZ Biocoal Project (Draft), S. C. Bhattacharya, et al., Asian Institute of Technology, Division of Energy Technology (P. O. Box 2754, Bangkok 10501, Thailand), 1988, 27p.

- *Cost and Availability of Selected Residues in Thailand,* AIT-GTZ Biocoal Project (Draft), S. C. Bhattacharya, et al., Asian Institute of Technology, Division of Energy Technology, 1988, ix+103p.

- *State-of-the-Art for Biocoal Technology,* AIT-GTZ Biocoal Project (Draft), S. C. Bhattacharya, et al., Asian Institute of Technology, Division of Energy Technology, 1988, vi+203 p.

- *Biocoal: A Report on Market Opportunities and Requirements in Thailand,* AIT-GTZ Biocoal Project (Draft), S. C. Bhattacharya, et al., Asian Institute of Technology, Division of Energy Technology,1988, viii+78p.

- *Report on the Training Workshop on Gasifier for Ice Plant Application*, 22 October 1986, Pablo City, Laguna, Philippines, Philippine National Oil Company - Energy Research and Development Centre, Manila, 1986, 45p.

- *Report on the National Seminars on Gasifier System for Ricemill Operation,* 15-16 July 1985, San Carlos City; 25-26 October 1985, Lingayen, Pangasinan; and 14 December 1985, Cabanatuan City, Nueva Ecija; Philippines, Philippine National Oil Company - Energy Research and Development Center, Manila, 77p.

- *Regional Seminar on the Utilization of Urban and Rural Wastes: Technologies for Microbial Conversion of Wastes and other Related Aspects,* Bangkok, Thailand, 16-19 December 1986, Chulalongkorn University, Bangkok, 1986, 48p.

- *Report on Training Course on Biogas Reactor Design and Development,* Bangkok, Thailand, 11 May-5 June,1987, organized by ASEAN Working Group on Non-Conventional Energy Research and ASEAN Working Group on Food Waste Materials, hosted by King Mongkut's Institute of Technology, Thonburi, 1987, 22p.+Appendices.

- *Review of Rural Application of Biogas Technology in China, India, Nepal and Thailand,* Regional Network on Biomass, Solar and Wind Energy, Natural Resources Division, Economic and Social Commission for Asia and the Pacific, Bangkok, 1987, xi+60p.

- *A Biogas Handbook,* Caribbean Development Bank, Technology and Energy Unit (P. O. Box 408, Wildey, St. Michael, Barbados, West Indies), 1985, 50p.

Energy

- *Report of the Regional Seminar on Alternative Energy Applications in Agriculture,* organized by Chiang Mai University, Faculty of Engineering and sponsored by UNESCO, 27-29 October 1986, Chiang Mai, Thailand, 1986, 28p.

- *Report of the Regional Training Workshop on Energy Conservation in Industry,* 10-14 March 1986, Bangkok, Thailand, Energy Research and Training Centre, Chulalongkorn University, Bangkok, Thailand, 1986, 37p.

- *Energy Balances and Energy Accounting, Section 16 of Energy Terminology : A Multi-lingual Glossary,* Pergamon Press, Oxford, 1985, xiv+65p.

- *World Bank/UNDP/Bilateral Aid Energy Sector Management Assistance*

Cont. P. 16

Diary of Events

March 6-9, 1989, Arlington, VA, USA
SOLTECH 89

SOLTECH 89 will be organized by The Solar Energy Industries Association.

For more details contact:
SEIA
1730 N. Lynn Street
Suite 610
Arlington, VA 22209
USA

March 19-22, 1989, Cairo, Egypt
ASRE 89 - International Conference on Applications of Solar & Renewable Energy

The Second International Conference on Applications of Solar and Renewable Energy is sponsored by the Egyptian Section of the International Solar Energy Society (ISES) with the Cooperation of the Egyptian Solar Energy Society and co-sponsored by New and Renewable Energy Authority, Ministry of Electricity and Energy, Arab Organization for Industrialization, International Center For Theoretical Physics (ICTP), and Japan Solar Energy Society (JSES).

The conference will cover the following aspects of solar and renewable energy: solar radiation, solar collectors, solar energy storage, solar cooling, solar ponds, solar desalination, solar power generation, photovoltaics, wind energy, bioconversion, energy conservation, rural and desert development, industrial application and economy and policy.

For more details contact:
Egyptian Solar Energy Society,
P. O. Box 487
Doki, Giza, Egypt
Telex : 92135 ENFAC UN
Telefax : 781236

March 29-30, 1989, St. Andrews University, Scotland
Conference on New Technology and Wind Energy

A conference on new technology and wind energy will be held on March 29-30, 1989, at St. Andrews University, Scotland.

The conference will consider new methods of harnessing wind power efficiently and will cover areas such as materials, control, and integrated systems including wind and diesel. The proceedings, will be published by the British Wind Energy Association.

For further information and paper submission contact:
Scottish Branch of the BWEA
c/o Energy Studies Unit
University of Strathclyde
Glasgow G1 1XQ, UK

May 8-9, 1989, Chilton, UK
Wind Turbines in Diesel Powered Networks

The conference will be sponsored by the British Wind Energy Association.

For more details contact:
J. E. Foster
Energy Research Unit
Bldg. R63
Rutherford Appleton Laboratory
Chilton, Didcot
OX11 0QX,UK
Tel: (0235) 21900 Ext. 5440

May 24-26, 1989, Lakewood, CO, USA
9th Solar Energy Research Institute Photovoltaic Advanced Research and Development Project Review Meeting

The 9th SERI PV A R&D project review meeting will be held on May 24-26, 1989, at the Sheraton Inn, Lakewood, CO, USA.

For further information contact :
Diane Christodaro
Solar Energy Research Institute
Conference Coordination Section
1617 Cole Boulevard
Golden, CO, USA
Tel: 303-231 1158
FTS 327 1158

Publications Received From P. 15

Program, Information and Status Report, August,1988. The World Bank, Industry and Energy Department, Energy Strategy, Management and Assessment Division, Washington, D. C. and the United Nations Development Programme, Division for Global and Interregional Projects, New York, 1988, 67p.

- *Proceedings of the Seminar on Energy Management in Buildings,* 2-4 October 1985, Makati, Metro Manila, Philippines, sponsored by: ASEAN - Australia Energy Cooperation Programme, UNESCO-ROSTSEA; Bureau of Energy Utilization; United Architects of the Philippines; National Science & Technology Authority; Philippine Council for Industry & Energy Research and Development; in cooperation with Philippine Computer Society and Philippine Association of Building Administrators, 1985, ix+119p.

- *Proceedings for Participants, ASEAN-Canada Energy Seminar Study Tour for Senior Executives,* held in Canada, 15 September-11 October 1986, ASEAN Working Group on Non-Conventional Energy Research, Committee on Science & Technology, Bangkok, 1986, 154p.

- *A Long-term Macroeconomic Equilibrium Model for the European Community,* Hans-Holger Rogner, Workshop on Economics, Modelling, Planning and Management of Energy, 18-25 September 1987, International Institute for Applied System Analysis, Laxenburg, Austria, 77p.

- *Energy Research Development and Information Centre (ERDIC) Annual Report 1987,* the University of New South Wales (P. O. Box 1, Kensington, NSW 2033, Australia), 1987, 63p.

- *An Energy-Efficient and Safer Space Heating Stove for Himalayan Regions: Preliminary Results,* Ashok Gadgil and Satwinderpal Singh Makkad, Tata Energy Research Institute (7 Jor Bagh, New Delhi, 110003, India), 1987, iv+45p.

- *Impact of Socio-Economic and Architectural Factors on Peak Electricity Demand : A Case Study of South Bombay,* Ashok Gadgil and Bhaskar Natarajan, Tata Energy Research Institute, 1988, v+24p.

- *Proceedings of the International Conference on Physics and Energy for Development,* 26-29 January 1985, Dhaka, Bangladesh Physical Society, Dhaka, 1986, iv+335p.+Appendices

- *The First National Conference on Thermal Engineering, Proceedings,* 4-6 April 1988, Kuala Lumpur, Universiti Malaya, Department of Mechanical Engineering, Kuala Lumpur, Malaysia, 1988, xvi+284 p.

RERIC news

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Biogas Plant Handing-Over Ceremony

Asian Institute of Technology - Kasetsart University, Thailand

« *Prof. Alastair M. North, President of the Asian Institute of Technology, delivering a speech at the Handing-over Ceremony. The biogas plant is in the background.*

On 31 January 1989, the Asian Institute of Technology (AIT) and the Kasetsart University, Bangkok, Thailand, celebrated the handing-over ceremony of a full-scale plug-flow biogas digester at Tabkwang Research Station of Kasetsart University. This follows two years of operation and testing conducted by the Research Team of AIT in cooperation with Kasetsart University, under the supervision of Mr. W. Tentscher. The project was sponsored by the Federal Republic of Germany through GTZ. RERIC News reported earlier about this biogas plant (Vol. 10, No.2, 1987)

The digester is the first pilot plant of this kind in Thailand. Similar designs exist in the Ivory Coast, China and Taiwan. During

Cont. P. 2

The biogas research team and visitors at the biogas plant.

Tsotso Stove
A Fuel-Saving Stove

After three years of research work, at first on an individual basis by David Hancock, and later as part of project work by the University of Zimbabwe Development Technology Centre (DTC), the Tsotso Stove is now poised for national and even international dissemination.

The stove won the 1986 Eicher Award. The award is a symbol of the Solar Energy Society's recognition of the achievements of University of Zimbabwe staff members and students in practical demonstrations of how solar energy can be used directly and indirectly to conserve natural resources, such as firewood and coal, and imported oil. The Tsotso Stove does just

Cont. P. 2

wind and sun compendium

Development of wind and solar energy for water pumping

CWD

Consultancy Services
Wind Energy
Developing Countries

Energy Information Service, CSIRO

Incorporates news from the Energy Information Service, CSIRO and Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

INNERTAP

Biogas Plant Handing-Over Ceremony

From P. 1

almost 2 years of operation, which was intensively monitored by AIT, the main results obtained are as follows :

1. The concentration of the manure to be loaded into the digester was very low, about 5 to 8 g TS (total solids)/1, caused by the high amount of flush water. The ratio of flush water to feaces varied between 69:1 and 43:1

2. The suspended matter was about 80% of total solids (TS).

3. Due to the low concentration, stratification occurred and particulated matter settled in the digester at a rate of about 10 kg/day. The sludge layer grew by about 20 cm per month.

4. Pigs were fed concentrated feed 2.3% on body weight. Gas production was about 1 N1/kg pig.d and about 47 Nl/ kg feed.

5. The digester was overdesigned and thus underloaded. The volumetric gas production rate was 0.12 Nm^3/m^3.d at a loading of 0.23 kg TS/m^3.d. The retention time was 29 days, without taking into account, that the sludge layer finally occupied about 50% of the digester working volume.

6. The sludge layer contributed to the gas production. Therefore, specific gas production rates increased steadily from 0.3 $Nm^3/kg\ TS_o$ to 0.77 $Nm^3/kg\ TS_o$ and 0.49 Nm^3/TS_r to 1.35 $Nm^3/kg\ TS_r$ in October 1987 and May 1988, respectively.

7. The TN content in the sludge layer was 3.5g/l, but in the liquid phase only 0.5 g/l. The sludge may therefore be used as a nutritional source for field crops, fish ponds or feed additive.

8. The Red Mud Plastic (RMP) film of 1.8 mm thickness did not show any sign of deterioration.

9. The engine-generator-set worked satisfactorily. It was working 4 to 6 hours per day at an output of 10.7 kW (25Amp, 400V). The efficiency was 19.6% and 1.46 kWh_e could be generated per cubic metre of biogas with 72% CH_4 concentration.

10. The second-hand engine had to be replaced after 1100 hrs by a stand-by engine (second-hand as well) because the oil pressure dropped too much and was overhauled.

11. Total construction cost was 350,000 baht, including all pipelines, power shed and digester. This can be reduced by at least 120,000 baht in the next prototype. If local plastic films are used as gas holder, total construction costs may decrease to 170,000 baht.

12. At the original construction cost, electricity production costs are about 1 baht/kWh at a volumetric gas production rate of 0.6 Nm^3/m^3.d. For improved models, the feasibility will improve at the same gas production rate.

13. Construction costs may be further reduced by separating the particulated waste from the liquid phase and by digesting the two substrates of high and low TS concentration in different digesters. This will be realized in the next prototype.

14. The potential of increasing the feasibility further will be investigated. Benefits may be achieved by using the effluent or sludge and energy in exhaust gas of the engine-generator-set (cogeneration).

(Source: Contributed by Mr. W. Tentscher, Energy Technology Division, Asian Institute of Technology, Bangkok).

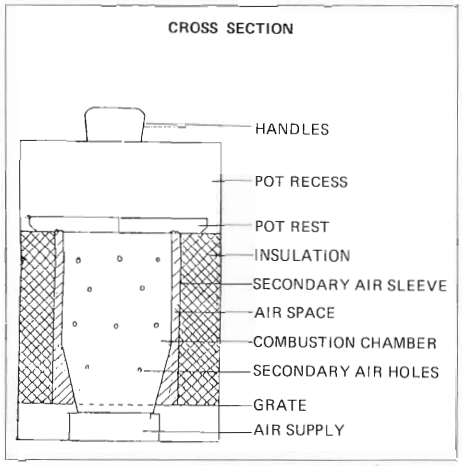
Some researchers and visitors at the Handing-Over Ceremony. From Left: Dr. Theera Chaichanawongse (Deputy Director, Kasetsart University Research and Development Institute (KURDI), Mr. W. Tentscher (Visiting Faculty, Energy Technology Division, Asian Institute of Technology (AIT)), Prof. Alastair M. North, (President of the Asian Institute of Technology), Prof. Dr. Sutham Areekul (President of the Kasetsart University), Prof. J.C. Mora (Chairman, Energy Technology Division, AIT), Dr. K. Woerner (First Secretary for Economic Cooperation, Embassy of the Federal Republic of Germany), and Mr. Sinchai Paraksa (Assoc. Prof., Kasetsart University, Kampaengsaen Campus).

Tsotso Stove

A Fuel-Saving Stove

From P. 1

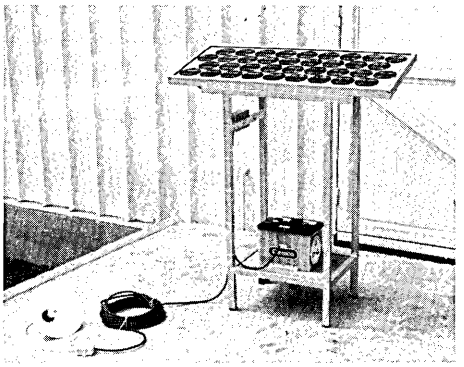
that. Tsotso means "little sticks". The Tsotso Stove is efficient and displays good combustion characteristics which help it to burn with greater speed and less smoke than the open fire stoves. Designed in the Development Technology Centre, the pilot study was conducted in the high density areas of Tafara and Mabvuku. It is sold in two fabricated models which differ in complexity,



Rural Electrification by Means of Photovoltaic Systems in Senegal

In February 1989, a 20 kW photovoltaic power plant was put into service in Senegal. More than 150 solar home systems are being installed in remote Senegalese villages to provide electricity for light, radio and TV for private homes, for village health stations and village schools with important evening activities. Furthermore, four photovoltaic pumping systems for drinking water and animal watering places will be installed during the next months. A system for a remote research health station providing electricity for cooling of vaccines and medicine; for lighting and a centrifuge has undergone testing since May 1988.

The objective of the Senegalese-German project on solar photovoltaic energy is the testing and dissemination of photovoltaic systems for rural applications. Therefore, the project concentrates its efforts on systems which are likely to be profitable or at least cost competitive with the traditional systems, such as kerosene lamps, diesel generators for electrical island grids and water pumping or batteries for radio and TV.



Standard solar home system (4 lamps 12V/10 W and one plug for radio/TV) for rural electrification.

The 20 kW_p power plant provides electricity for a village of about 1500 inhabitants which will not be connected to the national grid in the foreseeable future. The monthly electricity generation of this plant will be about 2000 kWh. The objective of the project is to prove that this fully automated power station is a better solution for isolated small village grids than the normally used diesel generators.

A thorough socio-economic study by a local NGO preceded the construction of the power station in order to prepare the comprehensive participation of the villagers in the financial management of its operation and maintenance.

The tariff per kWh has been fixed at 100 F CFA (= 2 Francs Français) per month for the first 20 kWh and at 140 F CFA beyond this limit. This is higher than the national electricity price of the customers of the Senegalese electric utility SENELEC. But it seems to be acceptable because of the very low average consumption in the villages of

Cont. P. 4

cost and efficiency. It is also sold in components so that the owner is able to build his own stove. It uses less firewood or maize cobs than the open fire stoves.

The combustion chamber of the stove is a cylinder-like tube with a grate at the bottom to allow primary air to pass through. There is a one cm gap between the combustion chamber and a metal sleeve which contains insulation material. Secondary air passes up between these two walls and enters the combustion chamber through holes drilled further up the tube. The air supply enters through a hole at the foot of the stove and is controlled by a small door. The pot sits on a pot holder above the combustion chamber and is surrounded by a wind shield. The design attempts to achieve as complete combustion as is possible within certain price and consumer constraints. Important design principles are :

1) creating a forced draft with a passive mechanism. This is achieved by placing the fire in a chimney-like structure;

2) insulation around the combustion chamber to protect children from burning, and to minimize heat loss to the sides which in turn makes for higher temperatures and better combustion;

3) the provision of preheated secondary air which makes combustion of unburnt gasses and volatiles possible further up the chamber;

4) control of heat output. This is made possible by manipulating the air supply; and

5) a collar around the pot which acts as a wind break and enhances heat transfer through the sides of the pot.

When the Tsotso stove and the metal cooking grate, a cooking device commonly used in Zimbabwe, were subjected to standard water boiling tests under controlled conditions, the following results were obtained:

	Metal Grate	Tsotso
Efficiency , %	9	22
Time to boil		
3.3 litres water, minutes	18	13

Field tests were conducted in Harare's high density suburbs. Wood fuel consumption measurements were taken of households cooking with the metal grate for two months. The participating residents then received a Tsotso Stove and their fuel consumption was measured for a further 2 months. The field test results are as follows:

	Average kg wood/ day per family	Number of meals prepared per day
Metal grate	5.128 (0.49) *	25.22
Tsotso	2.65 (0.238) *	26.83

*Standard deviation in brackets

The test results confirm that the Tsotso Stove saves fuel. The most important aspect is that the women are using the Tsotso Stove because it suits their needs as defined by them. This paves the way for the commercialisation and rapid dissemination of the stoves, and for them to make a significant contribution to reducing the rate of wood exploitation in the country.

For further details about the stove and the dissemination project contact:

Mr. David Hancock
Development Technology Centre
University of Zimbabwe
P.O. Box MP 167, Mount Pleasant
Zimbabwe

(Source : Information provided by Mr. David Hancock, Development Technology Centre, University of Zimbabwe.)

Rural Electrification by Means of Photovoltaic Systems in Senegal

From P. 3

the region. The connection fees and the price for a basic electrical installation (two lamps and one plug) have been kept very low (i.e. 1,000 F CFA = 20 F Français) to allow practically all families to be connected to the village grid. This tariff has been conceived to assure the operation of the plant financially during its expected life time of 15 to 20 years without further subsidies. It will cover the costs of maintenance, repairs, spare parts and in particular, the regular replacement of the batteries. The second tariff section of 140 F CFA per kWh is meant to cover an eventual increase of the capacity of the power plant according to increasing demand. This aspect of the project is being carried out jointly with the national electricity corporation SENELEC.

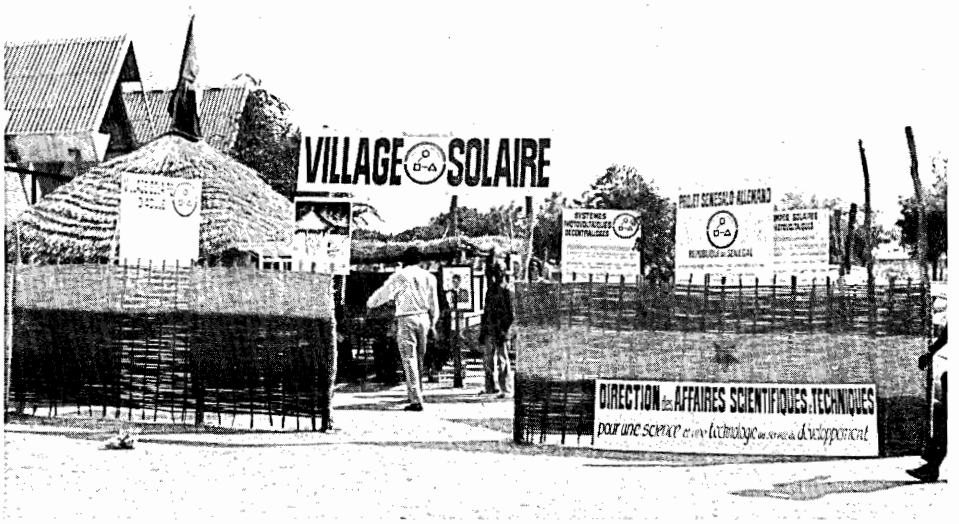
For the solar home systems special effort has been put to conceive robust low cost standard systems. Except for the photovoltaic module, all important system elements are produced in Senegal. Particularly, local production of the battery control unit has been initiated allowing for an important price reduction and facilitating the transfer of technology. This battery control unit which had been developed under a German-Philippines project on solar energy has been further improved under this project.

The installation of the first 150 out of 500 systems started in February 1989. These were distributed and tested in cooperation with four regional farmers' associations. The standard system consists of a photovoltaic panel of 50 W_p, a stationary lead-acid battery of 12V/50 Ah, a battery control unit, four low cost incandescent lamps with 12 V/10W (imported from the Philippines), and locally fabricated reflectors using reversed white plastic dishes.

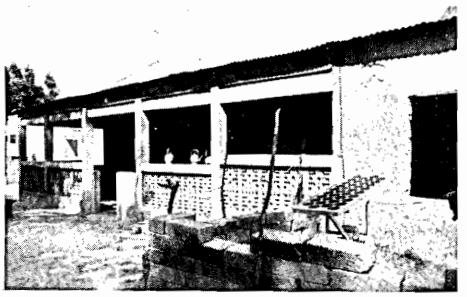
The above set has been given to the associations at cost price, duty and tax free (between 150,000 and 175,000 F CFA = 3,000 and 3,500 Francs Français). An important socio-economic follow-up is planned jointly with the users to develop systems really adapted to user's needs. For the next pilot projects, the price will probably have to be increased to at least 200,000 F CFA to allow for a larger involvement of local firms in the distribution and installation of the systems.

Rural electrification by means of solar home systems, even though it provides only basic services, could greatly contribute to the improvement of the quality of life in Senegalese villages. Initial feed-backs have shown that need and demand for such systems seem to be great owing to the fact that for the overwhelming majority of Senegalese villages, the connection to the national electric grid will not be possible for a long time. Only 2% of the national electricity consumption is actually of rural origin.

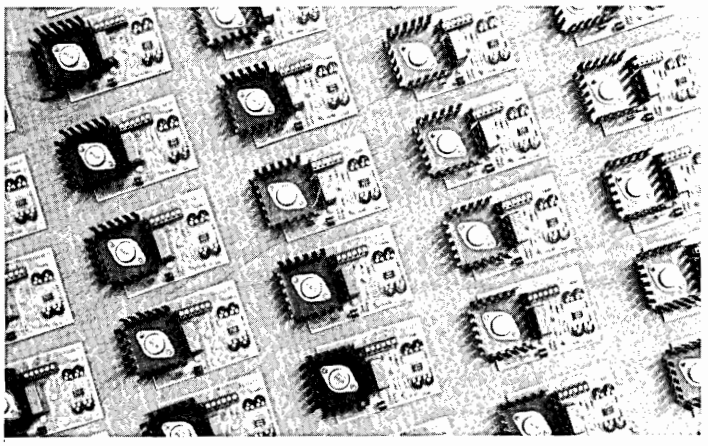
Cont. P. 6



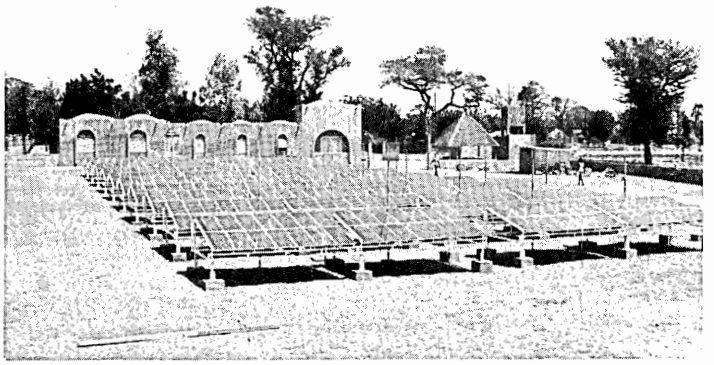
Foire Internationale de Dakar (International Trade Fair): exposition of the Photovoltaic Solar Energy Project of Senegal.



Solar home system for a mosque in Faoye/Senegal.



First series of battery control units produced in Dakar/Senegal.



Photovoltaic power plant in Diaoulé/Senegal.

Sandvip Solar Photovoltaic Demonstration Programmes Bangladesh

The offshore islands and the coastal belt of Bangladesh are often subjected to devastating cyclones and tidal waves. A large number of shelters, community centers, mud embankments, etc. have been built at a huge cost to protect lives and properties. But electricity supply (by the Power Development Board) is available only around the district/sub-district headquarters for only 6 to 10 hours a day. As such an effective warning system for cyclone disaster planning and an immunization programme for human and livestocks are not possible.

In order to assess the possibilities of applying solar PV systems for meeting the special electricity needs of the offshore islands and the coastal belt, Bangladesh Atomic Energy Commission selected Sandvip Island in March 1987 and designed the following two programmes:

A. Natural Calamity Management and Community Development Programmes, Red Cresent Cyclone Shelter, Sharikait Union.

B. Temperature Sensitive Essential and Life Saving Medicine Preservation and Hospital Emergency Programmes, Sandvip Hospital.

The salient features of the PV systems designed for the above two programmes (A,B) are shown in Table1.

Sandvip

Sandvip is one of the oldest islands in the Bay of Bengal with an area of about 376 square kilometers (including Urir Char) and a population of about 300 thousands. Agriculture; livestock and poultry farming; and fishing are the main economic activities of the island. In order to protect the island from the ravages of the tidal waves and cyclones, a 7 m high mud embankment was built around the island. Besides, 16 cyclones shelters, 12 community centers, 25 subcenters, etc., have been built with government financing and aid from several donor countries. None of these shelters have electricity or any form of warning system. But the Cyclone Preparedness Programme of the Government operates an office and 110 voluntary units to warn the people and take salvaging measures during the cyclones.

Natural Calamity Management Programme

The PV based system consists mainly of solar panels, charge-controllers, inverter, tower, beacon lights, battery, siren, radio, TV, etc. Electricity is maintained on a 24 hours basis and round the year through administrative control. In this system autonomy for 15 consecutive sunless days can be achieved.

Information on any ensuing cyclone is received through television or radio. In the original concept, one wireless set was to be installed with the help of the Red Crescent Society. People are warned by the hoisting of specially designed flags and the blowing of a siren in the day time. In the night time, tower lights and the siren do the job. The tower lights are visible up to 16 kilometers out in the sea. These lights also help people seeking shelter to find suitable shelters in the pitch darkness and inclement weather. Shelter lights, TV and radio help in keeping the morale of the people high during the disaster period. In the remaining period of the year the center may be used for various community development purposes, such as for carrying out vaccination, education, recreation and many other useful programmes.

Sandvip Hospital

Facilities have been created for providing electricity on a 24 hours basis and round the year for the preservation of temperature sensitive life saving medicines and vaccines like DPT, Polio, etc. The system can also meet the priority needs of electricity for an operating theatre, an emergency room, an X-ray machine and emergency lights.

Present Status

During the two cyclones in November 1988 the Sharikait Center was found very effective in warning the people. The lights of the center were sources of hope and assurance. The Livestock Directorate has been conducting vaccination of the island's poultry since June 1988. Presently, an artificial insemination programme using the freezers of the center is being planned. The center's TV has been a source of awareness and recreation.

The system at the hospital rendered useful services during the months of August and September, 1988. Certain teething problems (particularly involving the inverter and the charge controller) have to be solved to make the system reliable for continued and prolonged services.

(Source : *Sandvip Solar Photovoltaic Demonstration Programme*, Bangladesh Atomic Energy Commission, January 1989.)

Table 1. Features of the Sandvip solar photovoltaic demonstration programme.

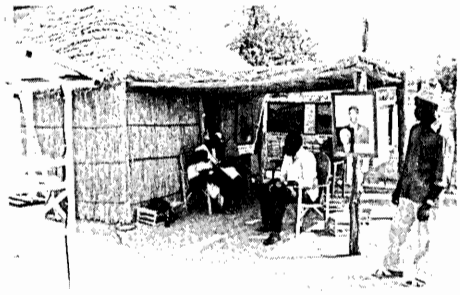
	Natural Calamity Management Programme, Cyclone Shelter Center, Sharikait Union	Medicine Preservation Programme, Sandvip Hospital
Capacity of Solar Panel	2162 Watt	1800 Watt
Capacity of Battery	12 Volts, 2568 A.H.	24 Volts, 624 A.H.
Capacity of Inverter	1200 Watts	2500 Watts
Design and Implementation	Bangladesh Atomic Energy Commission	Bangladesh Atomic Energy Commission
Main Equipment Supplier	M/s Showa Arco, U.S.A.	M/s Showa Arco, U.S.A.

Rural Electrification by Means of Photovoltaic Systems in Senegal

From P. 4

If the project manages to develop systems which are within the buying power of the villagers although at substantially higher prices compared to the traditional sources of energy for lighting and radio in rural areas, it could make an important contribution to rural electrification in Senegal. But to achieve the above objective active involvement of local institutions and enterprises in the production, dissemination and installation of those systems, is essential. Furthermore, the government should not levy too high customs duty on system elements to be imported, and assure the availability of an appropriate credit system.

The project on solar photovoltaic energy is a joint project undertaken by the "Direction des Affaires Scientifiques et Techniques du Ministère du Plan et de la Coopération (DAST/MPC)" of the Republic of Senegal and the "Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)" of the Federal Republic of Germany.



International Trade Fair of Dakar: exposition of a hut electrified by a solar home system.

For further information, please write to MM. Modou Mboup or Benno Schmidtküntzel, Project Energie Solaire, B.P. 3867, Dakar, Senegal.

(Source : Information provided by the Energie Solaire Photovoltaique-Project Sénégalo Allemand Office, Dakar, Sénégal.)

Micro-hydropower Rice Mills in Laos

Two micro-hydropower rice mills have been installed for the first time in Laos. Before these installations there were no modern water-powered rice mills in that country. The main objectives of this project were (i) to increase the awareness of this technology among the Lao, and (ii) to assess the potential for replication of this technology in Laos on a broader scale. This project was inspired by the tremendous success of similar micro-hydropower mills in Nepal, where the number of such installations is quickly approaching one thousand.

To permit increased exposure of this technology to potential interested parties, two relatively accessible sites in opposite parts of the country were selected:

- A 9 kW low-head (5.7 m) site integrated within an existing irrigation system in Champassac Province in southern Laos, and

FAO's Approach to Solar Energy

FAO's energy activities aim at assisting developing countries to meet their energy requirements through better use of new and renewable energy resources in conjuction with more efficient use of commercial energy.

FAO's work on solar energy applications has been mainly in the field of solar drying of agricultural and fish products. A review of the present status of solar drying activities and state-of-the-art of available technologies relevant to this field was undertaken. The following three systems were identified by the expert meeting as offering the highest potential for diffusion :

- Cabinet-type dryers with natural convection for internal air circulation of up to 1 tonne capacity for the processing of candied fruits such as mango, banana, pineapple, apricot, pear, apple, and also for lotus seed, potato chips.
- Greenhouse-type dryers with forced convection air circulation of about 500 cubic metres capacity (or 6 tonnes) for the seasoning of timber, rabbit skins and the processing of candied fruits.
- Forced convection indirect systems of about 5 to 10 tonnes capacity for the drying of agricultural products, cash crops, ceramics, noodles, tobacco, marine products, oil seeds, root crops, hides and skins. Collector sizes can range from 200 to 600 square metres.

A design manual is being prepared by FAO for the three systems.

Field activities on fish drying have been carried out in fishing communities in Thailand. Tent dryers of various sizes and geometries have been tested, leading to a better understanding of the construction, operation and potential of these systems. Expansion of this work to include inland fish drying is being pursued as a complementary activity to the promotion of fish production in rice growing areas of Thailand.

Although, there are numerous technical reports on the design, construction and operation of solar dryers, limited diffusion of these systems has taken place. FAO is aware of this situation and is presently carrying out a study on the economic characteristics of their application. The study is oriented towards evaluating the economic variables controlling the adoption of solar dryers, formulating a methodology for this evaluation process and developing criteria to guide investments in this field. Fish and rice-paddy drying are presently being studied.

FAO is also constantly monitoring the development of other solar technologies such as photovoltaic cells and their applications to refrigeration, water pumping, lighting, etc., solar greenhouses, solar ponds and solar thermal systems. It has installed various commercial solar systems in field projects in different countries and is in contact with many producing firms so as to update its knowledge on technological advances, prices and markets. Although relatively small in comparison with other projects on energy, FAO considers its solar energy activities an important element of its work in energy for rural and agriculture development.

(Source: Extracted from *UNITAR/UNDP Centre on Small Energy Resources Newsletter*, Issue No. 10, 1988, pp. 5-7.)

- A 10 kW higher head (25 m) site at an undeveloped stretch along a stream in Luang Prabang Province in northern Laos.

The first site along the Houei Nam Sai about 30 km south of Pakse in Champassac Province was constructed in a period of about 4 1/2 months with the assistance of the local irrigation construction company. Water from an irrigation canal is diverted through a short power canal into a penstock leading to a 2-story millhouse. In this system, a turbine manufactured by Balaju Yantra Shala, Nepal has been installed on the ground floor and it drives a rice mill located on the upper floor with the help of belts. This rice mill has an output of 250 kg of milled rice per hour. Work on the mill was completed in March 1988 and it was turned over to the district office, which is responsible for running the mill.

The second high head (25m) 10 kW project is located in Luang Prabang Province along Nam Xi River. The water for this scheme was taken from one of the many pools found along stream downstream and it is led through a 200 mm PVC penstock to the millhouse. The turbine for this site was manufactured by Butwal Engineering Works, Nepal. This site has been designed such that plant capacity can be increased to 20-25 kW for slightly more than the cost of another turbine.

Material and labour costs for implementing the low-head Houei Nam Sai project were about US$ 20,000 (1988), with the imported turbine accounting for about 40% of this cost. The second project at Luang Prabang costed about US$ 13,000.

This project was implemented under the auspices of the Mennonite Central Committee (MCC), with a grant from Bread for the World, with the cooperation of the State Council for Science and Technology. The technical assistance was provided by the National Rural Electric Cooperative Association (NRECA)with grant from NRECA International Foundation.

(Source : Extracted from *Demonstration Micro-hydropower Rice Mills Project in the Lao People's Democratic Republic, July 1987-July 1988* by Allen R. Inversin, prepared for the Mennonite Central Committee (Akorn, PA) and the NRECA International Foundation, Washington D.C. This report was supplied by Allen R. Inversin, Micro-hydropower Engineer for this project.)

Brazil Proves Air Pump Viable

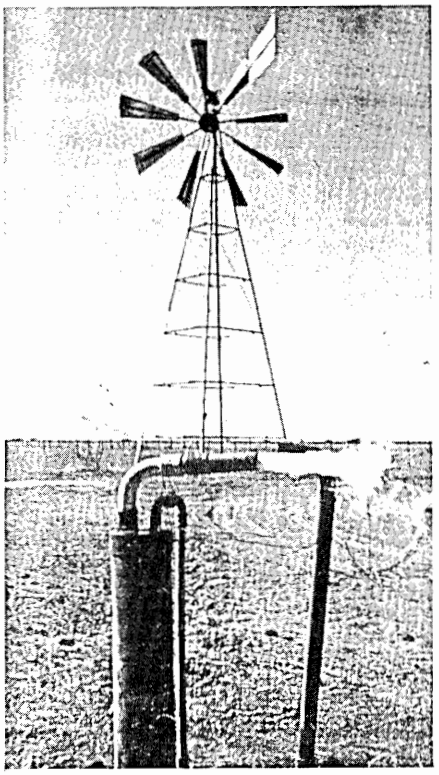
An innovative windpump - using a compressed air link between the rotor and pump to allow for siting of the machine at some distance from the well - has been developed in Brazil by the University of Recife in cooperation with Mapel s.a. of Salvador, an agricultural contracting and borehole drilling company.

The Bomba de AR Comprimido (BARC) windpump originates from an idea tested by Albert Soares of Mapel in the mid 1970s. He independently developed a compressed air windpump for his cattle ranch in the dry interior of northeast Brazil, using a standard compressor, found in most Brazilian garages and petrol stations, coupled to an air lift pump. Such a pump is nothing more than a nozzle injecting air at the bottom end of the rising main. The air mixture in it is lighter than the surrounding water in the borehole and rises to the surface.

During a seven year period of drought which followed this machine's installation, Mapel sold around 150 units, mostly for village water supplies.

Work by the Federal University of Recife corroborated that the system was eminently suited to local conditions. The water on which the 35 million inhabitants of the region rely is either saline or calcareous. The below surface components used in the windpump are all of PVC, avoiding problems of corrosion and calcium suffered by traditional metal piston pumps. In addition, boreholes are often percussion drilled and not perfectly straight so that problems are also created when pumprods chafe on their walls.

According to the university, these advantages, and the BARC's 80-85 per cent efficiency, outweigh the main drawbacks of low pump efficiency (around 30 per cent) and the need for deeper boreholes. Neither does the BARC need extra well depth, normally associated with air lift pumps which need to be submerged by at least one third of the pumping head to work with any efficiency. However in the region in which the prototypes have been tested most wells are already bored to sufficient depth. In addition a BARC windmill requires low starting torque, posing a serious threat to the traditional mechanical windpumps in terms of average output.



Experimental model: Advantageously the water rises at some distance from the pump.

The BARC consists of one or more pairs of tubular chambers, each with two hoses or tubes to the surface and a single foot valve. The chambers fill with water by gravity feed. Air pressure, applied through one hose, is then used to expel water from it, through the other hose. The chambers work alternately. The opening and closing of the air inlets and outlets is performed by a single multiple valve, located above ground, which is triggered pneumatically by the increase in air flow that occurs when a chamber has been fully emptied. The valve is an off-the shelf item.

The BARC-Mapel windpump has been patented in Brazil by FINEP, the agency that financed its development. Foreign patents have been applied for. It is currently undergoing an extensive monitoring programme being carried out by the Recife University with equipment supplied by the British Council.

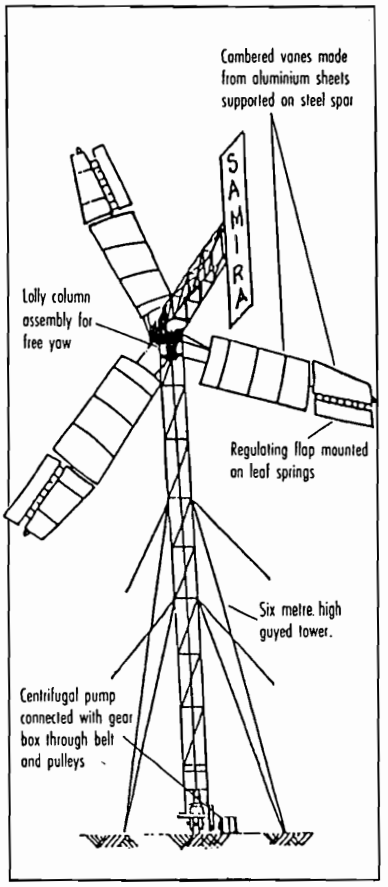
(Source : Extracted from *Brazil Proves Air Pump Viable* by J. van Beek, Wind Power Monthly, Vol.4, No.12, 1988, pp. 19-20.)

New Windpump for Low and High Winds

A low cost mechanical transmission waterpumper, an unconventional horizontal axis machine, has been designed and developed by National Aeronautical Laboratory (NAL) at Bangalore, India under its wind energy programme.

The machine, Samira, is primarily intended for water lifting from shallow depths in wind areas where its relative cost effectiveness is ensured. In this design reciprocating pumps have been replaced by rugged centrifugal designs equipped with gears. According to NAL, rotary transmission can be made virtually trouble free. Overspeeding is controlled by blade stall, an arrangement which is self actuating, resets automatically and is simple enough to be adapted to low cost windmills. Though its springs may be prone to fatigue, replacement is only a minor cost.

Samira's main advantage is that it can run in windspeeds up to 20 m/s and has been field tested in winds over 21 m/s when a typical low cost multivane design would have furled already at 10 m/s. Made entirely of steel, the machine weighs in at 800 kg, with the aluminium blades weighing an extra 40 kg.



Provided the wind resource is adequate Samira can effectively replace a five-horse power diesel pump. It is estimated that the cost of the machine can be recovered in less than five years through fuel savings alone. Samira can be coupled to small electricity generators for battery charging too. Clusters of modified Samira can also be utilised as stand alone systems with diesel back up. NAL is now working on a modified tower design to enable the pump to be lowered into an open well to avoid the suction limit of eight metres.

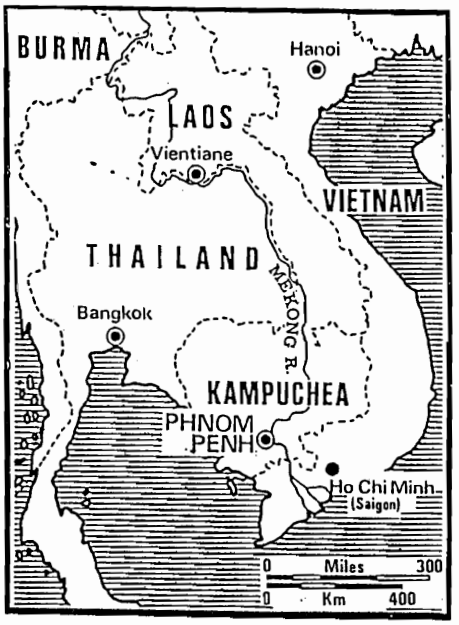
In India the standard multivane waterpumper, known as the American type, is too expensive if implemented with conventional technology. A typical 5 m rotor machine costs at least Rs 30,000 (US$2,000). Although low cost versions have been developed they do not offer satisfactory structural and performance reliability.

(Source: Extracted from *India Designs Pump for Low and High Winds* by N. Mathews, Wind Power Monthly, Vol. 4, No.12, 1988, p.20.)

Thailand - Laos Power Linkage

Thailand has maintained links with Laos for cultural and strategic reasons. The primary economic tie is the sale of hydropower from Laos to the Electricity Generating Authority of Thailand (EGAT). Under the terms of a ten-year agreement reached in 1982, Electricité du Laos (EdL) sells 80% of its capacity from 150 MW Nam Ngum Dam, located just north of Vientine on the Mekong River. Under this contract EdL sells 600 kWh annually to EGAT which is transmitted through a 155 kV line from the dam to substations in northeastern Thailand.

Thailand is facing an electricity squeeze because of an economic boom, and further electricity from Laos would be of great benefit to EGAT particularly for the rapidly-developing northeastern region, the closest region to the Thai-Lao border (Fig.1). With the improved political climate, Laos and Thailand have opened talks to cooperate on a number of hydroelectric schemes that previously have been considered only pipe dreams. The most realistic project includes building a 1,200 MW dam on the Nam Theun River in northern Laos. Some of the power from this plant would be sold to EGAT. Another big project (4800 MW) being considered will need a dam in the Mekong River at the border near the Laos city of Pa Mong.



While technically appealing, the scheme had previously been shelved because of the close technical cooperation that would have been required. However, in the new political climate the scheme may prove plausible. Outside funding agencies have shown their interests to finance the development of hydropower projects in Laos. The Asian Development Bank is helping to found the Lao Xeset Dam on the Xeset River, a tributary of the Mekong in the southern province of Saravane. Most of the scheme's power will be transmitted and sold to EGAT for an additional US$ M 5 a year. The total cost of the project is US$ M 39. Apart from the ADB, cofinancing is being provided by other sources - the Swedish International Development Authority has made a US$ M 17 grant for the hydraulic steelworks and the mechanical and electrical works; the UN Development Programme has given US$ M 1.76 to cover consulting services and vehicles.

(Source : Extracted from *Power in Asia*, Issue No.13, 1988, p.5.)

Private Power Activities in ASEAN Countries

A number of countries are turning to the private sector to help them meet power supply needs. Policies that allow such private participation have been introduced in the Dominican Republic, Pakistan, Indonesia, Philippines and Turkey, and are being developed in Thailand, Malaysia, and India. There are many reasons for this. First, large public sector debts of many developing countries hamper their ability to pay for new power sources. Second, the growing economics in these developing countries have created rapidly growing power demands. Third, the role of the private sector as developer of public sector infrastructure projects is expanding rapidly.

Activities related to private power generation in Indonesia, Malaysia, Philippines and Thailand, reported by the "Private Power Reporter" published by the US Agency for International Development, are as follows :

Indonesia

PLN Seeks BOT for Gresik

On 15 September 1988, Indonesia's National Utility (PLN) invited bids for the 900 MW combined cycle Gresik Power Plant. PLN will accept proposals for turnkey contracts or Build-Own-Transfer (BOT) arrangements for development. The project will require the developer to build the plant, ultimately expanding it to operate at 1,500 MW capacity. Bids and prequalification applications were accepted after 26 September 1988 and are due by 9 January 1989.

Malaysia

Privatization Proceeds

In its drive to cut public spending, the Malaysian government has encouraged private sector investments in public sector projects. The government is finalizing a privatization master plan to streamline this process and has ear-marked a number of infrastructure projects and industries for privatization, including the state-owned National Electricity Board.

The government has awarded an M$ 80 million power interconnection project to LBI Pte. Ltd, a local, privately-owned joint venture. LBI will finance, build, own, and operate two electrical substations and an 85 km power line between the island of Labuan and the mainland state of Sabah. After operating the concession for 15 years, the company will hand over the facilities to the government at no charge.

Philippines

Private Power Generation Plans

The National Power Corporation (NPC) has developed draft rules and regulations to implement the Executive Order No. 215 of July 1987, which gives the private sector the opportunity to construct and operate generating facilities and sell electricity. These regulations are currently under review and will be finalized in 1989.

NPC has indicated its interest in considering private sector proposals to develop power projects from its expansion plan including a 300 MW coal-fired plant at Calaca and a 200 MW gas turbine in Luzon.

Hopewell Proposes to Build Power Plant

Hopewell Holdings Ltd. (a Hong-Kong based development and engineering firm) has proposed to build, own, and operate a 200 MW gas turbine station in the Navotas Fishing Complex in Northern Manila. The plant will be transferred to NPC after 12 years. However, a disagreement between NPC and Hopewell over government guarantees has caused a delay in negotiations. Hopewell has also indicated its interest in developing two 350 MW coal-fired power plants in the Philippines.

Caltex Refinery Cogeneration Project

A consortium of five U.S. firms (Caltex Petroleum Company, Cogentrix, Foster Wheeler, Detroit Stocker, and General Electric) submitted a proposal to NPC in September 1988 to develop two 55 MW coal-fired units in the Caltex Oil Refinery. This cogeneration plant would supply energy requirements to the refinery and the excess power would be sold to NPC or other industrial users in the area. The project would cost approximately US$ 120 million.

Thailand

The National Energy Policy Office is currently developing guidelines for industrial cogeneration that will outline the terms for selling electricity to the grid. The government is also exploring the merits of private development of large power plants.

NPC/EGAT Agreement on Cogeneration Project

The National Petrochemical Corporation (NPC) and Electricity Generating Authority of Thailand (EGAT) have reached an agreement for a 55 MW cogeneration project. Under the agreement, NPC will sell the excess power to EGAT for distribution to EGAT's customers, including a few NPC subsidiaries.

Nongyai Sugar Mill Cogeneration Demonstration Project

The Nongyai Sugar Mill in Nongyai is participating in a 12-month cogeneration demonstration project sponsored by USAID. The project involves modifications to the sugar mill to allow it to generate 30 MW of power using bagasse as fuel. Power supplied by the system will be used by the mill and the excess will be sold to EGAT. Equipment used to collect the cane field residues has already been tested. The mill is expected to start generating electricity by mid-1989.

(Source : *A Summary of Private Power Activities in Developing Countries, Private Power Reporter*, January 1989, U.S. Agency for International Development, Office of Energy, Washington, D.C.)

Peak Load Management in Taiwan

Alarmed at the cost of building new power stations to meet fast growing peak load electricity demand, a number of Asian countries have introduced various load management methods in recent years to try and slow morning and afternoon peak load growth.

Tariffs have generally been the main method used for load management, with some governments publicizing their low night time tariffs overseas as part of efforts to attract foreign investors, such as electronics companies, which operate around the clock.

But low off-peak tariffs do not always provide a solution. In Taiwan the government recently has had to approve construction of a new power station following the failure of its two-year-old tariff-based load management programme to make any impact in curbing peak load growth. Plans for a new 700 MW combined cycle power station were drawn up in haste by state-run Taiwan Power Company (Taipower) early this year once utility officials realised that peak load growth at 10.03% was accelerating at double the previously projected rate of 5.5%, for the year 1988 due to the very high economic growth rate of Taiwan.

Efforts to redistribute peak load growth have failed mainly because industrial customers are unwilling to move part of their production schedules to off-peak hours. Currently Taipower's night time industrial off-peak tariff is about one-third the day time tariff, while evening half-peak rates are about 50% of the day peak rates.

Meanwhile, Taipower is being pressed by the government to develop other effective load management policies in order to hold back peak load growth to more reasonable levels in future. According to the utility's latest figures, Taiwan's peak load reached 12,330 MW in July 1988, up 10.3% from the peak load level of 11,113 MW recorded 12 months earlier.

Since the present peak load management has not been effective, Taipower is encouraging private industrial customers to use cogeneration and sell their surplus power at a reasonable rate to the state utility.

Over the past few years oil-fired cogeneration facilities installed by state-run and privately owned companies have begun to expand throughout the island. Currently some 18 companies have installed cogeneration plant totalling 723 MW, equivalent to 4% of Taipower's installed capacity. By putting in their own equipment, these companies have helped reduce Taipower's peak load growth rate. The state-run China Steel Corporation has installed 220 MW of cogeneration facilities, Formosa Plastics Corporation has 178 MW installed capacity; while the Chinese Petroleum Corporation has installed 100 MW of cogeneration plant at three refineries.

While a number of other state-run Asian power utilities are defending themselves against possible government support for privately-run power stations to help supply national grid requirements, Taipower already has passed the initial teething problems. Companies installing cogeneration plant are able to sell their surplus electricity production to Taipower at about 70% of the current average tariff rates.

Two more companies are due to begin operating cogeneration plant totalling 78 MW over the next 18 months. Whether Taipower is able to encourage other companies to install such plant will depend on how economical the scheme appears compared with buying in electricity from Taipower at industrial tariff levels.

(Source : Extracted from *Power in Asia,* Issue No. 13, 1988, pp. 3-4.)

Book Review

Training Manual on Energy Management

Regional Energy Development Programme (RAS/84/001)
United Nations Development Programme and Economic and Social Commission for Asia and the Pacific
(1987, 133p.)

A great deal of progress has been made in energy sector management in the past decade. The situation in the 1970s was characterised by sharp price hikes and shortages of oil, contributing to economic recession. Almost every country responded to the higher oil prices, leading to: (a) major changes in fuel mix, reducing the share of oil; (b) increase in indigenous production of fuels, reducing import dependence; and (c) reduced amount of energy required for each unit of gross domestic product. Conservation policy was an important part of national policies. The effectiveness of the conservation policies can be gauged from the 29 per cent economic growth registered in the past decade in the member countries of the International Energy Agency while holding the total energy consumption level.

Energy management in the industrial sector is stressed as this sector consumes 30 to 40 per cent of the commercial energy used in the economies of developing countries. While there is general awareness of the opportunities for reducing energy consumption in industry, progress in implementation has been slow and halting, particularly in medium- and small-scale industries. Part of the reason for this slow progress is lack of information on methodologies for management of energy. This training manual discusses many common aspects of energy management in small- and medium-scale industries. For existing organizations, implementing the least costly measures is a priority. These are commonly referred to as "good housekeeping practices" requiring measurement, control and monitoring of energy use. This calls for intensified and improved operating and maintenance practices. Savings ranging from 10 to 15 per cent have been realized where such efforts have been made in a systematic and planned manner.

In this training manual general approaches which are basic for energy management at plant level are discussed with stress on organization, auditing, monitoring and analysis. The manual is divided into five parts. The first part deals with energy management and audit, and includes an actual diagnostic audit of a factory in Thai-

Seminar on New and Renewable Energy

20-21 January 1989
Hanoi, Vietnam

The Seminar on New and Renewable Energy, held from 20-21 January 1989 in Hanoi, was organized by the Center of New and Renewable Energy Research, Hanoi, in cooperation with the Ministry of Electricity and the Scientific Institute, Hanoi.

Selected research papers in the fields of energy and renewable energy presented at the Seminar were published in "Scientific Bulletin of Universities". The main papers are in Vietnamese but English summaries are provided. The bulletin is published quarterly by Hanoi Polytechnical University.

Summaries of the research papers on solar energy presented at the Seminar are listed below.

Study to Improve the Structure of Solar Captor
by Nguyen Cong Van

The objective of this study was to improve the design of solar captors so as to increase the efficiency; to develop the technology for manufacturing them using local materials; and to reduce the costs of equipment. This study further aims at the local utilization and dissemination of this technology to other developing countries.

Technologies of Producing Thermoelectrical Semiconductor on Bi_2Te_3 Base
by Vu Linh

This paper reports some results of the investigation on the use of thermoelectrical semiconductors on Bi_2Te_3 base for thermoelectrical generators. The melting-zone method was used to obtain the pure materials Bi, Te and Sb. The semiconductors were grown using the technique of crystallization from the melting phase of the ceramics method. A model of the generators with electrical parameters 2W-3V, which used a small petrol-lamp as the heat source, was made.

Water from Solar Energy
by Le Van Khanh

Experimental data indicated that the productivity of capillary still was about 25% higher than that of basin type still of identical sizes.

A new capillary solar still with low thermal inertia was constructed and tested. An output of 6 to 7 liters of fresh water per square meter was obtained during a sunny day.

Technologies of Solar Cell Production and Natural Conditions in North and South Vietnam Where the Use of Solar Cells Has Been Investigated
by Vu Lihn

Solar Cells with capacities of a few watts to tens of watts were produced for applications, such as lighting, powering radio, radio-cassettes and TV-sets. This paper presents a review of feasibility of photovoltaic applications in Vietnam.

Solar Drying Equipment
by Nguyen Cong Van

Compared to traditional sun drying, the use of the solar dryer reduces drying time significantly and prevents other losses. Furthermore product quality can be improved significantly as the crop is completely protected from rain, dust, insects and animals, etc. A multi-purpose solar dryer was developed for drying various agricultural products, such as fruit, vegetables, and medicinal plant, etc. This paper describes some of the solar dryers constructed using local materials. Some of them were successfully tested in the LTE, Perpignan, France and at the Study Center for Renewable Energy Resources of the Polytechnic Institute of Hanoi, Vietnam.

Processing of Indium Tin Oxide
by Trinh Quang Dung

Indium Tin Oxide (ITO) films were prepared by reactive magnetron sputtering in a mixture of oxygen and argon. Excellent transparency of 95% at the wavelengths of 450 nm - 600 nm with a low sheet resistance 8 - 25 was achieved. The main factors which control the quality of ITO have been studied. ITO films are not only used as a front contact of solar cells but also as an antireflection coating (ARC) so the influence on the photovoltaic parameters such as V_{oc} and I_{sc} of a Si:H P-I-N diodes are presented.

land. Good housekeeping practices and checklists for common plant and equipment and services are outlined in part two. Calculations and case studies are given in part three, to help readers to do calculations based on measurements done in their plants. In part four figures and tables are given, based on which energy saving potential may be identified and calculated. These tables generally give targets and norms on important plant operating parameters. Part five briefly describes energy conservation technologies widely applied in developed and some developing countries, mainly to inform the readers on hardware-based energy saving solutions.

The training manual has been made as practical and simple as possible. Examples and case studies ESCAP/REDP on Energy Conservation (1 May 1985 - 10 August 1986) have been used extensively. The manual is intended for beginners as well as practitioners of energy management.

CHANGING VILLAGES
Rural News & Views

The journal "CHANGING VILLAGES", a technology oriented journal, published by the Consortium on Rural Technology is being revived. Contributions of articles on appropriate technologies, reviews on related literature are invited.

For details contact:
Consortium on Rural Technology
D-320, Laxmi Nagar
Delhi 110092, India

NEWSLETTER
New & Renewable Sources of Energy in China

The "Newsletter - New & Renewable Sources of Energy in China" is published quarterly by the Office of Information Network of New & Renewable Energy Resources in China (INNRERC), Chongqing Branch of the Institute of Scientific and Technical Information of China (CB-ISTIC), with support from UNESCO and the Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP). It reports research, development and application activities on energy and renewable energy in China.

For further information and subscription please contact :
INNRERC, CB-ISTIC
P.O. Box 2104, Chongqing, Sichuan
People's Republic of China

Publications Received

Biomass Energy

• *Economic Cook Stove*, Appropriate Technology Development Organization (1-B Street 47, F-7/1, P.O. Box 1306, Islamabad, Pakistan), 1985, 16p.

• *Dilution Tunnel Measurement of Wood Heater Emissions : Equipment Construction and Commissioning*, J.J. Todd, T.A. Quraishi and L.R. King, University of Tasmania, Centre for Environmental Studies (P.O. Box 252C, Hobart, Tasmania 7001, Australia), 1988, iv+95p.

• *Charcoal in Northeast Thailand: Rapid Rural Appraisal of Wood-based, Small-scale Enterprise*, Opart Panya, G.W. Lovelace, Prasat Saenchai and Panomsak Promburom (KKU-FORD Rural Systems Research Project, Khon Kaen University), Regional Wood Energy Development Programme in Asia (GCP/RAS/111/NET), Food and Agriculture Organization of the United Nations (FAO Regional office for Asia and the Pacific, Maliwan Mansion, Phra Atit Road, Bangkok 10200, Thailand), June 1988, xviii+62p.

• *Wood Based Energy System in Rural Industries* and *Village Applications - Nepal*, P.N. Suwal, Regional Wood Energy Development Programme in Asia (GCP/RAS/111/NET), Food and Agriculture Organization of the United Nations, Bangkok, December 1988, ii+84p.

• *Development of a Charcoal Retort Pilot Plant in Zambia*, African Energy Programme, Research Report Series No. 4, F.D. Yamba, Commonwealth Science Council, Technical Publication Series No. 239 (Commonwealth Science Council, Marlborough House, Pall Mall, London SW1Y 5HX, U.K.), May 1988, viii+49p.

Energy

• *Energy Conservation in Developing Countries : Report of the Executive Director*, Energy Report Series ERS-16-86, United Nations Environment Programme (P.O. Box 30552, Nairobi, Kenya), March 1986, ix+160p.

• *The Environmental Impacts of Production and Use of Energy, Part IV - Comparative Assessment of the Environmental Impacts of Energy Sources, Phase III*

• *Assessment of Tools and Methods for Incorporating the Environmental Factor into Energy Planning and Decision Making*, Energy Report Series ERS-17-86, Technical Research Centre of Finland, ESPOO, and United Nations Environmental Programme, Nairobi, June 1986, iii+91p.

Hydropower

• *Micro Hydel Plant*, Government of Pakistan, Appropriate Technology Development Organization (1-B, Street 47, F-7/1, Islamabad, Pakistan), 16p.

Diary of Events

♦ **May 8-12, 1989, Colorado Springs, Colorado, USA**

Eleventh Symposium on Biotechnology for Fuels and Chemicals

For further information contact :
Elias Greenbaum
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831-6194
USA

♦ **August 6-11, 1989, San Diego, California, USA**

Optical Materials Technology for Energy Efficiency and Solar Energy Conversion VIII

This conference is part of the SPIE's 33rd Annual International Technical Symposium on Optical & Optoelectronic Applied Science and Engineering. It will be held during 6-11 August 1989 at the Town and Country Hotel in San Diego, California.

For details contact :
The International Society for Optical Engineering
P.O. Box 10
Bellingham, Washington 98227-0010, USA
Tel: (206) 676-3290
Telex: 46-7053
Telefax: (206) 647-1445

♦ **August 16-17, 1989, Bangkok, Thailand**

Conference on Integrating Energy and Environmental Management: Trends and Opportunities in Thailand.

The conference will be held on August 16-17, 1989, at the Hyatt Central Plaza Hotel, Bangkok. It is being held in conjunction with ENERGY TECH, INSTRUMEX, ENPOLLEX '89 - Energy and Pollution Control Engineering Exhibition. Topics to be covered are impacts of energy use on the environment and options for reducing the environmental impacts through energy efficiency.

For details please contact:
The Energy Conservation Center of Thailand
c/o National Energy Administration
17 Rama I Rd., Phatumwan,
Bangkok 10500
Thailand.

♦ **September 11-29, 1989, Miramare-Trieste, Italy**

Workshop on Materials Science and Physics of Non-Conventional Energy Sources

The International Centre for Theoretical Physics, Trieste, Italy will conduct a Workshop on Materials Science and Physics of Non-Conventional Energy Sources from 1 to 29 September 1989. It will be directed by Profs. D. Nobili (L.A.M.E.L., Bologna, Italy), A.A. M. Sayigh (Engineering Department, University of Reading, U.K.) and B.O. Seraphin (University of Arizona, Tucson, U.S.A.). The local coordinator will be Prof. G. Furlan (University of Trieste and ICTP, Italy).

This Workshop is sponsored by the Direzione Generale per la Cooperazione allo Sviluppo, and the CNR (National Research Council), Italy.

For details please contact :
Workshop on Materials Science and Physics of Non-Conventional Energy Sources
International Centre for Theoretical Physics
34100 Trieste
P.O. Box 586 Miramare
Strada Costiera 11, Italy
Tel : 2240-I
Cable: CENTRATOM
Telex: 460392-I

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Charcoal Fuelled Open Core Ferrocast Gasifier Engine Systems for Lift Irrigation in Thailand

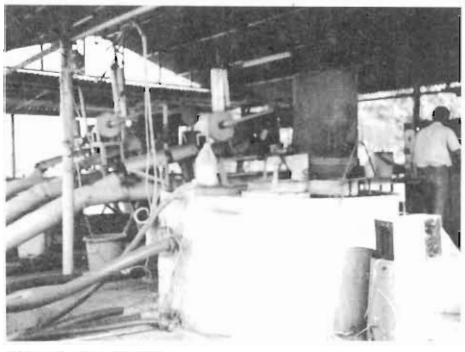


Fig. 1. Ferrocast gasifier engine system.

A research project funded by the GTZ/ Federal Republic of Germany has been conducted at the Asian Institute of Technology (AIT), Bangkok, Thailand to develop and test innovative cost effective designs, materials and fabrication methods for open core gasifier coupled engine pumping systems ranging in shaft power output from 1 to 10 kW for use in lift irrigation. The ferrocast gasifier concept represents a radical departure from classical metal charcoal gasifier systems. By employing an integrated design approach (ferrocast technology in combination with cast refractory open core reactors) it is now possible to achieve new gasifier configurations that can be fabricated using local craft skills and readily available materials which resolve many of the bottlenecks, such as tooling and system costs, methods of dissemination, corrosion, gas sealing and scaling to match available IC engines which are encountered with conventional charcoal gasifier systems. It also facilitates ease of repair, operation and maintenance.

Ferrocement, the primary material used in the construction of this water cooled gasifier, consists of a skeletal steel framework covered on both sides with wire mesh to form an armature of the desired component shape. A mortar comprised of a mixture of cement and fine screened sand mixed with water is then plastered to the armature forcing the mortar into the wire mesh. Although ferrocement has been successfully used in the construction of boats, wall and roof elements, liquid oxygen, water and grain storage tanks of various sizes and shapes, the application of ferrocement for the fabrication of gasifier components was not found in the literature.

Three ferrocast prototypes ranging in power output from 2 to 8 kW coupled to used automotive engines and locally manufactured low head mixed flow pumps providing water for crop irrigation at AIT are currently under test and refinement.

To clean the producer gas, both sand and cloth filter trains in combination with cyclones and settling tanks were studied.

System Design and Description

The ferrocast design is a modular system with a series of ferrocement cylindrical vessels each performing a specific function and interconnected by ferrocement piping all enclosed within a ferrocement tank. The ferrocement cylinders are submerged in water which is continually replenished by the irrigation pump through a bypass pipe. Water flows out of the tank by gravity to the pump outlet channel.

The ferrocement vessels are water cooled providing a relatively uniform temperature gradient over the ferrocast cylinder outer walls to minimize thermal stress. The water also serves as a heat transport fluid to make use of all cylinder walls as gas/water heat exchangers for gas cooling.

The arrangement and function of the individual cylinders and a description of all system components of one of the prototypes are provided in Fig. 2.

System Performance

The ferrocast gasifier Prototypes 2&3 are under test coupled to a 500 cc (with 4-speed transmission) and 1500 cc (direct

Cont. P. 2

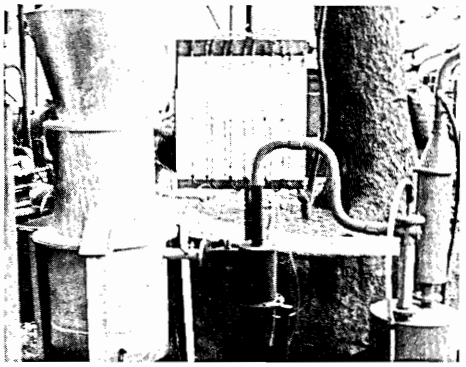
wind and sun compendium
Development of wind and solar energy for water pumping
CWP
Consultancy Services
Wind Energy
Developing Countries

Energy Information Service, CSIRO
Incorporates news from the Energy Information Service, CSIRO and Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).
INNERTAP

The State-of-the-Art Report on Rice Husk Gasification - The Indian Scene

Report prepared for BTG Group, University of Twente Enschede, the Netherlands by Biomass Gasification Research Group, Department of Mechanical Engineering Indian Institute of Technology Bombay 400 076, India, (1989, 75p.)

This report has been compiled as part of the project undertaken by the BTG Group at the University of Twente, the Netherlands to study the state-of-the-art of rice husk gasification. The report is divided into four sections: general country information; rice and rice mill industry; rice husk availability and its present usages, and rice husk gasification technology status. Lists of rice miller's associations, rice mill manufacturers, trading organizations dealing with rice and rice products as well as research institutions working in the area of rice husk utilization are included.



The modified set-up of the rice husk gasifier model IITB-II.

In India there are several academic and industrial groups which have been engaged in R&D activities related to the utilization of rice husk as a source of energy. Among the academic institutions are:

Bharatidasan School of Energy, Tiruchirapalli

The main gasification activity at the Bharatidasan School of Energy relates to the development of a 250 kW fluidized-bed rice husk gasification system funded by the Department of Non-Conventional Energy Sources (DNES), Ministry of Energy. A 5 kW fixed-bed downdraft rice husk gasifier for thermal applications is also being developed.

Indian Institute of Technology (IIT), Bombay

The rice husk related work at IIT-Bombay started in 1986. Since then two gasifiers have been designed, and prototypes developed and tested. The gasifiers are open-top, downdraft and throatless type. One gasifier is an intermittent semi-batch operation system which consumes 5 kg of rice husk per batch. In a typical run, 19 kg of rice husk are consumed in 165 minutes producing 14.3 m^3/hr of gas. The other one has a capacity of 45 m^3/hr of gas and consumes 25-30 kg/hr of rice husk.

Indian Institute of Technology (IIT)-Delhi

Rice husk gasification related activities at this institute are divided into two categories: fundamental studies, and equipment and process development projects.

Characterization of rice husk with reference to proximate and ultimate analysis, heating values and ash properties has received significant attention. Kinetic studies for determination of the rates of gasification, pyrolysis and combustion under various operating conditions and atmospheres have been carried out with an aim to identify the problems relating to incomplete combustion of rice husk. These studies have helped in establishing specific operating parameters such as heating rates, processing temperatures and residence time. Use

Charcoal Fuelled Open Core Ferrocast Gasifier Engine Systems for Lift Irrigation in Thailand

From P. 1

drive) engine driven 6" and 8" mixed flow pumps (with a head of 3 metres). Initial test results comparing charcoal to petrol fuel requirement for water pumping have yielded charcoal to petrol fuel consumption ratios ranging from 1.3 to 2.1 kg of charcoal per litre of petrol. Actual charcoal fuel consumption in the most efficient pump and engine combination has resulted in 1.9 kg of charcoal per 100 m^3 of water lifted.

Sand as a filter medium for gas cleaning was found to be unacceptable because of deposits found in the engine which rapidly reduced engine compression and fouled spark plugs. The sand filter tends to remove the carbon particulate fraction but increases ash sintering to form sub micron particles which pass easily through the filters independent of sand size or gas velocity. Cloth filter trains minimize ash size reduction because of lower superficial velocities and the trapping of both ash and carbon simultaneously to form a cushioned impact surface. When using cloth filters no deposits were found in the engine.

Test results revealed that the ferrocast gasifier concept does not appear to have any significant drawbacks. The initial system cost, method of fabrication and performance potential suggests that stationary low ash carbonized fuelled gasifiers can be economically viable and resolve many of the problems associated with dissemination.

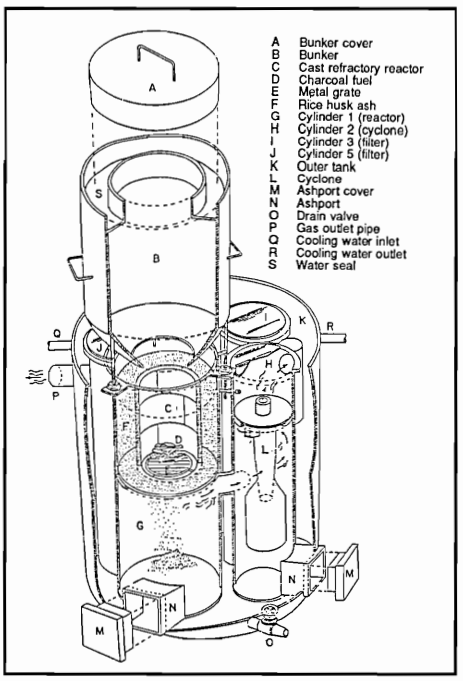


Fig. 2. Ferrocast gasifier, Prototype 3.

(Source: Extracted from *Charcoal Fuelled Open Core Ferrocast Gasifier Engine Systems for Lift Irrigation in Thailand* by R.G. Reines, Bui Tuyen, Alan Gonzales and Wu Weizhang, 6th International Solar Forum: Renewable Resources and Efficient Use of Energy in Industrialized and Developing Countries, 30 August - 2 September 1988, ICC Berlin, DGS-Sonnenenergie Verlags Gmbh, München, 1988, pp. 1112-1119.

of steam at the right stage is stated to have resulted in complete conversion of rice husk into combustible and tar free gas and carbon free white ash which is in an amorphous form.

The technology development activities carried out at IIT- Delhi are as follows:

Project-I

Under a UNIDO/UNDP sponsored project, a pilot plant to pyrolyse 25.3 kg/hr of rice husk was designed, fabricated and operated for three months in 1985 in the Philippines.

Project-II

A scaled-up pilot plant to pyrolyse 250-300 kg/hr of rice husk is being installed at a private rice mill near Delhi under the support of Department of Non-Conventional Energy Sources (DNES). Sub-systems of this plant, such as feeding and discharge mechanisms, have already been fully tested. Simultaneous production of amorphous silica has been confirmed in pilot testing.

Project-III

Two models of batch type, moving bed, annulus downdraft gasifier have been tested. The models performed basically as pyrolysers with minimal reduction of fixed carbon. Highly carboneous ash was produced.

In addition to the above-mentioned activities, works have also been carried out on: the development of a process for production of carbonized fuels from rice husk; the design of more efficient biomass stoves for cooking purposes; and the process for recovery of sodium silicate and activated carbon from rice husk.

Indian Institute of Technology (IIT) - Kharagpur

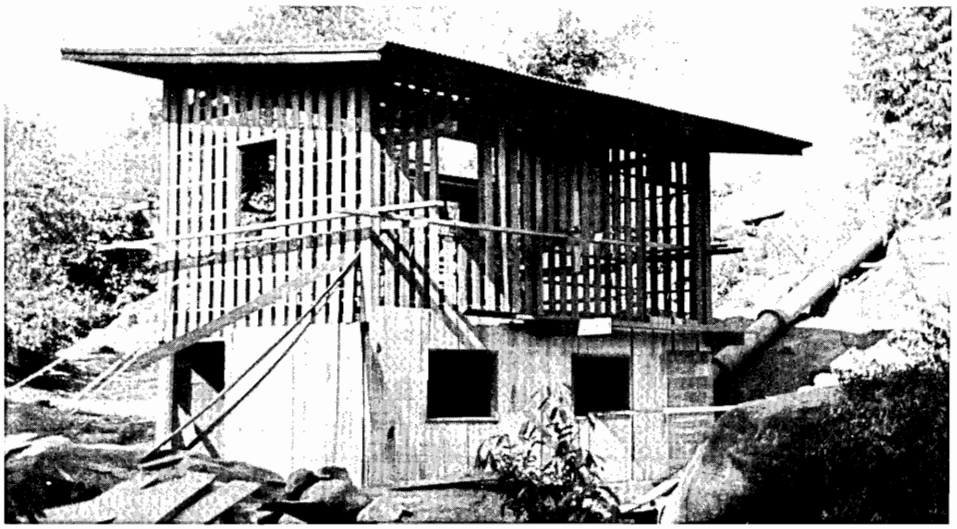
The research work of the Post Harvest Technology Centre (PHTC) of IIT- Kharagpur concerning potential uses of rice husk has mostly focussed on its utilization in the rice mill. In a current project a system which can simultaneously produce combustible gas and white ash for subsequent production of amorphous silica is being developed.

For further details about rice husk gasification activities in India please contact:

Prof. P.P. Parikh
Biomass Gasification Research Group
Department of Mechanical Engineering
Indian Institute of Technology
Bombay 400 076, India

Focusing on Project Viability and Replicability

*Allen R. Inversin**



Millhouse on the Houei Nam Sai in Laos where a 10 kW crossflow turbine on the ground floor, operating under a head of 5 m, drives a rice huller on the upper floor.

All too frequently, demonstration renewable energy projects are implemented in the field with little thought given to ensuring that they represent a viable and therefore replicable technology. However, in the implementation of the micro-hydropower mills in Laos described in the March 1989 issue of RERIC News, viability and replicability were major considerations.

Over the past several years, there has been increasing interest in Laos in harnessing indigenous hydropower resources to provide electricity to remote rural areas. At the "micro" end of the power scale (i.e., several kilowatts), some completely indigenous efforts have been undertaken with limited success.

To promote a viable approach to implement micro-hydropower projects in Laos, the Mennonite Central Committee (MCC) began by constructing two demonstration 10 kW micro-hydropower rice mills in opposite parts of the country. The first mill, 30 kilometers south of Pakse, is operating under a 5 m head and harnesses excess water in an irrigation canal. The second project, 30 km south of Luang Prabang, involved excavating a 350 m canal across a steep hillside to convey water from below the foot of a scenic waterfall to the village, resulting in a drop of 27 m.

The MCC has previously been involved in a very successful effort in Nepal where, in the past 15 years, *over 600 micro-hydropower plants* have been installed in rural areas, contributing *6,000 kW* of mechanical and electrical power *without subsidies* from either government or bilateral aid programs. Approximately a *dozen local manufacturers* in Nepal are now fabricating and installing turbines on their own.

Although in Laos, as in Nepal, there is frequently a demand for electricity for lighting, the MCC began by focusing on providing direct mechanical power to meet an existing need found in rural areas for rice hulling.

Since the two plants had to be implemented from scratch within a brief span of one year, it was decided to import crossflow turbines from Nepal. This permitted: (1) costs lower than those of turbines imported from industrialized countries, and (2) a rudimentary yet tried design which could serve as a prototype for turbines eventually fabricated in Laos.

Costs for the two projects were US$ 18,000 and US$ 13,000 respectively. If more time had been available, these costs could have been reduced significantly by: (1) local fabrication of the turbine, (2) less

Cont. P. 4

*Micro-Hydropower Engineer with the National Rural Electric Cooperative Association (NRECA) who provided MCC with technical on-site assistance supported by the NRECA International Foundation.

Testing of Energy Related Equipment in the Tropical Humid Climate

A test facility has been developed at the Division of Energy Technology of the Asian Institute of Technology (AIT) to provide the manufacturers of energy related equipment with the means to evaluate the performance of their product in the tropical humid climate.

Research, teaching and training activities in the field of new and renewable energy have been carried out in the Division of Energy Technology for almost 10 years. Many products available in the market were acquired for the Energy Park. Though these products had passed the tests in specialised laboratories using the national or international standard methods in their respective countries, the performances of many of them on site were found to be quite unsatisfactory mainly due to the adverse effect of the climate. It was strongly felt that facilities should be available in order to bridge the gap between the manufacturers, agents and consumers. This did not mean that the products would have to pass one more standard test but the manufacturers would get test results that may not only help them to improve the product quality but could also be used as a reference for designing and sizing to match properly with the requirements of a humid tropical climate.

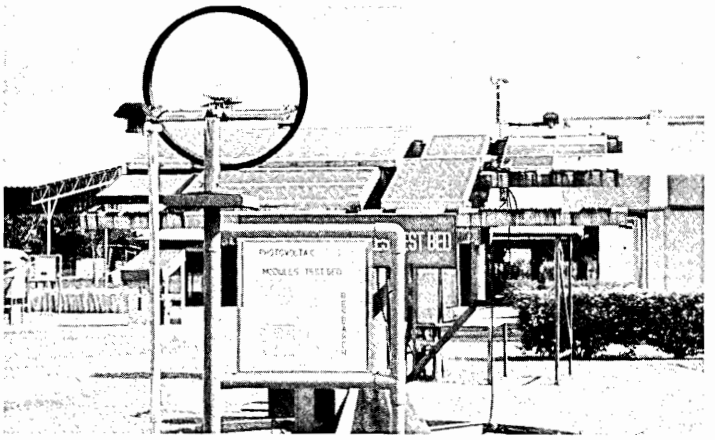


Fig. 1. Photovoltaic module test-bed.

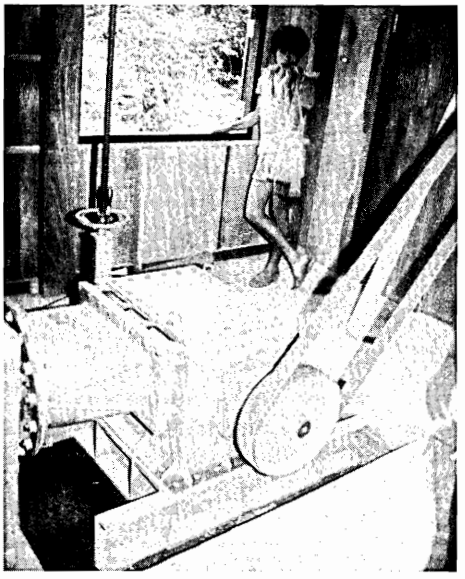
Therefore, a project was initiated with the sponsorship of the French Agency for Energy Management (AFME) with the objective to help in the transfer of technology from industrialized countries to developing countries by providing technical information such as the actual performance, productivity, efficiency and relia-

Focusing on Project Viability and Replicability

From P. 3

use of reinforced concrete, (3) more involvement of local villagers in actual construction of the civil works and millhouse, and (4) more rudimentary yet adequate designs.

To encourage project replicability, *increasing revenues* is as important as *reducing costs and complexity*. By focusing on a productive, income-generating end-use and operating the mills an 8-hour day, US$ 5,000/year in net profits could be generated. This is equivalent to an internal rate of return (IRR) of 25-40% even with the relatively high plant costs. If mills are judiciously located in rice-growing areas and well-managed, operating these mills for the better part of each day would generate enough income to cover the costs of the mills in 1-2 years.



A 10 kW crossflow turbine made by Balaju Yantra Shala, Nepal, operating under a head of 5 m, is more than adequate to drive the rice mill at the Houei Nam Sai site in Laos.

The rice mill on the Houei Nam Sai in Laos, driven by a turbine located on the ground floor, hulls 250 kg/hr.

On the other hand, had efforts initially focused on generating electricity, as is commonly done, and sold at the urban rate of about US$ 0.02/kWh, lighting would only have generated no more than about US$ 400/year, much less than milling revenues. A plant operated in this manner would not be replicable without continuing external funding. But if electrification is still of interest, a more viable approach would be to cover plant costs primarily through mechanical milling during the day and generating electricity primarily in the evening as a social benefit.

Because some villagers charge batteries in town for DC lighting for about US$ 2.00/kWh, battery-charging could also prove a viable end-use, generating considerable revenue while simultaneously reducing villager expenditures for battery charging. This would permit an initial stage of rural electrification primarily for lighting without the high costs of distribution lines and sophisticated generation and control equipment.

Future efforts in Laos will focus on local fabrication of reliable equipment, more appropriate designs and approaches to implementation, other income-generating end-uses, and ensuring a suitable rural credit mechanism to cover financial needs of individuals and organizations interested in installing micro-hydropower mills.

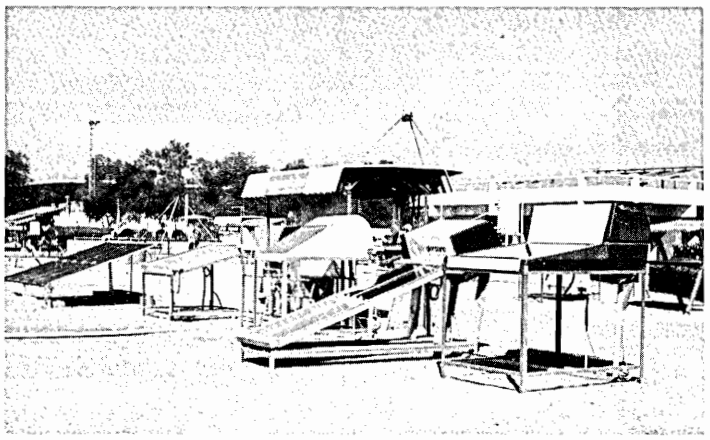


Fig. 2. Test-bed for solar thermal collectors and water heaters.

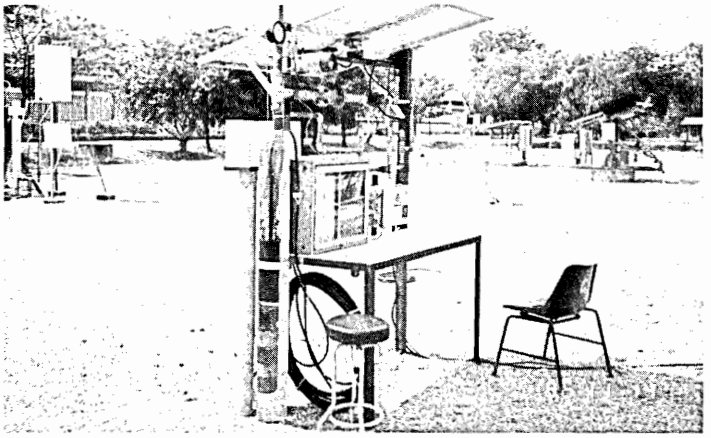


Fig. 3. Photovoltaic pump test-bed.

bility of energy products in the tropical humid climate and environment. It is expected that in the long run, this could contribute to the establishment of a regional testing facility at AIT which could deliver a kind of "certificate of performance".

Various test-beds have been set up at the open field Energy Park for intermittent and long-term testing of products in the field of new and renewable energy and rational use of energy (see Figs. 1-3). Products mainly related to solar thermal and photovoltaic applications have been extensively tested. In most cases, the results have been presented as defined by the manufacturers themselves so that they can be directly exploited in the product catalogs without any modifications. During the test period, feed-back is provided to the manufacturer on a confidential basis regarding the product quality and recommendations are made on possible modifications and improvements in the conception of their products to suit to the region.

It is also worth noting that at the request of the World Health Organizations (WHO), an experimental facility has been added to the existing ones in order to conduct tests on cold chain equipment according to WHO specifications and test procedures.

Each test-bed is well instrumented with various sensors necessary for performance evaluation. Figure 4 shows the schematic diagram of the solar water pump test-bed which is fully equipped to record solar insolation, ambient temperature, module surface temperature, PV panel current and voltage, manometric head and instantaneous water flow rate. Data is stored at an interval of one to five minutes in a portable memory storage module connected to a compact programmable data logger. At the end of every day, data from the memory storage module is transferred to an IBM compatible microcomputer where it is processed using a specific computer package especially developed to analyse the results. Figure 5 shows the type of results that one can expect from the data

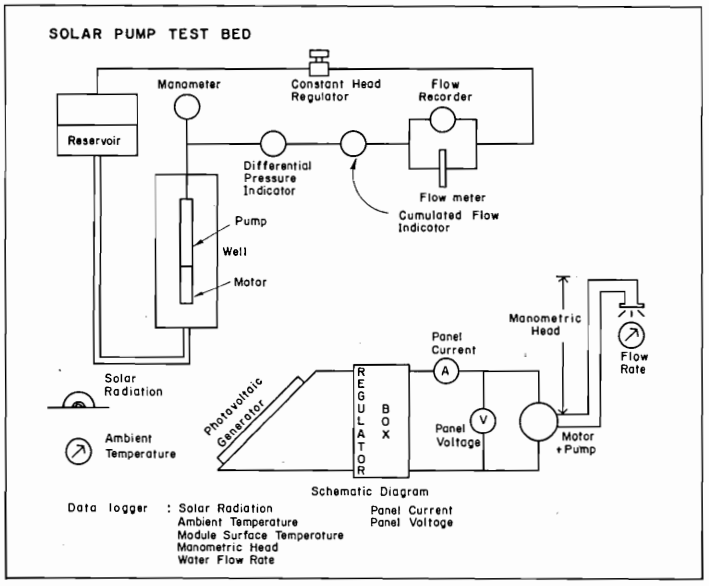


Fig. 4. Schematic diagram of the solar water pump test-bed.

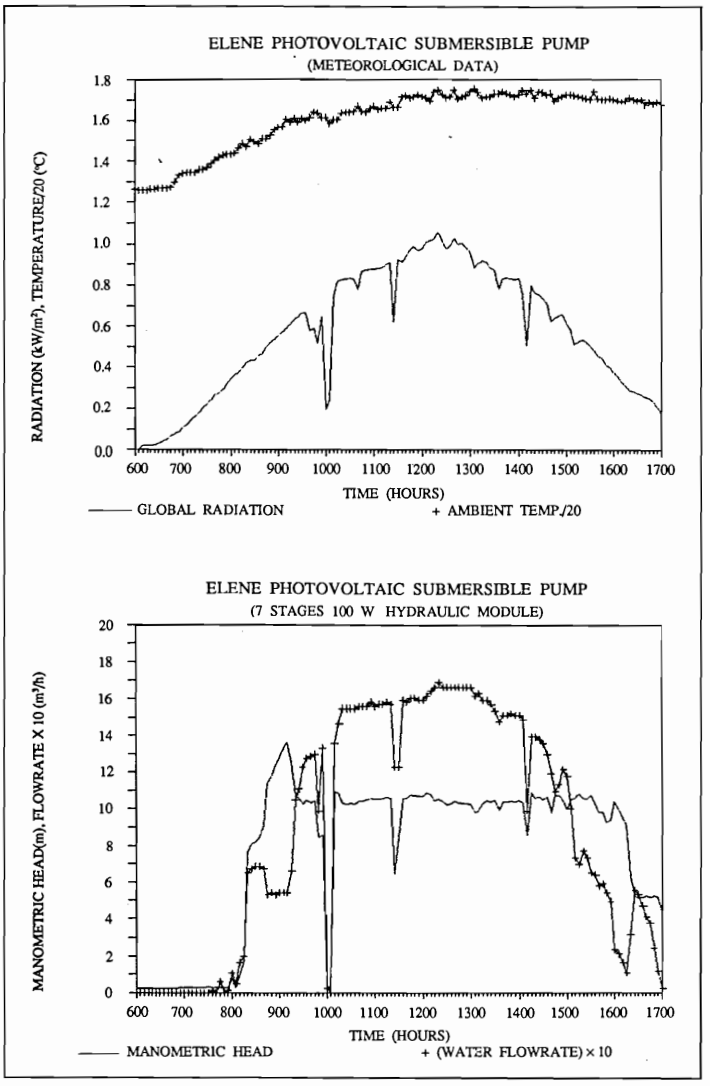


Fig. 5. Results of the performance of a photovoltaic submersible pump for a typical day with clear sky conditions.

Testing of Energy Related Equipment in the Tropical Humid Climate

From P. 5

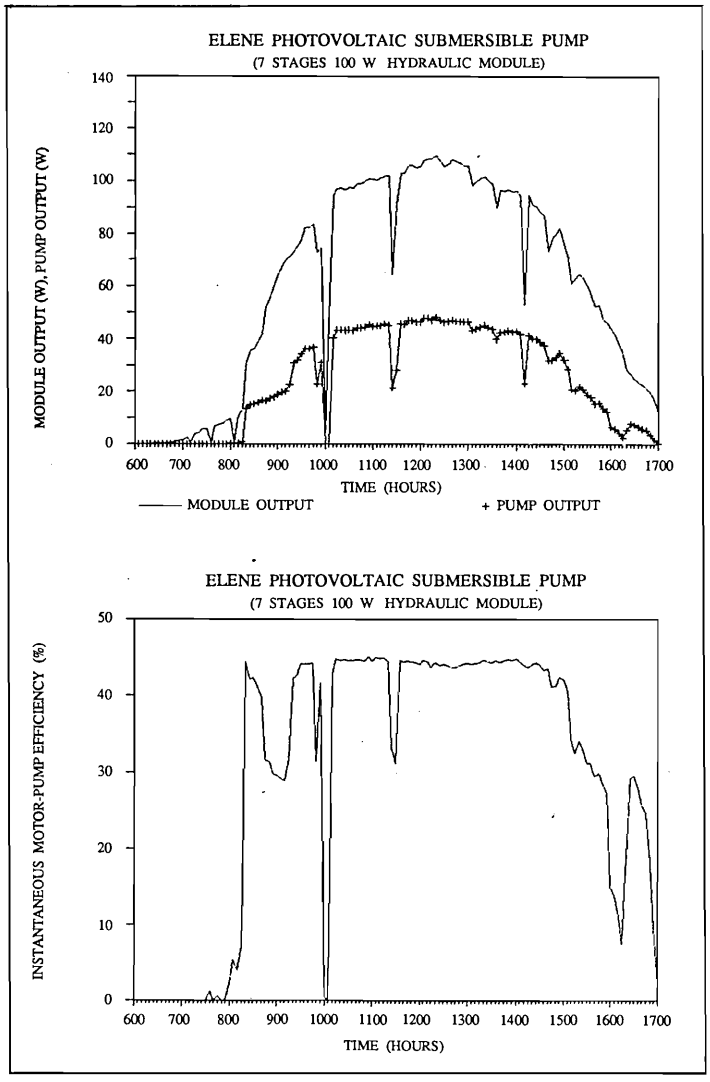


Fig. 5. (Cont.)

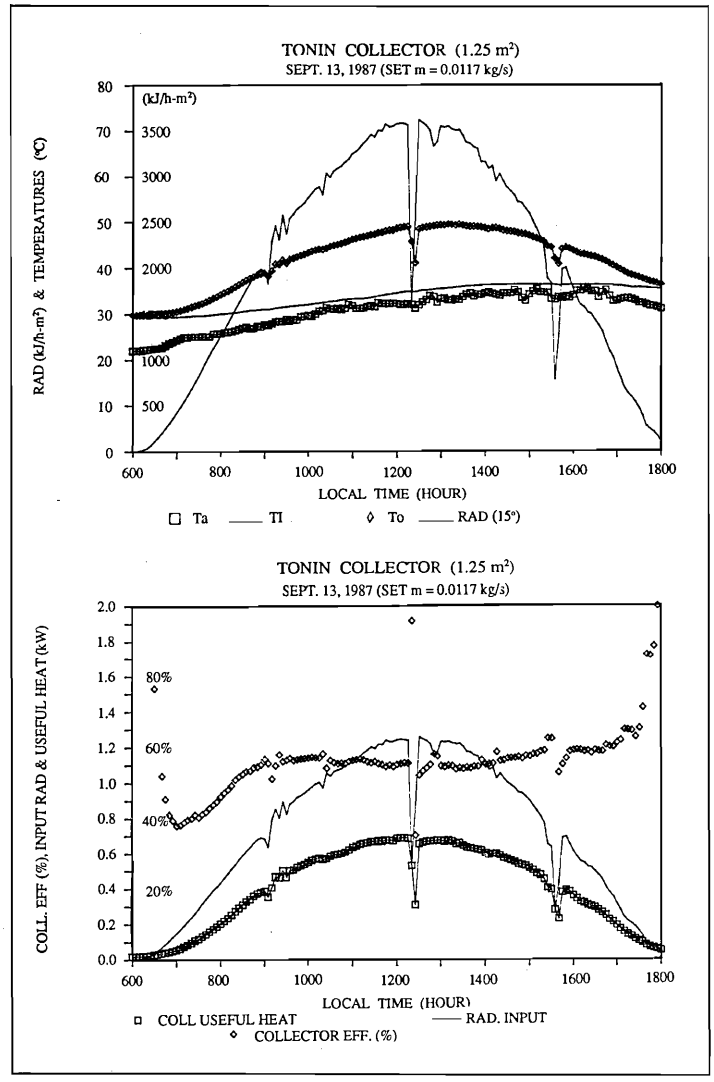


Fig. 6. Results of an analysis of a quasi-static solar thermal collector performance.

collected from the solar photovoltaic water pump test-bed for a typical day with clear sky conditions. Apart from presenting the measured results, the package calculates the module and pump outputs, and instantaneous motor-pump efficiency.

Similar to the pump test-bed, other units are available for evaluating the steady-state and transient performances of a solar thermal collector for either domestic or industrial applications. Figure 6 presents the results of an analysis of a quasi-static solar collector performance for preheating of a working fluid in an industry. Apart from providing the collector inlet and outlet temperatures, ambient temperature and the solar insolation on the plane of the collector, the package calculates the useful heat collected and the collector instantaneous efficiency throughout the day.

All the daily results are compiled to study the seasonal or long-term equipment performances. An example of such an analysis is presented for a solar water heater in Fig. 7. The maximum temperature in the storage tank of the water heater is plotted against the incident solar radiation. The effect of water withdrawal in the evening or the morning of next day are studied separately to estimate the losses from the storage tank. It is expected that if the hot water requirement of a client is known and the climatic data of the site is available, the manufacturer can make use of this result as a nomograph to design a suitable solar thermal system.

The testing of the equipment (the results of which are presented here) were carried out under the supervision of Dr. B. Mohanty. For further details of the testing facilities and the terms and conditions of testing a specific product, please contact: Mr. P. Bouix, Division of Energy Technology, Asian Institute of Technology, G.P.O. Box 2754, Bangkok 10501, Thailand.

Power Surge: The Status and Near-Term Potential of Renewable Energy Technologies

Despite a 90% cut in federal research and development funds during the Reagan Administration, renewable energy technologies have grown dramatically during the past eight years and now account for almost 10% of all domestic energy sources. They are poised to at least double their contribution by the year 2000.

Further, costs for these technologies have declined by as much as 75% since 1980. Renewable energy has consequently become a leading option for mitigating global warming – capable of eliminating at least 15% of U.S. carbon dioxide emissions by 2000.

These are among the key finding of a new study, *Power Surge: The Status and Near-Term Potential of Renewable Energy Technologies,* released by Public Citizen and more than 20 other citizen groups around the country.

The study is based on hundreds of interviews and documents obtained from government and industry sources. It represents the first comprehensive study of the price and supply status of wind, geothermal, direct solar, hydroelectric, and biomass energy technologies since the end of the Carter Administration.

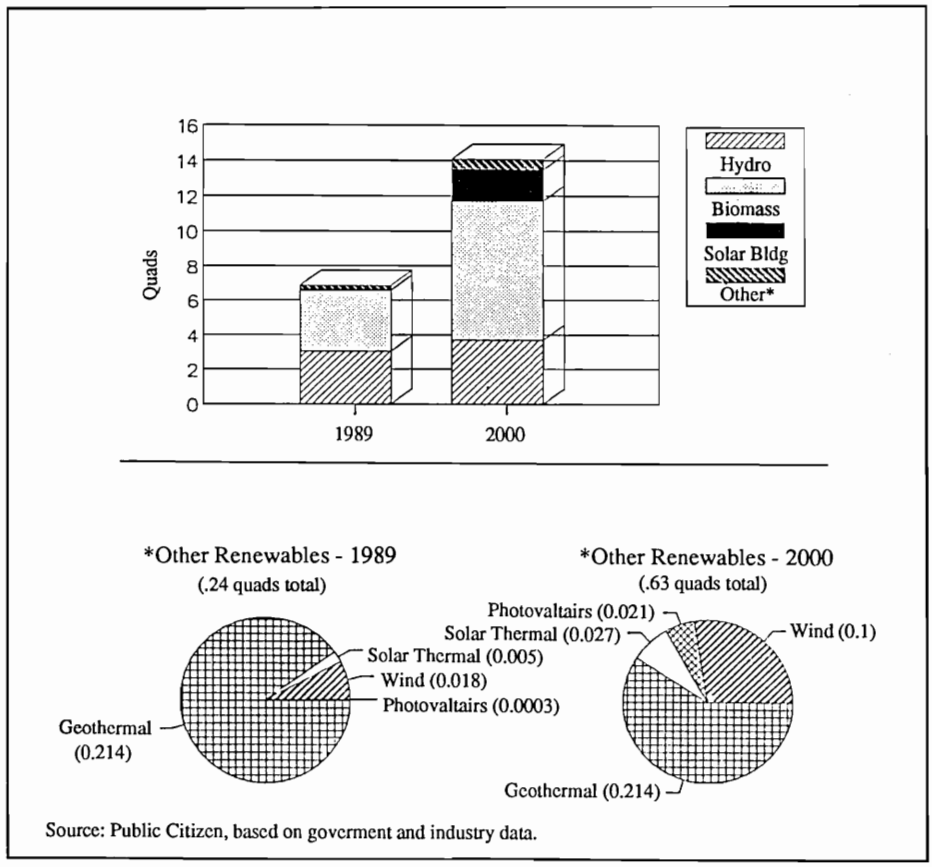


Fig. 1. Current and projected domestic renewable energy supplies.

Public Citizen found that while hydropower presently accounts for about 40% of total U.S. renewable energy use, biomass, wind, geothermal, and direct solar technologies account for much of the current growth. For example, the electric capacity of renewables other than hydropower has increased 10-fold over the past ten years; they now supply the equivalent of about eleven 850-MW coal or nuclear plants.

Including hydropower, total renewable electric capacity has grown from 77,309 MW in 1980 to 97,433 MW at the end of 1988 and is projected to total at least 129,000 MW in

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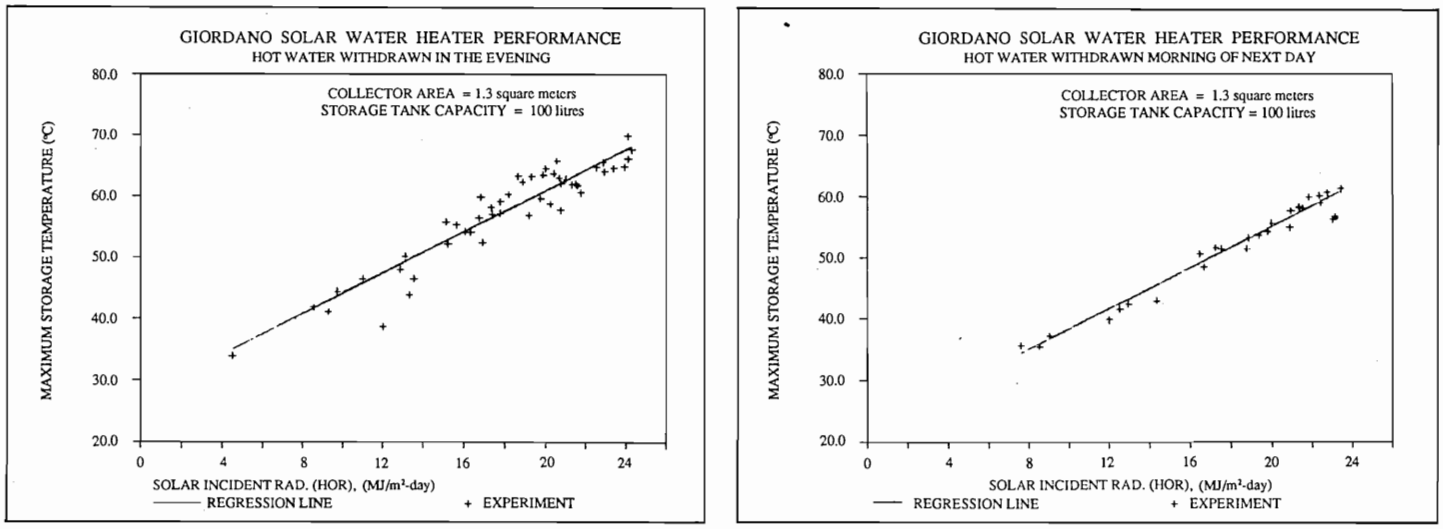


Fig. 7. Long-term performance evaluation of a solar water heater.

Power Surge: The Status and Near-Term Potential of Renewable Energy Technologies

From P. 7

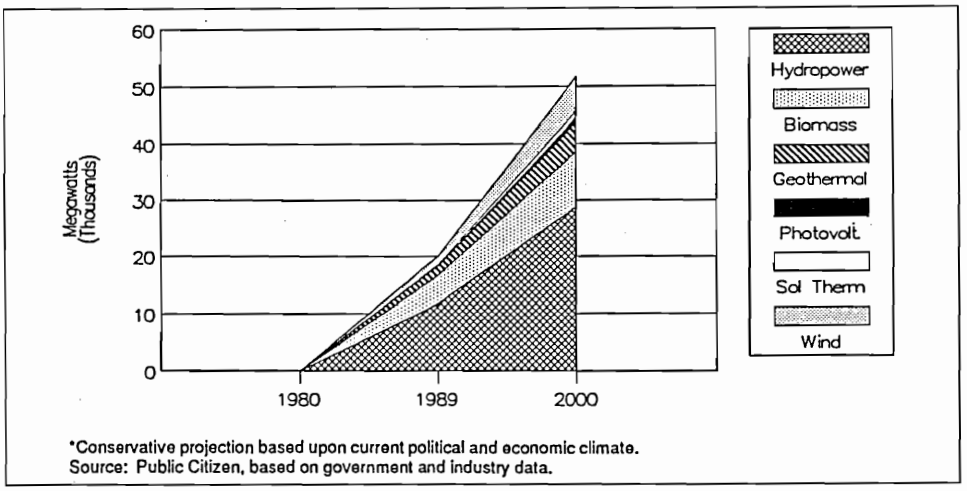


Fig. 2. Growth in renewable electric capacity, by source: 1980-2000.

2000. By comparison, the on-line capacity of nuclear power in 1988 was 97,220 MW and will likely be lower in 2000 as existing reactors are retired.

Including their non-electric applications, such as for space heating and liquid or gaseous fuels, renewables are conservatively expected to account for up to 19% of U.S. energy needs by the year 2000 and could provide up to 80% of all U.S. energy needs by the year 2010.

Public Citizen also found that the costs of many renewable energy technologies, notably wind systems and solar thermal plants, have declined by more than 50% since 1980. Along with biomass, geothermal, and solar building technologies, they are now competitive with, if not cheaper than, new conventional energy sources. Other options such as solar photovoltaic cells, whose costs have dropped 75% since 1980, are expected to be cost-competitive within the next five to ten years.

Public Citizen is a non-profit research and advocacy organization founded by Ralph Nader in 1971 to address a broad cross-section of consumer environmental issues. The Critical Mass Energy Project is the energy policy arm of Public Citizen.

Copies of the 100-page study Power Surge are available for $20.00/copy; copies of the 14-page "Executive Summary" are available for $5.00/copy. Copies of both are available without charge to members of the news media.

For further information contact:
Public Citizen
215 Pennsylvania Ave. SE,
Washington, DC 20003, USA

(Source: *Public Citizen News*, May 11, 1989 and *Power Surge: The Status and Near-Term Potential Renewable Energy Technologies, Executive Summary,* by Nancy Rader et al., Public Citizen, Washington, D.C., May 1989.)

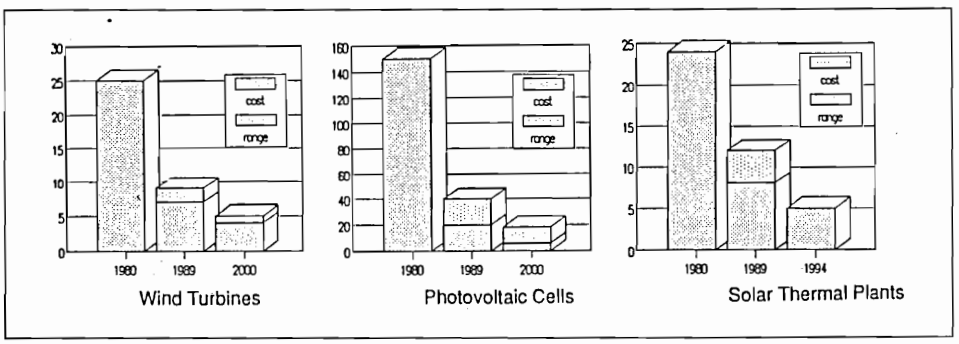


Fig. 3. Electricity production cost declines of solar and wind systems (cents/kWh).

Folkecenter for Renewable Energy, Denmark

The Folkecenter is a non-profit organization located on a 25 acre site in the north-west of Denmark with demonstration plants for wind, solar and biotechnology. The center is funded by the Ministry of Energy and local councils to: do research and development; act as an information and training centre; provide the public with all the results of designs, development and experiments on renewable energy systems carried out at the center that are suitable for local applications and construction.

Some of the Folkecenter's renewable energy activities are as follows:

Wind Energy

The Folkecenter has achieved notable results for wind turbine construction, adaption of standard industrial components for use in wind turbines, and PC-software for datalogging and wind mill regulation analysis.

Wind test field at Folkecenter.

Since the turn of the century, Denmark has been a forerunner in the production of electricity generating wind turbines. The contemporary development at the Folkecenter started in the mid 1970's. The first construction manual on a 22 kW wind turbine (the "Blacksmith" windmill) was issued in 1978. Over the past 3 years the Folkecenter has brought out construction manuals on a whole series of advanced wind turbines, known as DANmark-series and consisting of 20 kW, 75 kW, 95 kW, 150 kW, and 200-270 kW plants. The DANmark-series is manufactured by several Danish companies and is fully tested and approved.

Blades

In order to avoid fatigue problems with fibre glass blades and to make use of

an indigenous material, the Folkecenter has made a special effort to develop wooden blades. The effort goes back to 1980, and today advanced blades of laminated wood are available for all sizes of wind turbines. The DANmark-series can be fitted either with fibre glass or wooden blades.

Air brakes

In co-ordination with blade manufacturers, the Folkecenter has developed hydraulic brakes for modern wind turbines, activated by loss of pressure in the hydraulic system. The air-brakes are used as operational brakes in combination with a disc brake and thus reduce brake loads on the transmission system.

Integrated gearbox

The integrated gearbox is an outstanding result of the Folkecenter's efforts to adapt industrial standard components for use in wind turbines. The concept of the integrated gearbox was first applied in a F.L. Smidth wind turbine, constructed in 1941. Up-to-date versions of the integrated gearbox have been developed in co-operation with gear manufacturers. The gearbox features main shaft, main bearing, gear, generator flange, and bottom plate in one compact unit. The integrated gear has 11 varieties and is now available in all sizes from different manufacturers.

Double-wound generators and control systems are other examples of standard components, adapted for use in wind turbines by the centre.

PMG/ES - A new and emerging concept

The centre has conducted several experiments with small-scale windmills for different purposes. Both mechanical and electrical systems have been developed for water pumping, battery charging, grinding, heating, etc.

Based on past experience in the field, the centre now presents a series of small-scale electric windmills for multiple uses.

The basic design concept is the introduction of a slow rotating permanent magnet-generator (PMG) to be connected directly to the rotor, without any couplings and gearboxes. The PMG-wind turbine will be a simple and robust electrical system and will supply electricity with varying voltage and frequency for a wide range of applications. It will be driven by a standard asyncronious motor.

The center intends to develop a series of PMG-wind turbines in the range of 1.5 and 10 kW which will be able to meet different needs.

The PMG/ES-series is a new concept and will basically be designed as stand alone systems, that will meet the needs of remote locations such as islands and rural areas in the third world countries.

Solar Energy

Low-cost household small water heater systems have also been developed by the Folkecenter. A solar thermal system of different modules ranging from 6-9 m^2 is installed on the roof of the workshop at the Folkecenter. Most systems have copper absorbers with electrogalvanized selective coatings.

The capacity of the system is about 400 $kWh/m^2.yr$ which gives approximately 300 litres/day of hot water.

Mounted on the ground are 4 modules of solar thermal systems each of 12.6 m^2 area with a peak capacity of 30 kW. The unit gives about 340 $kWh/m^2.yr$ which is used for heating the building complex.

The modules are being developed for district heating systems.

Biogas

The development of biogas technology at the centre dates back to the late 1970's where several pilot plants were constructed on Danish farms. The experiences from these plants and the transfer of know-how from India and Germany, are the basis for the contemporary development at the centre.

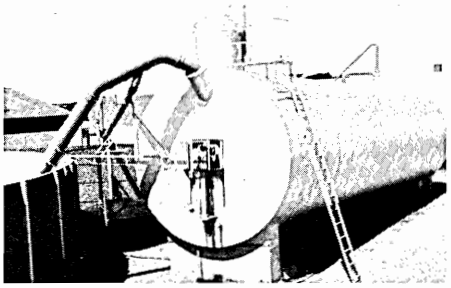
The biogas technology is being developed to minimize costs of installation on site and to maximize energy-efficiency in the production and utilization of the gas.

Co-generation

To achieve maximum energy efficiency the biogas plants are supplied with a co-generation unit to produce electricity and heat. The electricity can be used locally for a variety of purposes or can be sold to the national grid. The heat can be utilized for heating farm buildings, crop drying, cooling systems, etc.

The center has installed two pilot plants: one horizontal at Sindrup and the other with silo digester at Boddum.

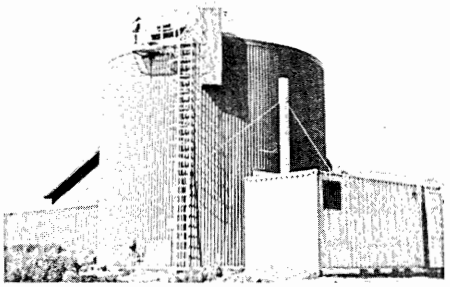
The horizontal digester has a capacity of 150 m^3 and is fed with pig dung. It produces about 160 m^3/day gas which is used for heating a private house and pig stables. The digester is made of mild steel and has a slow moving agitator with paddles along the tank wall. The insulation comprises 200 mm mineral wool.



The horizontal digester at Sindrup.

The "silo" digester at Boddum has a capacity of 400 m^3 and it produces about 208 m^3/day of gas. The electricity and hot water produced are used for heating the digester and domestic purposes.

The digester is made of glazed steel plates bolted together with sealing compound at the joints. The bottom is made of concrete. The agitators comprise 2 pieces of propellers, a mammoth pump and gasgets. The insulation is made of 200 mm mineral wool. Cattle dung is used as input.



The silo digester at Boddum.

In addition to the research and development activities mentioned, the Folkecenter also conducts training programme, international conferences and workshops on renewable energy.

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(Source: Information provided by Dr. A. Jagadeesh, Folkecenter for Renewable Energy).

SARGOB - State of Art Report on Gasification of Biomass Database

A State of Art Report on Gasification of Biomass was compiled by the Indian Institute of Technology (IIT), Bombay under the sponsorship of the Department of Non-Conventional Energy Sources (DNES), Ministry of Energy, Government of India. In the course of this compilation, over 2000 research publications/books/reports/case studies were collected. SARGOB is the database constructed from all of these records. Published literature on various facets of thermochemical gasification process, gasifier designs, design criteria and procedures, gasifier testing and performance evaluation, laboratory studies as well as field experiences have all been included in SARGOB. All those working in the area of biomass gasification such as researchers, designers, manufacturers, planners and policy makers will find this database useful.

Structure of the Database

The bibliographical details of the publications stored in the database are as follows:

a) SAR-NO: A Serial Number
b) AUTHOR (S): Author(s) of the article/book/report
c) TITLE: Title of the article/book/report
d) KEYWORD(S): Keywords and sub-keywords, i.e. subject cataloguing
e) PUBLISHED: Published in proceedings/journal/presented at conference/patent paper, etc.
f) ADDRESS: Address of the first author
g) INSTITUTE: Institute of the first author
i) COUNTRY: Country of the first author
j) PRESENTED: Year presented.
k) PRINTED: Year printed.

The stored information has been categorised by subject under 24 main keywords. The information associated with each keyword is further split into several sub-keywords. Organisation of the information on the basis of keyword and sub-keywords permits split second retrieval of highly selective information. At times, when a word is used both as a keyword and a sub-keyword, it is distinctly recognised by the program and information is accordingly selected and supplied. The package is designed to be user-friendly through instructions displayed in the form of a menu.

Retrieval of the information can be carried out in four different ways:

1) Keyword, 2) Author
3) Country, and 4) Year.

Depending upon the need of the user, he has only to key-in the corresponding numeral to choose the option.

Keyword retrieval

On choice of keyword retrieval, the menu-screen displays 24 main keywords numbered in serial order. By keying-in the particular numeral, all the sub-keywords pertaining to that keyword appear on the screen. The second step, therefore involves keying-in of another numeral to choose a sub-keyword under a previously chosen keyword. There is an option where one can ask for all the records under a particular keyword irrespective of sub-keywords. The records can be seen on the monitor and/or a hard copy can be obtained.

A Hybrid Power Generation System

Wind power - Micro hydropower - Biomass energy

A hybrid power generation system that combines wind power, micro hydropower and biomass technology is being developed by a specialist team at Japan's Mei University. Intended for use by island populations or to supply power to medium-sized production plants, the system has the advantage of being able to operate in a wide variety of weather conditions.

The development team, headed by Dr. Yukimaru Shimizu, has been working on the project for five years. The test system is made up of a 10 kW wind turbine, a simple mini hydro-electric plant comprising three water wheels, and a biomass system where sawdust is burned to produce hydrogen and carbon monoxide to drive a turbine.

As part of the development programme, a series of wind measurements were made which showed that the average wind speed for most parts of Japan was 6-7 m/s, with the maximum instantaneous wind velocity rising to about 25 m/s. Like most Japanese wind researchers, Dr. Shimizu is concerned about the effects of the country's seasonal typhoon on wind power plants.

Tropical storm winds can be as high as 40 m/s and at an early stage of the project it was decided that a turbine with a collapsible tower was the most effective solution to the problem.

Between March and October, however, Japan has heavy rainfall and during this period the hydropower system works at maximum efficiency. In the dry season it ceases to work and power is supplied by the wind turbine and biomass plants. However, this is presently only operating at a conversion rate of sawdust to electricity of around ten per cent, says Dr. Shimizu. He adds that modifications to the system to include a hot water boiler to use the lost heat could increase efficiency to 45 per cent.

Despite the hybrid plant's teething problems, Dr. Shimizu says that under Japanese conditions it could produce a stable power supply throughout the year, although he admits that a regular supply of sawdust could be a limiting factor. As the system will mainly generate electricity using wind and hydropower, and biomass will supply only the deficiencies for the smooth flow of electricity, the consumption of large quantities of biomass can be avoided.

He now envisages developing the hybrid system so that when running in parallel it would have a maximum rated capacity of 400 kW. It would comprise a 100 kW wind turbine, 200 kW biomass unit and 100 kW hydro-electric plant.

(Source: Extracted from "Japanese Work on Total Solution" by Vicki Hyde, *Wind Power Monthly,* Vol. 5, No. 3, March 1989.)

Author retrieval

The database has publications of more than 2000 authors and co-authors. This package provides retrieval of information on the basis of an author whose name is required to be keyed-in. The retrieval would produce all the records whether the particular author is the main or co-author. Selective retrieval or records pertaining to an author is also been provided, either on the basis of keywords or title of the article or the year of publication. Keyword selection is made easy by displaying all the keywords and sub-keywords with serial numbers. The title, however needs to be keyed-in, so also, the year of publication.

Country retrieval

The records included in the database are from 51 countries worldwide. The names of the countries are displayed on the screen with an assigned serial number. By keying-in a particular numeral, the records originating from a given country can be accessed. Further selection of the records is provided on the basis of keywords, title, author and year of publication.

Year retrieval

Information contained in the database can be retrieved on the basis of the year of publication. Selective retrieval for a particular year on the basis of keywords, title, country of origin is provided too.

The SARGOB database being menu driven and extremely user-friendly can be used without any detailed instructions. IIT has plans to continue with this activity by continuous updating. A list of biomass gasifier manufacturers constitutes another small database which provides country information regarding manufacturing activities of biomass gasifiers. Steps are being taken to merge the two databases and to put this database on an active node of an electronic mailing system. Package details are also being formulated to make the database into a comprehensive product.

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Biomass Project
Mechanical Engineering Department
IIT, Bombay - 400 076,
India

Seventh Asian School on Energy "Industrial and Rural Power Production" 17-26 January, 1990

Asian Institute of Technology (AIT)
Bangkok, Thailand

The Seventh Asian School on Energy is organized jointly by the Asian Institute of Technology (AIT), King Mongkut's Institute of Technology Thonburi (KMITT), and the Regional Center for Energy, Heat and Mass Transfer (RCEHMT). The school is sponsored by the French Agency for Energy Management (AFME) and the United Nations Educational Scientific and Cultural Organization (UNESCO).

Objectives

The School will provide an opportunity for the participants to learn and assess the new technology-energy-economics relationship. The common problems of non-utility power production will be addressed in the first part of the School.

The second part of the School will include lectures, round-table discussions and case-studies by experts. Two parallel sessions are planned to address the issues related to the following two modules:

Module 1
Industrial Power Production as a Supplement or an Alternative to the Utility

Program contents

- Potential for private power generation
- Comparative efficiency and economics of industrial cogeneration and power generation by utility
- Power generation from agricultural residues and waste management
- Reliability and integrity problems in connection to the grid
- Electricity quality in non-utility production
- Monitoring and control of power flow
- Load planning and management
- Institutional aspects of industrial power production.

A field trip will be organized to visit an industrial cogeneration plant in the eastern coast of Thailand.

Participants

This module is designed for :

- Technical and planning people from the utilities,
- Energy Managers from industries,
- Manufacturers of power generating equipment and supporting industries.

Enrolment

The tuition fee for this module (includes course material, refreshments, field trip and banquet) is US$ 300.

The number of participants is limited to 15.

Module 2
Decentralized Power Production for Rural Consumers

Program contents

- Trends of rural electrification and demand for electricity
- Alternative sources for rural power development
- Energy project economics of private power production
- Reliability and integrity problems in connection to the grid
- Electricity quality in non-utility production
- Institution issues and problems of pricing
- Environmental impact of different scale power production.

A field trip will be organized to visit a remote area with a 40 kW hybrid (mini hydro-solar PV) power system in the eastern part of Thailand.

Participants

This module is designed for:

- Authorities and staff of institutes involved in decentralized power systems,
- Technical and planning people from the utilities, and
- Government officers who formulate

Cont. P. 12

Solar Photovoltaic Products: A Guide for Development Workers

Anthony Derrick, Catherine Francis and Varis Bokakalders
Intermediate Technology Publications
103-105 Southampton Row
London WC1B 4HH,
United Kingdom
ISBN 1-85339-002-X
March 1989, viii + 127p.

Photovoltaic (PV) systems are being used in developing countries to provide power for water pumping, lighting, vaccine refrigeration, electrified livestock fencing, telecommunications and many other applications.

Large numbers of PV systems are currently being installed. This proliferation of the technology has, however, created a need for accurate, reliable and objective information among field workers who seldom have time to grasp the intricacies of all the various gadgets offered to them by manufacturers and agents. PV differs from several other renewable energy technologies in that it has already been proven under widely varying circumstances, and that a major bottleneck to its dissemination is not connected to the technology as such (as is the case with many other renewable energy sources), but rather to the lack of availability of reliable information on its operation, cost and range of applications.

The book entitled "Solar Photovoltaic Products: A Guide for Development Workers" aims at addressing this shortfall in information and to assist anyone with a little technical experience, but probably no previous knowledge of photovoltaic systems to decide:

- if a PV power supply is suitable for the purpose in mind;
- the type of equipment needed; and
- how to proceed in implementing a project using PV products.

This guidebook has been prepared by I.T. Power Ltd of Eversley, UK and the Beijer Institute of Stockholm, Sweden for the Swedish Missionary Council Office for International Development Cooperation, and published by the Intermediate Technology Publications, the Publishing arm of the Intermediate Technology Development Group (ITDG).

This book provides a brief introduction to photovoltaic conversion technology, photovoltaic system types, different components, and system sizing procedures. The major areas of application considered are water pumping, vaccine storage for health care, lighting, rural telecommunications and other miscellaneous applications, such as water treatment, security systems, domestic transport and agricultural applications. In each case emphasis is placed on experiences, relative merits of the system under consideration, commercial availability, procurement and implementation procedures. Information on operation, cost, range of applications, and possible suppliers of such systems are listed. A sample tender document is also included. This book will be a useful guide for project designers as well as decision makers.

Seventh Asian School on Energy "Industrial and Rural Power Production"

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and implement decentralized power projects.

Enrolment

The tuition fee for this module (includes course material refreshments, field trip and banquet) is US$ 300.

The number of participants is limited to 15.

Date and Venue

The School will be held from 17 to 26 January 1990 at the Division of Energy Technology of AIT. The AIT campus is situated about 20 km north of Bangkok International Airport.

For more details contact:
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Asian Institute of Technology
G.P.O. Box 2754,
Bangkok 10501 - Thailand

Forthcoming Events

- **September 18-21, 1989, Charlottetown, Prince Edward Island, Canada**

Canadian Wind Energy Conference & Exhibition'89

For details contact:
Nancy Phillips
Passmore Associates International
209-135 York Street
Ottawa, Ontario
Canada K1N 5T4

- **September 17-22, 1989, Montreal, Quebec, Canada**

Energy for Tomorrow

The Fourteenth World Energy Congress will be held in Montreal.

For details contact:
Guy Coulombe
Hydro Quebec
1 Place Ville Marie
Montreal, Quebec
H3C #H2 Canada

- **September 24-27, 1989, San Francisco, California, USA**

Windpower'89

For details contact:
American Wind Energy Association
1730 N Lynn St.
610, Arlington, VA 22209, USA

- **October 2-4, 1989, Bucharest, Romania**

Conference on Solar and Wind Electricity

For details contact:
Prof. Florin Teodor Tanasescu
Research Inst. For Electrical Engineering
Bd. Tudo Vladimirescu 45-47
Sector 5, Bucuresti 79623
Romania

- **October 22-26, 1989, Caracas, Venezuela**

International Conference on Energy, Environment and Technological Innovation

For details contact:
Publicis Inc
Parque Central
Nivel Lecuna, Ofic. No. 29
Postal 17614
Parque Central 1015-A, Caracas
Venezuela

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AIT Cold Chain Equipment Testing Facility for WHO

Fig. 1. Swing type doors with inspection glass windows of the climatic chamber.

In recognition of its status as a collaborating centre for the testing of cold chain equipment, the World Health Organisation (WHO) advised the Asian Institute of Technology (AIT), Bangkok, Thailand, to design and build a suitable testing facility. The unit, catering to the requirements outlined by WHO, will serve in testing refrigerators, freezers, cold boxes and vaccine carriers for their suitability to store vaccines at safe temperatures.

Physically, the unit consists of a well-insulated chamber (called the climatic chamber), an air-conditioning system, a set of temperature measuring instruments, a microprocessor based system of data acquisition and control, and AC/DC power monitoring modules. Thus, with facilities to vary as well as control the temperature and humidity levels inside the climatic chamber, it will be possible to simulate the ambient environment for the refrigerators (seated inside the climatic chamber) to be used for storing vaccines as well as ice packs. Performance tests of refrigerators can be carried out under conditions stipulated by WHO, to cover, viz. i) A range of dry bulb temperatures between 15° and 45°C and relative humidity (RH) between 45 and 75%, and ii) stable running temperatures of 32°C and 43°C, applicable for the environment inside the climatic chamber.

The Climatic Chamber

This chamber of external dimensions 3.5m long, 2.4m wide and 2.5m high is fabricated with ready-made insulated panels of 10 cm thickness made of painted steel sheets packed inside with polyurethane fiber insulation. It has two swing type insulated doors each door being 1.0 m wide and 2.0m high. A view-glass window provided on each door enables the operator to carry out visual observation and inspection during the course of the test (Fig. 1).

The Air-conditioning System

The air-conditioning system comprises:

a) Two cooling systems of capacity 3.5 kW and 0.8 kW used to control the room temperature inside the climatic chamber. While the compressors and the condensers of the systems are placed outside the climatic chamber, the evaporators of both systems are incorporated in a fan-coil unit installed

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1 *Equipment Testing Facility*
3 *Cogeneration*
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10 *Hydropower*
12 *Solar Energy*
13 *Geothermal Power*
15 *New Publications*
19 *Diary of Events*

wind and sun compendium
Development of wind and solar energy for water pumping
CWD
Consultancy Services
Wind Energy
Developing Countries

Energy Information Service, CSIRO
Incorporates news from the Energy Information Service, CSIRO and Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).
INNERTAP

AIT Cold Chain Equipment Testing Facility for WHO

From P. 1

inside the chamber. The higher capacity cooling system is capable of reducing the room temperature from 45°C down to 15°C within 3 hours and the smaller capacity one is used to control the room temperature at any specified temperature (32° or 43°C). A blower capable of handling up to 700 m^3/hr of air is used in the fan-coil unit.

b) An electrical heating system consisting of two 0.5 kW constant heaters, a 1 kW variable heater and a blower, capable of generating a maximum power of 2 kW installed inside the climatic chamber. The heating power can be varied in order to obtain the required room temperature within a specified time period and to control the room temperature at a desired stable level.

c) A portable air humidifier placed beside the heating unit to supply ultrafine (5 to 10 microns in size) completely drop-free aerosol mist. The purpose of this is to increase the humidity of air in the room. The maximum output is 0.8 litres per hour.

d) An electric reheater of 1 kW maximum power placed after the evaporator coil inside the fan-coil unit to reheat the air to the desired temperature after dehumidification by the smaller capacity cooling unit. In this way the required RH of the air is obtained. The power input to the reheater can be varied by the dimmer facility provided in the indicator panel.

Measuring Instruments

Six pairs of type T thermocouples (copper - constantan) are installed at several locations inside the climatic chamber in order to measure the dry bulb and the wet bulb temperatures which will determine the temperature and the RH of the air inside the chamber. Fifteen thermocouples (type T) are provided for measuring the temperature inside the refrigerator to be tested.

A voltage variable transformer of range 0 to 250 V is used to measure the minimum starting voltage for the compressor driven appliances. The voltage and current (both AC and DC) are measured by the micrologger via the AC and DC power monitoring modules. From the recorded data, the on-off duty cycles and power consumptions of the compressor can be determined.

Data Acquisition and Control

All the measurements are made by a Campbell Micrologger-21 X which combines precision measurement with processing and control capability in a single battery operated system. Data acquisition and processing functions are controlled by the user through a set of programmed instructions. The maximum rate at which a measurement can be made and the resulting value stored in the final storage is 256 per second.

The storage module - SM192, is microprocessor controlled and has 8k plus bytes of ROM for memory read/write, addressing, telecommunications and command mode operations.

The control system enables the measured parameters to be processed by the micrologger itself. The output from the micrologger, viz. the appliance temperatures, average temperature and RH inside the climatic chamber are sent to the storage module at every pre-determined time interval for final storage. The control outputs from the micrologger, viz. average temperature and RH, are used to control the equipment such as coolers and heaters via the relays connected to a decoder which in turn is connected to the control ports of the micrologger.

Control Logic for Various Tests

Figure 2 is a flow chart which explains how the control is accomplished during the stable running test at a temperature of 32°C. Pre-determined temperature and RH range scales as per WHO requirements, i.e. 32 ± 1°C and 45 to 75% RH, are set for initiating the relays for the ON/OFF of the equipment. The temperature range scales for each stable running temperature are stored in separate subroutines and can be called by the main program to run for a

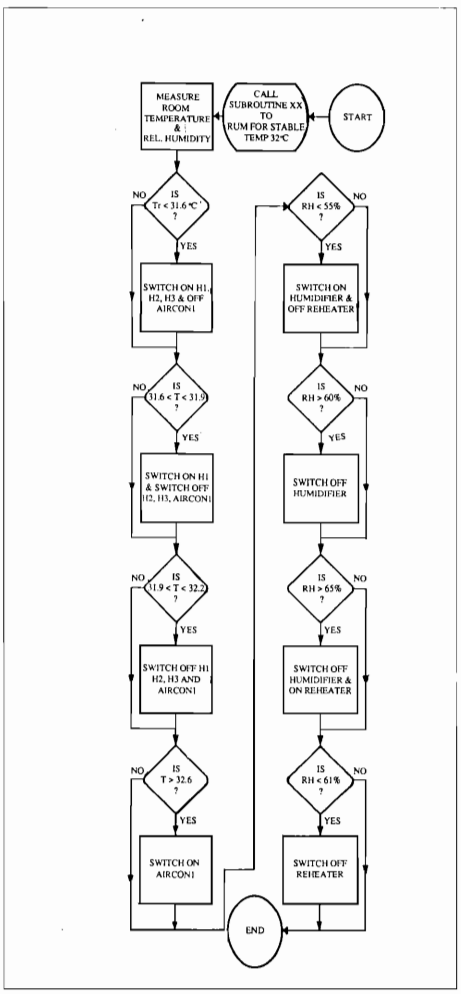

Fig. 2. Flow chart for stable running test (at 32°C).

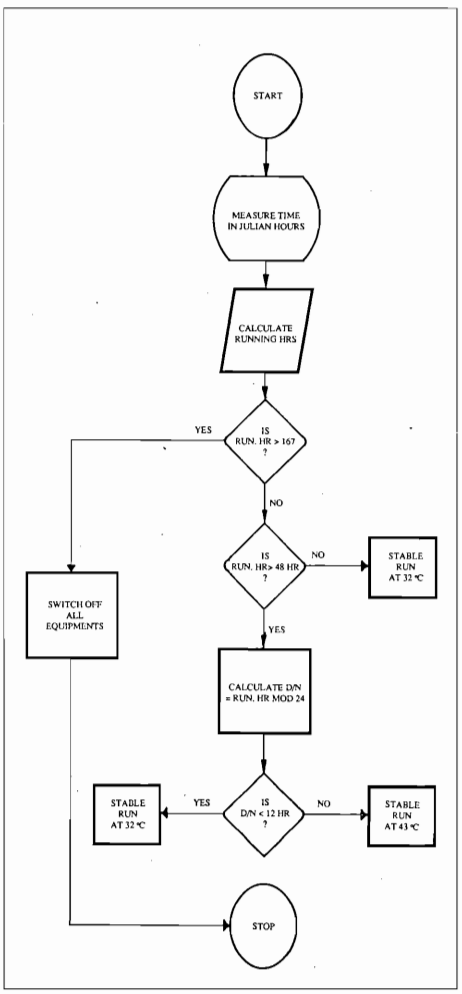

Fig. 3. Flow chart for day/night test.

Feasibility of Cogeneration Using Rice Husk as Fuel, Thailand

A study on the feasibility of steam cogeneration (and gasifier cogeneration as an alternative) using rice husk as fuel was carried out at the Asian Institute of Technology, Bangkok. A brief account of the findings of this study is presented below.

Figure 1 shows a typical arrangement of a steam cogeneration (and gasification cogeneration) system for a parboiled rice mill. Although white rice mills do not need heat for their processes, most of them still use boilers to produce steam which is used for driving the steam engines supplying mechanical power to the milling plant.

Results of economic assessment of steam cogeneration and gasification systems have been summarized in Table 1 based on the following major assumptions:

Energy use in parboiling	=	532 kJ/kg
Life time of cogeneration system	=	15 years (steam) and 5 years (gasification)
Annual rate of interest	=	15%
Annual O&M cost as % of first cost	=	13% (steam) and 30% (gasification)
Price of grid electricity	=	US cents 7.2/kWh
Price of electricity sold to the grid	=	US cents 3.8/kWh

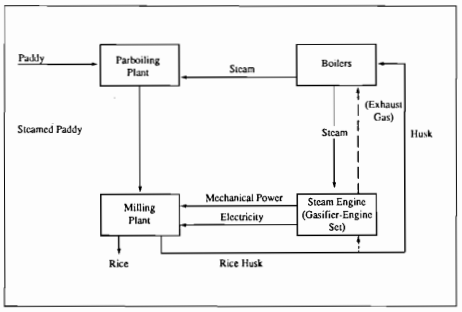

Fig. 1. Flow diagram of a typical parboiled rice mill using steam cogeneration system (gasifier-engine cogeneration system).

Conclusions drawn from this study are as follows:

1. According to the assessment, the cogeneration system can only be economically used in very large parboiled rice mills. This is due to a very high investment cost of the system. The feasibility of applying cogeneration in rice mills depends on the following two main factors:
   (a) the capacity of the system: the larger the generation capacity, the greater the benefit per unit of husk input.
   (b) the plant factor of the system: since large capacity mills gener-

Cont. P.4

particular stable temperature.

Figure 3, a flow chart for the Day/Night test, depicts the logic by which the control of the environment inside the climatic chamber is achieved during the course of the test. It takes 167 running hours for a complete test. The program here decides automatically whether the test duration is completed and if not, the control is shifted to a particular stable running temperatue (as above) depending on the time of the day and the stage of progress of the test.

Tryout Tests

Several tryout tests were performed in order to investigate whether or not the operational functions of the constructed facility meet the requirements of the WHO test procedures.

(a) Stable running at 32°C

The results depicted in Fig. 4 show that the room temperature can be controlled at 32°C (likewise at any other stable temperature) for the whole period of 24 hours with a maximum deviation of only ±0.3°C for a variation in RH from 55 to 75%. The outputs from this test were stored every 5 minutes.

(b) Stable running at 43°C

Figure 5 shows satisfactory results in maintaining the room temperature at 43°C with outputs recorded every half an hour.

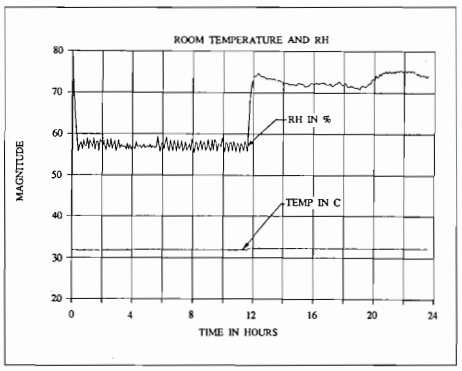

Fig. 4. Stable running at 32 °C.

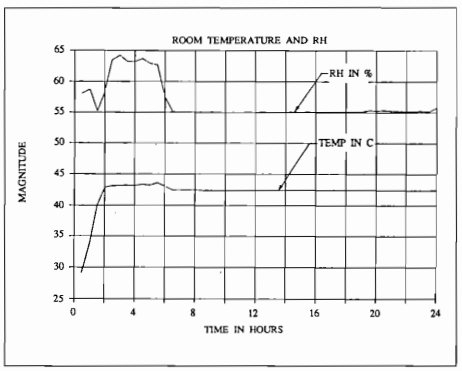

Fig. 5. Stable running at 43 °C.

(c) Day/Night test

Figure 6 displays the room temperatures and RH recorded every 15 minutes in the test according to the WHO Day/Night test procedures. In this test, a freezer was also operated inside the climatic chamber. The results show that the room conditions can be successfully achieved to the requirements as prescribed by WHO.

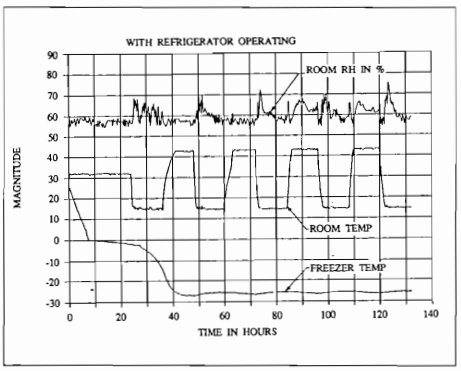

Fig. 6. Day/night test.

For more details, please write to:
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(Source: *Test Facility for Refrigerators & Freezers for WHO Cold Chain Applications,* a report submitted to WHO, Geneva, by Supachart Chungpaibulpatana and B. Balasubramanian, Energy Technology Division, Asian Institute of Technology, June 1989.)

Feasibility of Cogeneration Using Rice Husk as Fuel, Thailand

From P. 3

Table 1. Economic assessment of the cogeneration systems.

	Steam System		Gasification System	
	Parboiled Rice Mills	White Rice Mills	Parboiled Rice Mills	White Rice Mills
% of rice mills that economically use steam topping cycle/gasification systems	20	4	50	64
% of capacity	21.1	3.6	65	66
Number of rice mills	5	5	13	82
Average capacity, tons per day	169	122	200	129
Working hours per year	6500	4040	6500	4040
Generated electricity:				
kWh per million kg of paddy	30140	59460	24860	39680
GWh per year/mill	1.36	1.22	1.35	0.86
kW/mill	210	302	208	214
Investment cost, US$/kW	1069	1278	769	362
Saving, US$/kW per year	415	487	419	191
Operating cost, US$/kW per year	84	94	164	55
Internal rate of return, %	16	16	14	15
Payback period, years	5.3	5.4	4.8	4.0

ally work for longer hours than smaller ones and the parboiled rice mills usually have higher plant factors than white rice mills, only the large parboiled rice mills can economically use the steam cogeneration systems.

2. The gasification system appears to be economical for only large parboiled rice mills. The main advantage of the gasification system is a low investment cost. The gasifier itself can be made locally at a very low price. The engine used is normally adapted from a second hand engine.

The main problem regarding the gasification system lies in the fact that producer gas from rice husk usually has very high tar content, thus a very high maintenance cost is required for cleaning the system. The cost of waste water treatment has not been included in the calculations presented here.

3. The efficiencies of the steam cogeneration systems in the rice mills are very low compared to those in Thai sugar mills. A combination of a high-pressure boiler and steam turbine should considerably increase the cogeneration efficiency in the rice mill.

4. The assessment in this study is based on the assumption that the rice mill owner can sell the electricity generated to the utility at US cents 3.8 per kWh. Cogeneration and also gasification systems will hardly be viable if the rice mill cannot sell excess electricity to other customers.

Further work recommended in this connection are as follows:

1. To stimulate private generation, the government should create suitable conditions for the private sector to sell electricity generated.

2. During this study, several assumptions have been made for lack of reliable data. Further studies should be conducted to verify the consistency of the data on:

- the energy used in soaking and parboiled processes;
- the amount of non-commercial use of rice husk;
- the energy used in the steam engine;
- environmental aspect of waste from gasification systems; and
- operating and maintenance costs of gasification system.

3. A study on feasibility of high-efficiency steam cogeneration systems using high pressure boilers and steam turbines should be conducted in order to estimate the upper limit of the national potential for cogeneration in rice mills.

4. Feasibility of cogeneration using a rice husk gasifier coupled to a gas turbine and a waste heat boiler should be investigated.

5. Feasibility of power generation from rice husk in small and medium-sized rice mills should be studied.

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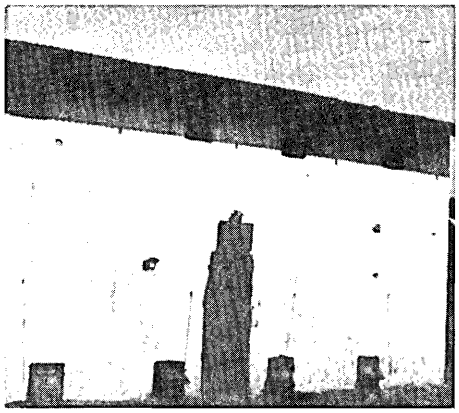
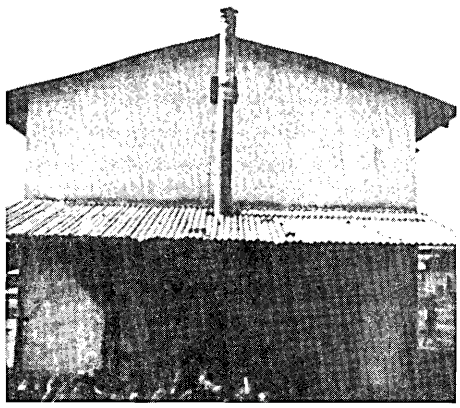
Tobacco Curing in Africa
Improving Woodfuel Use Efficiency

In the eastern and southern regions of Africa, tobacco was cultivated as a cash crop as early as the 1940s. Greek, Dutch, and British settlers introduced commercialization which has spread to small holders and estate producers. Not withstanding the controversy over the smoking of tobacco, the leaves of this plant provide several African countries with much needed cash income from its export.

The production of flue-cured tobacco, however, has contributed significantly to localized deforestation and acute woodfuel supply and demand imbalances. As the majority of tobacco farmers in these regions are now small holders, their ability to substitute wood as their fuel of choice is limited. Since 1983, the Government of Malawi, Uganda, and Tanzania with the assistance of ESMAP (Energy Sector Management Assistance Program, World Bank/UNDP/Bilateral Aid) have been conducting prefeasibility studies and pilot projects to demonstrate to farmers ways that could improve woodfuel use efficiency for tobacco curing.

In order to alleviate the woodfuel shortages and contain the growing costs of securing woodfuel supplies, farmers in all three countries are being encouraged to grow their own fuelwood on woodlots and plantations. This, however, is not an adequate solution. With yields from woodlots in the region between 8-25 tons/hectare per year and farmers using on average over 20 cubic metres of fuelwood to cure each ton of tobacco leaves, the equivalent of about one hectare of woodlots would need to be maintained per hectare of tobacco cultivated. For most farmers, tobacco production has already become marginally profitable; the additional cost of tree farming would be prohibitive. The governments involved recognized that from an energy efficiency perspective, there was considerable merit in pursuing the option of improving the efficiency of fuelwood use for tobacco curing and thereby minimizing the





Renovated barns in Tanzania with improved ventilation systems, furnaces, and chimneys.

localized deforestation impact of the industry.

Initiatives to Improve Tobacco Curing Efficiency

Tobacco curing is a controlled process of removing moisture from the leaf which is made up of approximately 80 percent water, the balance being made up of organic and inorganic solids. Starch is the single largest component of the dry matter in mature green leaf and accounts for 30 percent of the dry matter. It takes heat to evaporate the moisture which is provided through respiration by the tobacco itself or supplemental sources. Green leaf varies in moisture content based on plant position, growing season, and other factors.

The process of curing is not mere drying of the leaf but involves complex chemical and physical changes. Thus, varying physical environments need to be maintained in the barn during the curing process, so that a commercially acceptable cured leaf of lemon or orange color is produced. The cured leaf, in addition, must possess certain desirable physical characteristics as texture, elasticity, body, and aroma.

As early as 1983, ESMAP began assisting counterpart agencies in Malawi, Uganda, and Tanzania to conduct prefeasibility studies and pilot demonstration projects that could be formulated into national strategies for improving tobacco curing efficiency. The first exercise in Malawi set out to compile and evaluate the various technical options that could be used to improve the efficiency of fuelwood use in the tobacco industry. The funds for the pilot research and demonstration project were drawn from a World Bank/IDA (International Development Agency) credit. A representative from the FAO (Food and Agriculture Organization) assisted the Malawi Tobacco Research Authority during its implementation.

From 1984 through 1987, the Ugandan Government and BAT (British American Tobacco) Uganda Ltd. were assisted by ESMAP in preparing and implementing a pilot demonstration project on tobacco curing efficiency measures. Funds from the UNDP IPF (Indicative Planning Figures) for Uganda were used to support the pilot project.

Finally in 1987, Tanzania joined with ESMAP in a pilot demonstration project to coincide with the 1987/88 curing season. Funded by SIDA (Swedish International Development Authority), this project drew on the experience gained in the previous activities in Malawi and Uganda.

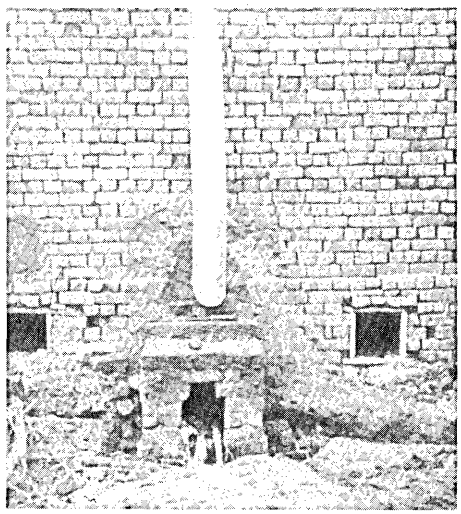
Small holder farmers for whom income from tobacco production is relatively low because of poor quality and high post-harvest losses were the primary target group for these activities. For this group of farmers in all three countries, the scale, methods, and type of facilities used for tobacco curing are similar. Most conventional barns are brick or traditional mud and wood construction. Thatched roofs made out of reed grass are commonly used. Many furnaces are open-hearth. Often, flues are mud jointed and chimneys nonexistent.

The majority of these farmers cure tobacco inefficiently resulting in a considerable waste of fuelwood and tobacco. Curing losses by such farmers are estimated at between 20 and 40 percent of the harvested leaves. Investigations in the three countries confirmed that, for the most part, the inefficiency of tobacco curing by farmers could be attributed to four factors:

- Poor management and control of the curing process, particularly the uneven loading of barns and the inadequate regulation of humidity levels inside the barns.
- The lack of proper furnaces or major deficiencies in the open-hearth type of furnaces that are commonly used, resulting in incomplete combustion.
- Major deficiencies in the design and installation of flue-pipe and chimney systems that are vital for effective transfer of heat into the barns.
- Poor construction and maintenance of barns, including lack of proper insulation and ventilation mechanisms on walls thereby increasing heat losses.

The pilot projects were meant to tackle these deficiencies and lower specific fuelwood consumption in the industry. At the same time the projects were designed to recognize that the key to long-term improvements lay in upgrading farmer skills and know-how about the curing process itself. They were devised to test measures

Cont. P. 6



Improved flues and slot-type furnace.

Rice Hull Gasifier

The Philippines Department of Agriculture (DA) in collaboration with the International Rice Research Institute (IRRI), with technical assistance from the University of California at Davis, has carried out the design, production and performance testing of rice hull gasifiers. The work is based on earlier R&D work carried out in China and at the University of California at Davis. The open-core down-draft gasifier (Fig. 1) is discussed here.

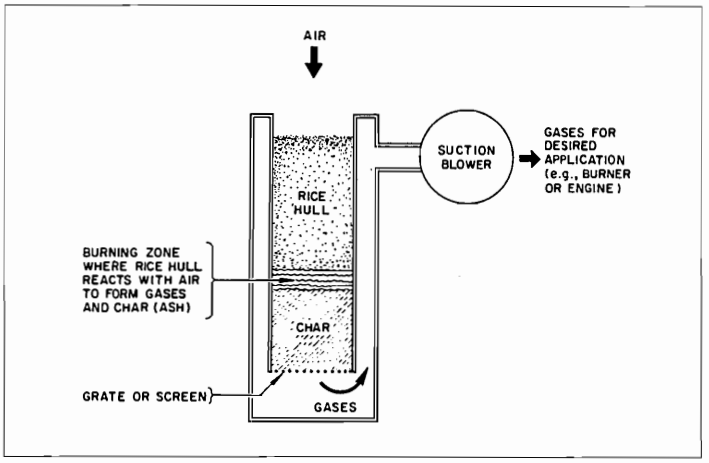


Fig. 1. The open-core down-draft gasifier.

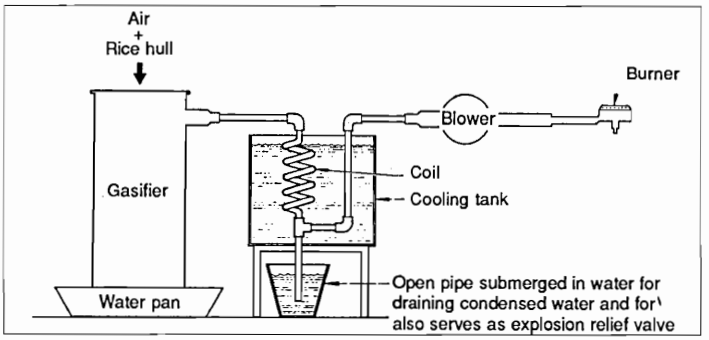


Fig. 2. The DA-IRRI rice-hull gasifier.

Design

The DA-IRRI Programme developed a small-scale gasifier (Fig. 2) suitable for demonstrations as well as commercial cooking and small-scale food processing. The gasifier is not, however, recommended for domestic cooking because of the dangers described later.

The gasifier reactor consists of two concentric cylinders which are easily constructed by rolling and welding sheet metal. The inner cylinder is filled with rice hull which is supported by a wire-mesh grate located at the bottom of the cylinder. A suction blower (either manually or electrically powered) is used to pull air from the atmosphere through the hull which is then gasified, owing to partial burning. These gases flow through the wire mesh and then upwards through the space between the inner and outer cylinders, leaving through the gas-outlet tube near the top of the outer cylinder. This tube is connected to the suction blower and to a burner where the gases are burned to produce the desired heat.

As shown in Fig. 3, the reactor sits in a pan of water which provides a simple and low-cost means of sealing the bottom of the reactor. The water level is adjusted to be at least 3 cm below the wire mesh, thereby providing space for the flow of gases. The water seal prevents atmospheric air from leaking into the reactor at the bottom of the outer cylinder, and also serves to cool the gases and to collect some of the tars produced during the gasification of the rice hull. The water pan is far more economical than closing off the bottom of the outer cylinder by means of a metal plate, which requires flanges or the machining of the mating surface.

The blower is a centrifugal unit, two versions of which are commercially available: a hand-operated version or an electric motor-powered version. The capacity of the electric blower (150W) is adequate for operating two burners simultaneously. Lower-cost blowers could easily be developed, including blowers using other sources of power such as a foot-operated treadle. The burner is a locally available component (spread-head, side-entry)

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that would improve farmer awareness and skills on vital elements of the curing process such as optimal loading of the curing barns, the use of wet- and dry-bulb hygrometers (as opposed to thermometers) as a primary instrument for monitoring and controlling humidity levels in the barn, and the proper construction, operation, and maintenance of curing barns and furnaces.

Emphasis was placed on low cost measures such as upgrading existing barns. This included refurbishing the barn walls, installing adjustable ventilators, and re-thatching roofs. Furnaces were reconfigured as were flue-pipes and chimney systems to ensure more efficient combustion and transfer of heat into the barn. The open-hearth furnaces are being retrofitted with slot-type furnace designs which have been successfully tested in the region.

Potential Benefits and Farmer Payback

The results of the pilot projects in each of the three countries have been very encouraging. They indicate that, with effective application of the technical packages, specific fuelwood consumption levels in the region can be reduced to the order of 10 cubic metres of stacked wood per ton of tobacco. This is 50 percent below existing levels.

Equally important from the viewpoint of overall profitability of tobacco production, the results demonstrated that the improvements also impact favorably in reducing curing losses and increasing the quality of cured leaf. In Tanzania, for example, output per cure increased some 20-50 percent because of the reduction in curing losses, and prices realized for the leaves produced by the pilot project were higher than average. The overall analysis of costs and benefits in each country confirms that the expenditure by farmers on the measures would be recovered in less than two curing seasons.

(Source: *ESMAP Information and Status Report, April 1989*, Energy Sector Management Assistance Program, World Bank/UNDP/Bilateral Aid, The World Bank, Washington D.C., 1989, pp.3-8)

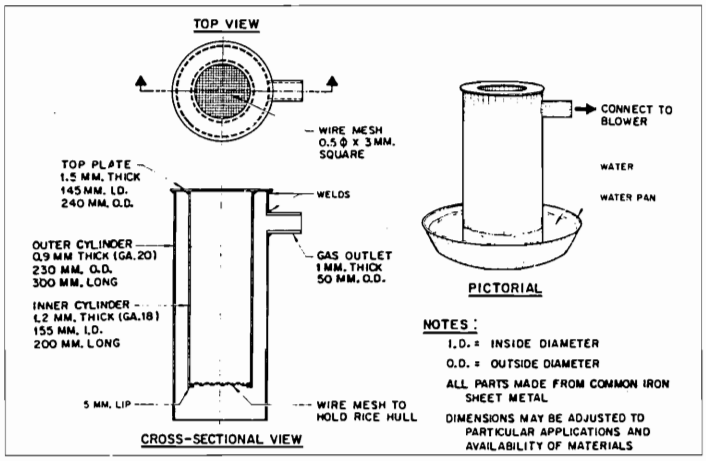

Fig. 3. Cross section of the reactor of the DA-IRRI ricehull gasifier.

for liquefied petroleum gas (LPG), which could be simplified to reduce the price (US$14).

Operation

The operating procedure consists of the following steps: A layer of rice-hull char (the burned hull from a previous run) is placed on top of the wire mesh to form the bed for igniting the reaction. A thin layer (about 1 cm thick) of dry rice hull is then placed on top of the char layer and is ignited with a piece of burning paper. The blower is operated to pull air from the atmosphere through the burning layer. When the entire surface area of the exposed hull is burning, additional hull is carefully loaded on top of the burning layer in such a manner that the layer is not extinguished. The burning layer then slowly moves upwards into the rice-hull column inside the inner cylinder, leaving char behind. The blower control valve is adjusted to obtain the desired gasification rate, which influences the speed of upward movement of the burning layer. This also controls the amount of gas produced, which enables the operator to vary the intensity of heat produced at the burner.

When all of the rice hull has been gasified and the burning layer has reached the top of the inner cylinder, the blower is stopped and disconnected from the reactor. The operator then picks up the reactor cylinder and tilts it to dump the char. The operator may then reassemble the unit and repeat the loading and igniting process. This operation of emptying and reloading the gasifier can be carried out in less than five minutes.

Large-scale Version

The DA-IRRI Programme fabricated a large gasifier (0.77 m inside diameter) to provide heat to a rotary paddy drier. The components and operational procedures are similar to those described for the small-scale gasifier, apart from the following:

- the outer cylinder has a welded-metal bottom rather than a water seal;
- the burner is a concentric tubular design mounted in a combustion chamber; and
- the grate is fabricated from iron bars.
  This grate is vibrated periodically by an electro-mechanical mechanism, thereby causing the char to fall through the grate and allowing additional rice hull to be added through the top of the inner cylinder. This enables the operation to be continuous.

The gasifier was tested with a rotary paddy drier at a commercial rice mill in Libmanan, Camarines Sur, Philippines. The results are summarized in Table 1. The gasifier consumes less than 30 per cent of the hull of the rice processed by the drier, thereby ensuring that there is an ample quantity of hull to fuel the system. In fact, the owner of the rice mill has to pay for excess hull to be removed from his mill for disposal.

Table 1. Summary of test results for the DA-IRRI paddy dryer equipped with a rice-hull gasifier.

Run	Moisture Content of Paddy (% by weight)		Flow Rates (kg/hour)	
	Initial	Final	Paddy	Hull
1	31	18	1029	–
2	27	16	878	47
3	31	18	809	55
4	28	18	837	–

The results of these preliminary tests indicated that either of the two gasifiers may be appropriate for several applications in the Philippines, as well as in other developing countries. The most attractive features of the present design are:

- the low cost of initial investment and of operation and maintenance;
- the ease of construction, utilizing tools and materials available throughout most of the Philippines;
- it does not require costly fire bricks or refractory cement;
- it is simple to operate, maintain and repair;
- it is easily adapted to different applications (ranging from small to large sizes); and
- it may be adapted for continuous operation, if desired.

Risks

It should be stressed that the gas produced by a rice-hull gasifier is explosive and toxic (carbon monoxide causes asphyxiation). The risk of explosions can be minimized by ensuring that the system is free of leaks and is equipped with a relief valve (Fig. 2) and a warning device to indicate when the burner flame has accidentally been extinguished. These precautions also reduce the danger of carbon monoxide escaping, and the gasifier should be located in a well-ventilated area. Since the tars produced by rice-hull gasifications are also toxic, careful disposal is essential to avoid skin irritation and the contamination of food or water supplies.

The major limitation in applications of the gasifier is the bulkiness of the rice hull which hinders transportation and storage. Because of this, the most viable applications are those located either inside a rice mill or within a short distance from a source of dry rice hull. The gasifier is not suitable for domestic applications such as cooking or lighting because of this transportation problem and because of the danger described above. There are however a number of potential applications which include food processing, grain drying, industrial process heating, and power generation through internal combustion engines.

(Source: Converting Rice Hull to a Gaseous Fuel, by R.E. Stickney, V.N. Piamonte and A.T. Belonio, *Appropriate Technology*, Vol.16, No.1, 1989).

Wood Fired Bread Ovens for Small Industries

In some countries bread is baked in very simple, wood fired ovens. Much of the wood used for baking is purchased from the local market and its cost can account for 30% of the cost of the loaf of bread. As wood becomes scarce and cost increases are much greater than the inflation rate, many of these bakeries are unable to make a profit and have to close down.

Biomass Energy Services and Technology Pty Ltd. (BEST), Australia, in collaboration with researchers, entrepreneurs and extension officers in developing countries and Dr. Bill Lawson at the University of New South Wales, has developed a range of ovens to meet the needs of small food processing industries. The designs derive from extensive theoretical and experimental research at Reading University and at the BEST research station at Wamberal, Australia.

Computer models helped to determine the performance of different designs and test rigs helped to determine consumption of wood fuel with a range of moisture contents. A number of prototypes have been built and tested at Wamberal and one design is now being built and tested in Indonesia and Papua New Guinea.

Description and Performance of the Oven

The bread oven has three distinct components:

1. A well insulated firebox that has a grate and primary and secondary air control.
2. Two baking chambers.
3. A series of passageways that separate the baking chambers from the outer insulated walls.

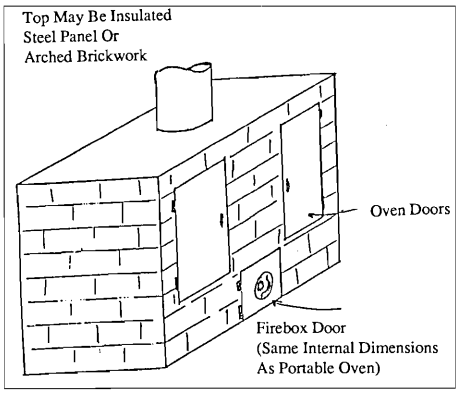

Fig. 1. Brick oven.

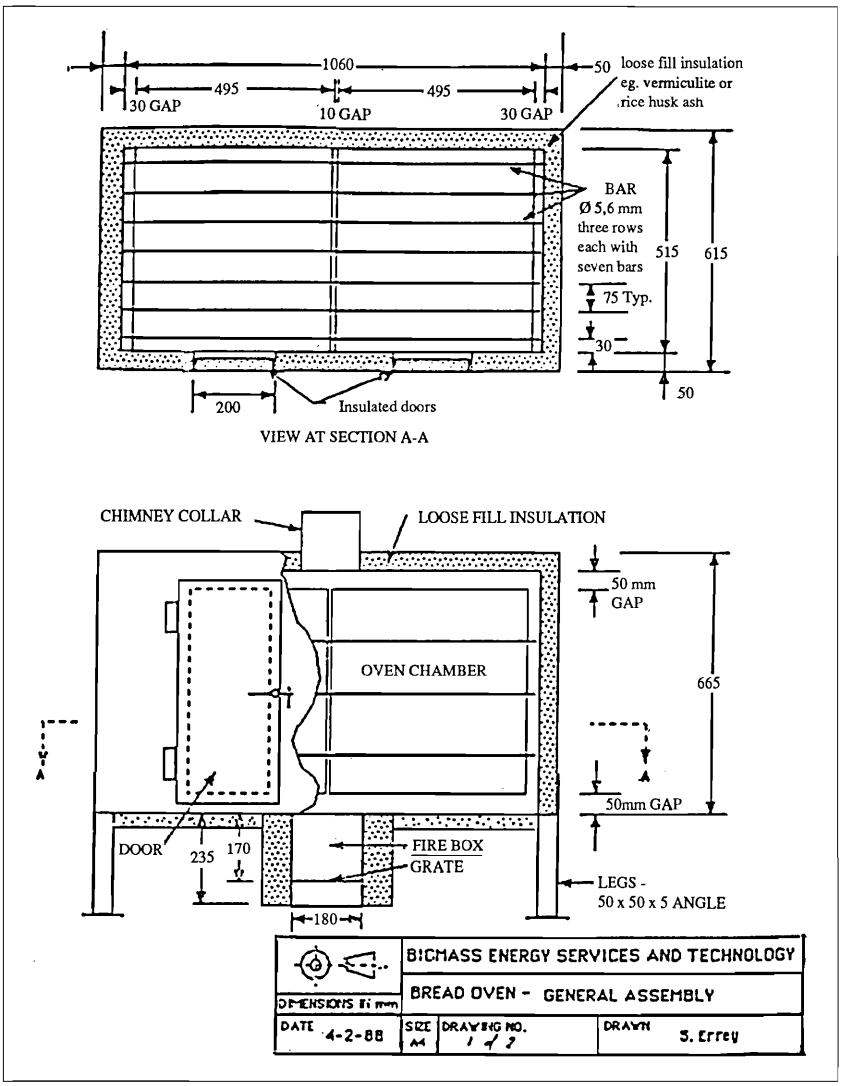

Fig. 2. Movable oven.

The flue gases produced from the burning wood pass from the firebox around all four walls of the baking chamber and then out of the chimney. To increase the rate of heat transfer from the hot gases to the bread, steel bars are placed through the baking chambers into the flue passageways. These bars are also used to support the bread tins inside the baking chamber.

The baking chamber is made from steel-sheet. The outer walls can be made from steel and insulated with ash, vermiculite or diatomite or from bricks made with ash, husks and a high quality clay. If steel is used for the walls the oven is light enough to be carried from village to village. The oven can be made in a range of sizes with a minimum capacity of forty loaves and a maximum of two hundred loaves. The cost and the lifetime depend on the quality and type of materials used.

The portable oven takes 20 minutes to warm up. During that time the bread can be raised on top of the baking chamber. The bread is then baked at 240°C for 20 to 25 minutes. By then it has a golden crusty surface and can be removed.

It takes 10 minutes to warm up the oven again to baking temperature before the second batch can be put into the oven. On average 0.13 to 0.2 kg of wood is required to bake one loaf of bread. A unit capable of baking 500 loaves in a day has now been installed in Papua New Guinea and local manufacture is to begin in the first half of 1989.

(Source: Low Cost, Efficient, Wood Fired, Bread Ovens for Small Industry, by S. Joseph and W. Lawson, *Boiling Point,* April 1989, No. 18, pp. 26-27)

Expanded Bed Anaerobic Decomposition of Pig Manure

Two full-scale plants for mesophilic (35°C) fermentation (or decomposition) of pig manure have been erected on farms in Sweden under the auspices of EnerChem AB and supported by the Swedish National Board for Technical Development (STU). In one plant the gas is used mainly for the production of heat, while both electricity and heat are produced in the second.

The project is aimed to reduce the size of the decomposition chamber of manure. Conventional mesophilic decomposition necessitates a long period in the chamber and therefore the decomposition chamber has to be large in volume which results in greater investment costs and greater internal consumption of heat.

Decomposition at higher temperatures, thermophilic decomposition, results in a shorter time being spent in the chamber and hence a smaller decomposition chamber, but the heat losses are great unless manure/manure heat exchangers are installed. In addition, the thermophilic process is liable to breakdown, particularly when pig manure or other nitrogen-rich material is used and the methane content in the biogas is lowered, thus making the production of electricity more difficult.

Reactor Design

In order to reduce the time in the decomposition chamber the number of active bacteria must be increased in relation to the amount of material. Since it is not possible to increase the rate of growth of the bacteria to any great degree, the bacterial duration of stay must be increased in relation to the hydraulic duration of stay. This can take place by means of the bacteria being fixed on some kind of substrate. Several types of biological filters and other solid substrates are available for effluents of various kinds but these cannot be used for liquid manure. The dry content in the liquid manure is high (8-10%), of which a large proportion is made up of long fibres which easily form a dense floating mat, called a "floating quilt". These fibres can quickly block a solid bed.

Since a bed with static substrate material cannot be used, the idea arose of allowing the bacteria to grow on free floating particles. The particles should have a higher density than the liquid manure so that they are not discharged in large amounts with the used-up manure. This type of bed is used for waste water and in this case sand particles are used as the substrate. It is, however, believed that the grain of sand is too small and that larger particles, approx. 5-8 mm, would be preferable. This would then be made to fluidize by circulating the manure under pressure from a pump. Fluidizing requires energy and in addition there is abrasion of the particles against each other. Fluidizing too forcefully would lead to energy consumption being too high and would also rub off most of the bacteria which have grown on the particles. For these reasons it was decided to fluidize the bed intermittently. This method of operation has been called the expanded bed.

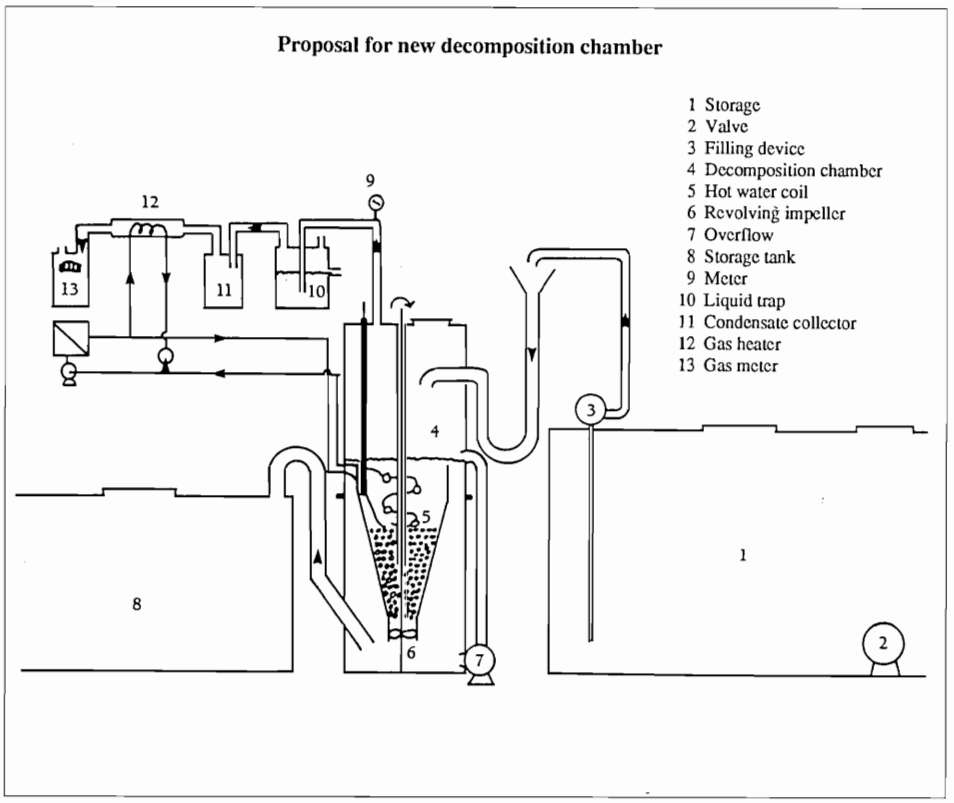

Fig. 1. Installation of decomposition chamber.

Experiments

The project was carried out in two stages. Stage I consisted mainly of trying out the equipment and testing the substrate. In stage II prevention of "floating quilt" formation by modifying the reaction was carried out.

Stage I

The research installation for stage I is shown in Fig. 1. The storage tanks 1 and 8 for fresh and decomposed manure respectively are both of 5 m^3 capacity. The submerged pump and the bottom sediment are shown. The decomposition chamber, or reactor, has an active volume of approximately 750 litres and is equipped with a lining in the form of a conical basket with a metal net at the bottom. A revolving impeller is mounted below the net to carry out the fluidization.

The overflow is lowered to just above the bottom of the reactor, outside the liner so that the substrate particles are not discharged upon emptying. The reactor is heated to the correct temperature using a hot water coil in the liner. In order to avoid syphoning effects and to make it easy to remove any deposits, the feeding device is constructed as a single liquid trap with open filling. This arrangement also facilitates the easy addition of water during operation, for example. The pressure is kept at approximately 50 mmwp above

Cont. P. 10

Expanded Bed Anaerobic Decomposition of Pig Manure

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atmospheric pressure by means of a liquid trap (10) and then the gas is taken through a condensate collector (11) and a gas heater (12) to the gas meter (13).

Stage II

During stage II the reactor was constructed as shown in Fig. 2. The lining was removed completely and the reactor's previously cylindrical lower part was replaced by a conical one. In addition, a pump was installed for fluidization and a revolving impeller was placed immediately below the surface of the liquid to prevent the formation of a "floating quilt". The particles of light ash which were used as substrate were replaced by new ones with somewhat lower density. The active volume of the reactor was approximately 500 litres in the modified version.

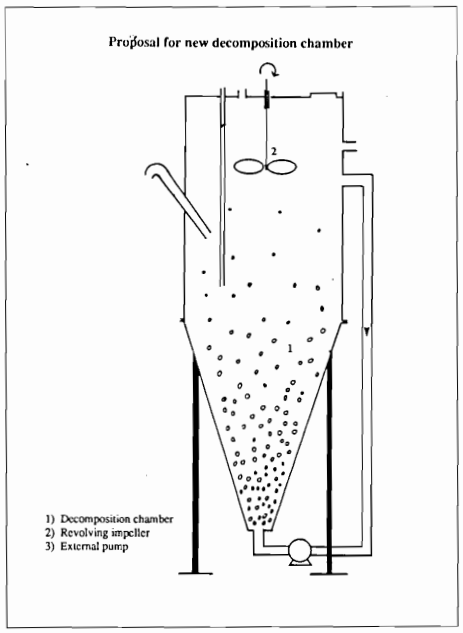

Fig. 2. Mesophilic anaerobic reactor.

The pig manure which was used in the investigation was brought from EnerChem's biogas plant at Marieholm in Skåne. This plant is a conventional tank reactor of 140 m^3 active volume and it has been used as the reference plant in evaluating the results in the experimental installations. In order to correlate the experimental reactor with the reference reactor a fermentation process was carried out without substrate at the start of stage II.

Results

The results of the experimental operation were;

- 0.82 m^3 biogas/m^3 reactor day;
- 15.6 m^3 biogas/m^3 supplied manure; and
- 19 days retention period.

The corresponding data for the Marieholm plant is:

- 0.85 m^3 biogas/m^3 reactor day;
- 15.5 m^3 biogas/m^3 supplied manure; and
- 18 days retention period.

As can be seen, the correlation between the reactors was very good and the results obtained in the experimental reactor should be achievable under actual conditions.

The experimental operation proper with substrate was started with a small amount of substrate and the amount was gradually increased. The longest continuous period of operation was six months and the largest quantity of substrate was 16% of the total volume. With 12% of substrate the following production figures were obtained:

- 1.3 m^3 biogas/m^3 reactor day;
- 16.5 m^3 biogas/m^3 supplied manure; and
- 13 days retention period.

With 16% of substrate in stable conditions the following were obtained:

- 1.7 m^3 biogas/m^3 reactor day;
- 19.5 m^3 biogas/m^3 supplied manure; and
- 11.5 days retention period.

At 16% of substrate the process could thus be operated with a retention period of 11.5 days, compared with 18 days for a conventional reactor, while the gas produced increased from 15.5 to 19.5 m^3/m^3 of manure supplied.

Conclusions

A good result was obtained biologically with the addition of substrate material and the project was successful in this respect. However, the intention was to add substrate material amounting to at least 50% of the reactor volume. On account of insufficient pressure attained by the fluidization pump this was not achieved. Problems also remained with the formation of a "floating quilt". The substrate material had a tendency to stick together with the fibres and the fluidization was then impeded.

The results of the evaluation of the project after the completion of stage II show that in spite of the fact that the theories concerning the biological results were upheld, it is not realistic to plan a full-scale plant of this type. This is in part because a lot of work remains to be done at great expense before a reactor can be made to operate with at least 50% of substrate material, and partly because it is recognized that it will be very difficult to find a substrate material with such a density that the energy requirement for fluidization is not unreasonably great. Calculations showed that the density of the substrate material must be almost identical to that of the liquid for the energy requirement to be reasonable, and in such a case there is a risk of too great a loss of substrate when the decomposed manure is emptied out. The project was therefore abandoned by EnerChem after the completion of Stage II.

(Source: Anaerobic Decomposition of Manure in an Expanded Bed. *Energy Technology*, No. 1, 1989, pp. 8-10).

Internat

A number of Italian engineering companies and researchers at the University of Genoa have been involved in a micro-hydro project in Latin America, which has resulted in the construction of several micro-hydro plants. The project, carried out under the auspices of the Italian Ministry of Foreign Affairs, covered the design of schemes, materials research, and the development of standardized machinery and components for the plants.

Technical and socio-economic studies relating to the specific environments of the tropical developing countries concerned were carried out. Following these initial studies, a joint venture was formed between both private and public corporations and the University of Genoa, and some demonstration projects were constructed, with funding from the European Economic Community. As a result, a number of mini- and micro-hydro projects, financed by the Italian Government, went ahead.

In Ecuador, the Ona, Valladolid, Zumba and Borja plants were built; in Bolivia, the Comarapa scheme was constructed; and in

l Co-operation in Micro-hydro Projects, Latin American

Colombia, the Lopez-Puerto Sergio plant is under way.

In mid-1989, a major programme of mini-hydro schemes is scheduled to go ahead in Peru, with plant sizes ranging from 200 to 1700 kW. Another project will start soon in Bolivia.

Similar schemes are also under way in Africa, and in various other developing countries. The schemes are generally being built by Ansaldo (CESEN-ASI), Hydro Co, and Orengine, with co-operation from the research laboratories of the Hydraulic Institute of the University of Genoa.

Micro-Hydro Projects in Ecuador

Research on the hydrology and the hydro potential of the provinces of El Oro and Loja in Ecuador has been carried out, and the results, together with the hardware and software used for the survey, have been provided to the national power authority. A grant of US$1.65 million was extended by the Italian Government for this scheme, which covered the engineering work, the machinery, the instrumentation for the hydrological survey, the hardware and software for the two computer stations, staff training, two vehicles, and the necessary air fares.

The Government of Ecuador paid for the civil works, transportation costs within Ecuador, and the transmission system.

The basic data for the four power plants are shown in the Table 1.

Table 1. Data on four micro-hydro schemes in Ecuador.

Name	Head (m)	Installed Capacity (kW)
Ona	26	135
Valladolid	29	235
Zumba	17	200
Borja	41.5	300

Each of the plants is equipped with crossflow turbines, designed in Italy by Orengine, working in partnership with technicians from OLADE (the Latin American Energy Organization). The plants are completely automated, and therefore do not require trained personnel. The Borja plant also has a microprocessor-based control system which has been designed with a view to simple maintenance requirements.

One of the most important lessons arising from this co-operation programme was a recognition of the need for a local technical organization to be available and in a position to provide funding for the basic project materials.

One problem is that the development of small hydro plants in rural areas and with limited funding is often managed either by local organizations without technically qualified personnel or purchasing power, or by central national organizations (at high managerial level) which often under rate the importance of this kind of development, and therefore give it a low priority. Consequently they do not devote the necessary attention and/or funding to the projects, resulting in delays which can sometimes reduce the overall success of the schemes.

Some new valuable experience has been gained in the design and construction of electromechanical equipment. This has led to the development of new machinery, which aims to be cheaper and more reliable than traditional units.

The adoption of new design techniques, and the use of synthetic materials and electronic governing systems, have enabled a range of standardized machinery to be developed. The standardized units are designed to be as compact and light-weight as possible, with simple geometry and with few components to ease maintenance. The machines are designed for high operational stability over a wide range of electrical loads and discharges. They are also suitable for unmanned operation.

(Source: Extracted from "International Co-operation in Micro-hydro Projects" by W. Narder, *Water Power & Dam Construction,* June 1989, Vol.41, No.6, p.22).

TRAINING COURSE ON SOLAR REFRIGERATORS REPAIRS & MAINTENANCE

Asian Institute of Technology, Bangkok, Thailand

9 – 20 July 1990 (Tentative)

This inter-country/inter-regional training course organized by the Asian Institute of Technology, Bangkok, Thailand, is intended for the solar refrigerator repair and maintenance technicians.

The course aims to fill the gap of suitably trained repair and maintenance technicians capable of installing and keeping the solar-powered refrigerators in good working order. Rapid expansion of the cold chain infrastructure including the use of solar refrigerators necessitates the training of more cold chain technicians.

The course is organized in collaboration with EPI of WHO-SEARO and WHO-HQ and follows the EPI scheduled program of instructions and training materials which is particularly orientated for hands-on experience.

Candidates/sponsors interested in the course should ask for more details and application form from:

Regional Advisor
Expanded Programme on Immunization
World Health Organization (SEARO)
World Health House
I.P. Estate
New Delhi 110002
India
(Tel: 3317804; Telex: 31-65031, 31-65095; Fax: 91-11-331-8607)

Application

Applications should reach WHO-SEARO NOT LATER THAN 30 MARCH 1990.

Photovoltaic Conversion Research Projects at the University of New South Wales, Australia

The University of New South Wales is one of the major centres for energy R&D in Australia. The 1988 Annual Report of the Energy Research Development and Information Centre (ERDIC) lists 102 active energy projects of the University in the following fields: Coal, Liquid Fuels and Engines, Oil and Gas, Energy Management, Socio-Economic Studies, Solar Energy, Biomass, Power Generation, Nuclear Energy, Wind Energy, Energy Storage, and Materials.

Out of a total of 15 projects in the solar energy field in 1988, 9 projects were reported in the area of direct conversion of solar energy to electricity. These are as follows:

Photoconducting Polymers in Solar Energy and Imaging Processes

Garnett J. L.

The aims of the project are to develop novel photoconducting polymeric systems for application in the areas of imaging photocopying and solar energy. Predominant aims, following demonstration that the first two objectives could be attained, are now to extend the work to solar energy applications, in particular to the development of a photovoltaic device for direct energy conversion. For this purpose polymers capable of being used for exterior applications, with properties such as good weathering, are being developed.

Photovoltaic Conversion of Solar Energy to Electricity

Green M.A., Wenham S.R., Blakers A.W.

This project includes a broad range of subprojects being conducted within the solar photovoltaic laboratory in the School of Electrical Engineering and Computer Science. Major activity has been directed at developing novel high efficiency silicon solar cells. Other activities have been concerned with exploring the potential of this approach on low quality silicon material, including thin film silicon. Other project areas include integrating bypass diodes into the structure of conventional solar cells to improve tolerance to shadowing and related effects, and evaluation of high efficiency cells for space use. Experimental investigation of improved solar cell structures has been carried out. Silicon cells of energy conversion efficiency in the 21-22% range, as measured by Sandia National Laboratories in New Mexico, have been produced. These are among the highest efficiency cells ever produced worldwide. Cells with efficiency in the 16-17% range have been produced on polycrystalline Wacker SILSO, and in the 14-15% range on EFG ribbon silicon. These are believed to be the highest efficiencies ever obtained on these lower quality substrates.

15% Efficient Solar Cell Module

Green M.A., Wenham S.R., Willison M.R.

The aim is to fabricate silicon solar cell modules of 15% energy conversion efficiency using the high efficiency cell technology developed at the University. Module rating is approximately 40 watts under standard test conditions. The initial stages involved the development of the simplest processing sequence capable of producing 18% efficient cells on 100 mm diameter silicon wafers. Cells will be combined with an efficient module design to achieve the project goals. Using the laser grooved, buried contact approach, cell efficiencies approaching 20% have now been demonstrated on cells of size 7 cm·x 7 cm. Initial modules show efficiencies in the 16-17% range. This is a joint project with BP Solar Australia, which is responsible for module design and the final module assembly.

Laser Grooved Solar Cells

Green M.A., Wenham S.R., Willison M.R.

The objective of the project is to improve the efficiency of cells fabricated using low cost metallization techniques such as screen printing or electroless plating by laser grooving of the cell surface. This gives a number of advantages, the most apparent of which are finer top contact metallization lines and lower top contact coverage. Earlier work on small area cells (2 cm x 2 cm) has been scaled up to large area cells (7 cm x 7 cm). Efficiencies close to 19% have been obtained on commercial solar grade crystalline silicon for the larger cells. This is a joint project with BP Solar Australia, which will be responsible for evaluation of the approach at the pilot production level.

High Efficiency Silicon Concentrator Solar Cells

Green M.A., Blakers A.W., Narayanan S., Taouk M., Chong C.M., Campbell P.

The aim of the project was to improve the energy conversion efficiency of silicon solar cells when used under concentrated sunlight. The high efficiency sequences developed for non-concentrating cells were applied to concentrating cells. The effects of cell resistivity and thickness were investigated. Some novel light trapping schemes were also studied. Cells with efficiency approaching 25% at 50-100 suns concentration were fabricated and efficiency values independently confirmed by Sandia National Laboratories in Albuquerque. Other cells maintained an efficiency above 20% at 1000 suns.

Fifth Generation Silicon Solar Cells

Green M.A.

In terms of cell efficiency, four generations of silicon solar cells can be identified since their invention in 1953. The fourth generation of cell, the high efficiency passivated emitter solar cell, was developed in Australia at the University of New South Wales. These were the first silicon cells to exceed the 18% energy conversion efficiency levels, as well as the 19% level. The objective of the present project is to build on this very sound base to develop a fifth generation of silicon cell with substantially improved performance over the levels already established. The main target of the programme is a cell with efficiency in excess of 22%. Efficiencies in the 21-22% range have now been independently confirmed, with the most recent generations of cells expected to exceed the 22% target. Secondary objectives are to identify those elements of the improved technology which could readily be incorporated into commercial processing sequences, to keep local industry informed

of such elements, and to facilitate technology transfer to local industry. This project is coordinated with one in progress at BP Solar Australia aimed at demonstrating high efficiency cell technology in pilot production.

Thin Film Polycrystalline Silicon Solar Cells

Green M.A.

The aim is to develop thin film polycrystalline silicon solar cell technology demonstrating 10% energy conversion efficiency at the module level. Films have been deposited on silicon and oxide-covered silicon wafers and evaluated. The most appropriate approach to developing cell processing sequences will be identified.

Copper Indium Diselenide Thin Film Photovoltaic Cells

Haneman D., Kristensen R., Hafiz A., Chu J., Chaudhuri T.K.

This project has as its aim the development of photoelectrochemical cells using the ternary semiconductor copper indium diselenide. Durable low cost cells of 6% efficiency have been made from both bulk and thin film material fabricated in the University of New South Wales laboratory. A chemical film can be grown on the surface to produce a heterojunction. Thin films have also been applied successfully, initially by coevaporation, now by flash evaporation and electro-deposition. The cells have shown no deterioration after the equivalent of several months of ordinary exposure to the sun.

Solar Cell from Organic Materials

Hora H., Imbusch F.G.

The objective of this project is to produce low-cost P-N junction solar cells made from (unsaturated) polymeric organic materials. A subthreshold electron beam is used for generation of the junction. The thermal effects involved are under study. Polyacetylene material studies have been performed.

(Source: *Energy Research Development and Information Centre, 1988 Annual Report,* University of New South Wales, Kensington, Australia, 1988, 62 p.)

Second Geothermal Station in New Zealand

The country's second geothermal power station, at Ohaaki on the Broadlands steam field on the North Island thermal belt, has been commissioned at a cost of US$185 million.

The station, 30 km north east of Taupo, is close to the Waikato river, some 22 km from the Wairakei geothermal power station which has been in operation since 1958.

A total of 45 bores were drilled. Twenty-three bores were found suitable and are being used for production, with a further seven for reinjection. The bore depth varies from about 500 m down to a maximum of 1800 m. The shallowest bore of 500 m is a condensate reinjection well.

The output of the field is about 6 per cent gas, the bulk being CO_2 and some 2.4 per cent hydrogen sulphide. The steam/water mixture is separated at five centralized separation plants, three in the western field and two in the eastern field. Steam is produced at two different pressures, 12.5 bar (HP) and 3.5 bar(IP).

The steam is transmitted to the power station by two 750 mm carbon steel HP pipes and a single 1000 mm IP pipe. All the pipes are laid above the ground, being thermally insulated and lagged with aluminium foil.

From the separation plants the separated water is returned to the periphery of the field and reinjected deep into the ground. This process is designed to replenish geothermal water levels and to prevent ground subsidence. Reinjection techniques have been used previously in both Japan and in the Philippines but this is the first time that they have been used on a large scale in New Zealand although tests were done at Wairakei.

Introduced primarily as a means of avoiding pollution of the river by chemicals dissolved in the hot water, reinjection is said to offer better ground stability and improved field operating performance. Some 1800 tons per hour will be treated in this way.

Each separation plant has up to four reinjection pump sets. Raising the pressure on a reinjection bore increases the flow of reinjected water and reduces the number of reinjection bores required.

It is expected that pressure of up to 40 bar will be necessary. The water will be reinjected at temperatures over 150°C to avoid silica build-up in pipelines and plant.

Cont. P. 14

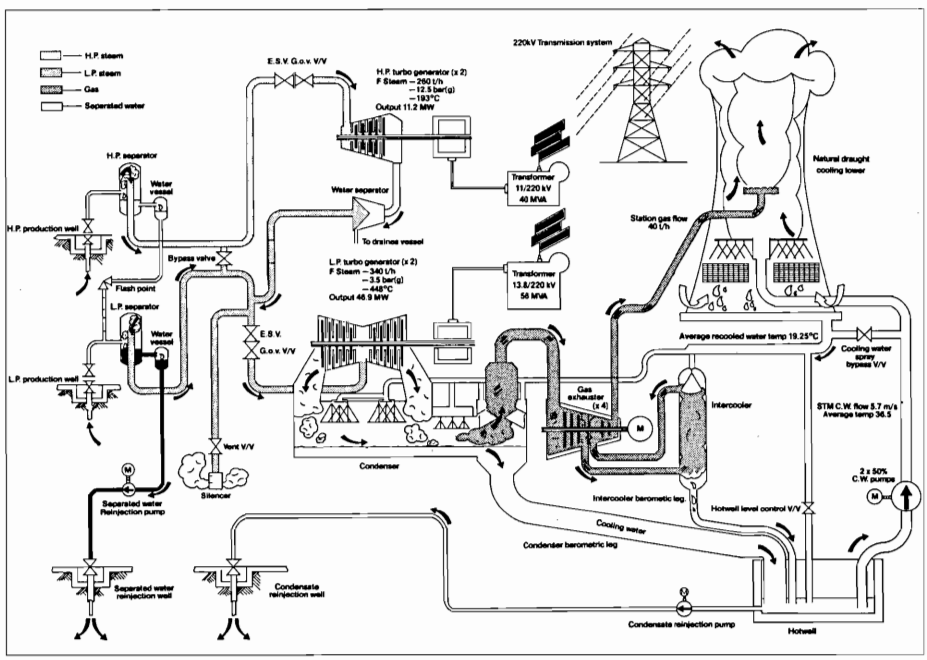

Fig. 1. Flow diagram for Ohaaki power station. 1. HP turbine generator. 2. HP separator. 3. HP production well. 4. IP production well. 5. Valves. 6. Separated water reinjection pump and well. 7. LP turbogenerator. 8. Water separator. 9. Transformers. 10. Intercooler. 11. Condenser. 12. Transmission system 220 kV. 13. Natural draught cooling tower. 14 Hotwell. 15 Condensate reinjection well.

Geothermal Power
Scientists Probe Deep for New Energy Source

Drilling an US$8 million experimental hole in the earth may reveal a huge new source of energy. The Department of Energy's Sandia National Laboratories is launching a four-year programme to penetrate nearly 4 miles to molten rock in the Long Valley caldera near Mammoth Lakes, California.

According to the geothermal research division of Albuquerque-based Sandia, it is one of more than two dozen magma bodies in the western U.S. within a depth of 6 miles that may reach temperatures of 1,650°F. Scientists calculate that they could contain as much as 500,000 quadrillion Btu of energy, each quadrillion being equivalent to the energy content of 172 million barrels of oil.

By 1992, the contractor, Loffland Brothers Co., is supposed to drive to a depth of 20,000 ft or until a bottom-hole temperature of 930°F is encountered. While that will not pierce deeply into the caldera it will provide knowledge about locating and exploiting magma.

Meanwhile, Sandia engineers are studying means of recovering energy from the molten material based on earlier work at a shallow lava lake in Hawaii. Water would be circulated through the fractured magma producing steam to generate electricity. A model developed at the University of Utah predicts temperatures and water flow rates necessary to obtain the maximum amount of energy.
(Source: Extracted from: Scientists Probe Deep for New Energy Source, *ENR, The McGraw-Hill Construction Weekly*, July 27, 1989, Vol.223, No.4, p. 20).

Postgraduate Course on Principles of Renewable Energy Use

The Department of Physics of the University of Oldenburg/ Federal Republic of Germany provides a postgraduate course on "Principles of Renewable Energy Use". The first course started in October 1987. Its objectives are to enable scientists and engineers, who intend to work in Third World countries, to plan and design energy supply systems based on renewable energy resources (solar and windpower, biomass, water power, etc.).
The topics to be covered during the eleven-month course are:

- Scientific principles and techniques for the design of renewable energy systems.
- Methods for economic and social analysis for the end-uses during the planning and diffusion phases of such systems.
- Laboratory experiments on decentralized energy supply systems.
- 6 weeks practical course in institutions and companies related to renewable energy.
- Master theses related to the subsequent activities of the student.

Successful participation is acknowledged by conferring the degree "Master of Science". The course is held in English. There are possiblilities for scholarships for candidates who satisfy certain criteria. Applications should be sent to the Embassy of the Federal Republic of Germany. Inquiries and applications should be directed to:

Dr. E. Naumann
Department of Physics, University of Oldenburg
P.O. Box 2503, D-2900 Oldenburg
Federal Republic of Germany

Second Geothermal Station in New Zealand

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Power plant and buildings

Four turbo-generator sets are to be installed. Two of the four are refurbished 11.2 MW high-pressure back-pressure sets which were originally installed at Wairakei power station and were in service there from 1962 to 1982 until falling field pressures reduced their output to an uneconomic level.

These high-pressure units are installed in the HP turbine house which is adjacent to the IP turbine house, ("A"station) linked by an overhead walkway. The other two machines are installed in a separate building, the "A" station, and are new 49.6 MW IP condensing sets. Turbines and generators have been supplied by Mitsubishi while the condensers and gas extraction plant have come from Franco Tosi of Italy.

A natural draught cooling tower, 106 m high and 70 m across the base, is a dominant feature of the development. Built of high-grade reinforced concrete with special additives to prevent corrosion, the cooling tower removes some 420 MW of heat from the 20,000 tons per hour of circulating cooling water.

Multi-stage gas exhausters have been used at Ohaaki because of the high gas content (approximately 6 per cent) of the steam. The gas, which is predominantly carbon dioxide, also contains some hydrogen sulphide which will be dispersed by discharging it into the cooling tower plume.

In addition to the two turbine houses, a third building stands on the same site and is linked with the "A" station by an overhead walkway. It contains administration offices, workshop and stores.

Progress

At the present time, two units, Nos. 2 and 6, are operating. Commission testing of the three main features of each unit, steam supply, cooling and electrical systems, is currently being carried out following critical paths.

The station is intended for remote operation via UHF radio link from Wairakei from 1 October 1989 with practical completion of the works by 1 May 1990.

When that happens, the load on each machine will be controlled from Wairakei and the plant is so designed that, should the Ohaaki station develop a fault, then the plant will shut down automatically.

Each block of plant has its own automatic control functions and monitoring systems.

In the long term, a further "B" station may be built. Power from the generators is transformed by 220 kV by watercooled, oil-filled transformers situated outside the turbine halls and from there taken via busbars and circuit breakers in the outdoor switchyard for transmission to Wairakei and interconnection with the national grid.

During the construction period, electric power was obtained via a 33 kV feed from Wairakei power station to an outdoor switchyard on the eastern side of the site where it is transformed to 11 kV.
(Source: Second Geothermal Station Starts in New Zealand, *Modern Power Systems*, Vol.9, No.5, May 1989, p. 23).

Course on Wind Energy for Water Pumping

From Resource Analysis to the End Use of the Pumped Water

5 February to 16 March 1990
Enschede, The Netherlands
Organized by the University of Reading and CWD in cooperation with the Technology and Development Group of the University of Twente
Sponsored by the Minister for Development Cooperation, Section for Research and Technology, The Hague

The aims of the course are:
- To gain understanding in the management aspects which are required for successful implementation of projects, specifically: site selection, manufacturing and installation of wind pumps, selection of piping and storage tanks, manpower development, marketing and credit facilities, etc.
- To enable the course participants to make conscious choices.
- To make the participants aware of the money saving possibilities of wind energy for water pumping purposes.
- To develop the ability of the participants of the course to:
  - specify the conditions necessary for successful application of wind energy for water pumping purposes;
  - assess the technical merits of windmill components;
  - install, maintain and modify a water pumping system powered with wind energy;
  - judge the performance of different wind pump systems;
  - gain understanding in the water and wind resources of specific regions; and
  - gain understanding in the interaction between windmills and water pumps under various wind and water conditions.

Course contents consist of:
- General overview on energy;
- Wind and water resource analysis;
- Economics of water pumping;
- Technology of wind energy systems; and
- Feasibility and implementation of wind energy projects.

The time involved in the different course parts is: lectures 110 hours; workshop sessions and exercises 80 hours; case studies 40 hours; excursions and social programme 30 hours; and literature studies 30 hours.

The course is principally intended for engineers or persons with a technical background who are involved in the execution of projects for the application of wind energy for water pumping. Scientists at universities or institutes who are engaged in wind energy research and development programmes are also invited to apply for the course. Priority is given to those who are directly involved in field projects.

The course fee will be 5400 DFL (1 US$ = 2.10 DFL). This fee covers the costs of lectures, workshop sessions, excursions, the social programme and the course manual. Living expenses and accommodation are not included.

Applications should be submitted before 15 December 1989 to:
Consultancy Services Wind Energy
Developing Countries (CWD)
P.O.Box 85, 3800 AB Amersfoort, The Netherlands
Telephone: 31-33-682174, Telefax: 31-33-615047
Telex: 79348 DeHaVe NL

Bulletin of the Co-operative Programme on Energy and Development

Issue No. 1, September 1989
Science Policy Research Unit, University of Sussex, UK (98 p.)

The Cooperative Programme on Energy and Development (COPED) established in June 1981 was formed to facilitate collaborative activities by institutes in Europe and developing countries in order to: i) undertake research to increase understanding of the energy situation in developing countries and its relevance for Europe, ii) build consistent information about energy in developing countries, iii) develop new approaches to the planning and management of energy systems that are appropriate to the conditions in developing countries, and iv) build local capabilities to manage energy systems through training and the exchange of staff.

This Bulletin is the first concrete result of the decisions taken at the annual meeting of the Network in 1988 (in New Delhi) to disseminate the results of the work more widely. It contains in total fourteen (14) papers covering the history of the Network and its main achievements so far, COPED activities in China, India, Mexico, Brazil, Algeria, several Arab countries and the Asian Institute of Technology (including reporting of the research outcome in some cases). A few of the above papers have reported about the contributions made by SPRU (U.K.), ENDA-TM (Senegal), IEPE (France) and IDEE/FB (Argentina) in the activities of COPED. A list of other formal publications disseminating results of COPED activities is also provided.

TIPS Bulletin on Energy

TIPS Energy, a daily bulletin containing technology offers and requests, new products, and consultancies, is being released by DEVNET and the United Nations Development Programme (UNDP).

The bulletin, one of ten different bulletins published by DEVNET/UNDP Technological Information Pilot System (TIPS), covers information ranging from technology and trade trends, policies, research and development, consultancies, news and offers and requests.

Topics in the latest issues, for example, include technology trends on amorphous material for large capacity transformers; wood gasifier for diesel engines from India; policy on the declaration of regional energy cooperation in Latin America; a news item on oil well exploitation in Ecuador; offer for electric-solar water heating systems from Brazil; and a technology offer for a rice hull fuelled grain dryer from the Philippines.

The articles are simple, concise and precise. The 3-page daily bulletin is designed for quick reading by decision-makers.

TIPS bulletins are unique for their specialization on activities in developing countries for which information is usually difficult to secure. This has been made possible by a network of more than 120 people working in developing countries all linked together by a 24-hour telecommunications system.

Entrepreneurs, investors and policy makers who wish to submit an item or subscribe to TIPS bulletins should contact:
DEVNET/UNDP TIPS
Via Panisperna 203, 00184 Rome, Italy
Fax: (39-6) 481-78-77
Telex: 610574 IPSROM I

Pump Selection: A Field Guide for Developing Countries

WASH Technical Report No. 61
Prepared by Richard McGowan and Jonathan Hodgkin
Funded by the Water and Sanitation for Health (WASH) II Project under the auspices of the U.S. Agency for International Development's (AID) Bureau for Science and Technology, Office of Health.
(1989, ix+192 p.)

The improvement of rural water supplies has been a major focal point of rural development efforts in developing countries. This manual is written to aid a wide variety of people who are involved in making decisions about water pumping equipment and its use. The authors claim to introduce readers to important issues such as recurrent O&M costs, availability of technical skills and spare parts, system reliability, ease of installation and/or operation and related considerations which, in their opinion, were missing from previously published similar handbooks which primarily focused on the technical aspects of choosing a pump.

The second chapter shows how to determine the water demand at site and calculate this. It also discusses water-resource characteristics such as well yield (if source is ground water), pumping head and water quality. Chapter 3 describes how to calculate the energy requirements for meeting the demand determined already in Chapter 2. It discusses four types of energy sources, viz. diesel fuel, wind and solar energy and human power. The types of pumping equipment and their operating characteristics are covered in Chapter 4. This chapter also includes summaries of the important advantages, disadvantages and typical applications of different types of pumps and energy sources. The next four chapters (5 thru' 8) focus on technical system design for the four types of energy sources mentioned earlier. Except for the section on handpumps, which is a much simpler technology, each chapter concludes with a detailed example of the design of a pumping system using that technology.

The final two chapters on economics and other non-technical considerations are the final stages in the screening of equipment options. Chapter 9 discusses analytical methods and then shows how to apply them by taking the reader through two detailed examples that compare two pumping options.

Appropriate Technology in Industrialized Countries

Willem Riedijk, General editor
Jan Boes and Wim Ravesteijn, Editors
Delft University Press
Stevinweg 1, 2628 CN Delft, The Netherlands
ISBN 90-6275-284-5 1989, xxxiv+372 p. (Dfl 60.00)

The field of appropriate technology has experienced profound changes during the past decade. New concepts in which appropriate technology has become a modern tool for sustainable development have replaced outdated clichés such as "second-hand technology" which have been applied to define this technology used in the past. This book is intended to contribute to that new image.

"Appropriate Technology in Industrialized Countries" should be regarded as essential reading for technical students and all others concerned with the application of a technology which is both beneficial to mankind and environmentally benign.

This publication directs its focus not only at practical applications of appropriate technology in industrialized countries, but, in addition, gives this a conceptual and theoretical foundation. It concludes a series of which "Appropriate Technology for Developing Countries" (1982) and "Appropriate Technology for Liberation" (1986) were the preceeding volumes.

This book consists of three parts. The first part enters into the theoretical points of departure of appropriate technology with emphasis on cultural and economic factors. The second part deals with appropriate technology in industrial society. It contains contributions which examine the cultural- and political-economic environment of social movements inducing the implementation of appropriate technology. The third part shifts the focus to techniques used in some important fields of application. Experts exemplify appropriate technology solutions in their field of interest, specifically, water, nutrition, housing and energy.

The energy section contains the following articles:

- Appropriate Energy Technologies (Theo Potma)
- Energy Conservation and Ecology (Wouter van Dieren)
- Safeguarding Energy Supply and the Environment (Wiero Beek)
- Towards Integrated Energy Systems (Pieter van Abshoven).

Technology Survey on Electric Power Systems

Lionel O. Barthold
The World Bank
1818 H Street, N.W.
Washington, D.C. 20433, USA
February 1989.

This report prepared by Power Technologies, Inc. (PTI) of Schenectady, New York, is one of a series issued by the World Bank's Industry and Energy Department for the information and guidance of Bank staff.

This report presents an overview of the status of today's power system technology and expectations for future development. The report examines all the main areas of the power system – supply and demand, generation, energy storage, transmission lines, transmission substations, system operation, distribution, system design, software, and utility management. Throughout the world shortage of investment funds is requiring utilities to give greater emphasis to operational improvements to extend plant life, improve capacity factors and effect energy conservation. Combined cycle units (gas

First International Conference on Renewable Energy and Local Production: A Vehicle for Development, Proceedings

18-23 September 1988
Danish Centre for Renewable Energy
Thy, Denmark

The conference was organized by the Danish Centre for Renewable Energy in cooperation with the United Nations Department of Technical Cooperation for Development (UNDTCD), supported by the Danish International Development Agency (DANIDA) and the Danish Council of Technology, Ministry of Industry.

The conference focussed on the combination of renewable energy with local production which has been seen as an increasingly useful method for many regions of the world to reduce their need for imported fuels and to stimulate their own economy.

The Proceedings published by the Danish Centre for Renewable Energy, in May 1989, contains 45 papers related to: exchange of technology, renewable energy technologies for water pumping, electricity from renewable energy, biomass and thermal systems, integrated systems and future development in renewable energy systems.

The Proceedings which is priced at US$50 per copy (excluding postage charge) can be ordered from:

Folkecenter for Renewable Energy
P.O. Box 208
DK-7760 Hurup Thy, Denmark
Tel: + 45 97 95 65 55
Fax: + 45 97 95 65 65

AT Source

AT Source is a quarterly magazine dedicated to the dissemination of information on appropriate technology for improving the position of underprivileged people in the Third World Countries.

AT Source offers:

- Supporting technical know-how in all fields of rural development, such as water and sanitation, agriculture, energy, building and construction, small-scale industries, food production and health care.
- Descriptions and analyses of technology introduction to developing countries.
- Case studies of both successful and unfruitful technology implementations.
- Comparisons of products and techniques (e.g. waterpumps, photovoltaic supplies).

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turbines plus waste heat boiler and steam turbines) are emerging as the preferred generating source because of their low capital cost and high efficiency, particularly where gas is available. These units can also be adapted to coal fueling through coal gasification to minimize using oil as a fuel and to utilize indigenous resources. Increased environmental concern over conventional coal thermal emissions in many countries is giving impetus to the development of fluidized-bed and coal gasification technologies to permit wider use of coal for electricity production. Unless economic hydro is available, diesels will continue as the predominant supply source on small systems up to about 100 MW. Public concern, low oil prices and high capital cost will limit the use of nuclear power to only a few developing countries. It will be many years before new technologies such as fuel cells or ocean thermal energy conversion can be considered for the developing countries. The limit of AC transmission voltages has levelled off at about 800 kV because DC transmission is available for long distance transmission and the maximum generating unit size has also levelled off. There is considerable scope of improving utility productivity through computer automation in specific areas such as generation dispatch, distribution operation and system control optimization.

Solar Science
A Solar Experiments Package for Schools

Solar Science is a kit of solar cells and motors with more than 12 hours of activities for schools. The activities have been designed to involve students individually or in groups.

The activities take students from the basics and give them activities that help them understand how a solar cell works and how it generates electricity. The students are then encouraged to develop the use of solar cells through simple experiments.

The kit contains:

- Teacher guide and lesson plans
- Five solar cells and motors
- Connecting cables and clamps
- A meter
- Wire.

Teacher Guide

The Teacher Guide is a 24 page booklet containing 12 complete activities. All activities are clearly written and illustrated. Each experiment has been thoroughly trialled and researched. The 12 activities cover:

- Introduction to solar cells
- Making a solar cell meter
- Controlling the light source
- The colour of light
- Concentrating light
- Making a circuit
- Conductors and insulators
- Current in a circuit
- Series circuits
- Constructing a switch
- Converting light to mechanical energy
- Designing solar products.

All these packages have been produced by the Victorian Solar Energy Council (Australia) in close co-operation with the Ministry of Education.

For details contact:
Victorian Solar Energy Council
10th Floor, 270 Flinders Street
Melbourne 3000
TEL: (03) 654 4533

Proceedings available from RERIC

Energy Conservation in Buildings, Proceedings of the 5th Asian School, AIT, Bangkok, 15-23 June 1987

B. Mohanty & P. Bouix (Eds.)
Asian Institute of Technology, Bangkok, Thailand
(June 1988, 254 p.)

The Fifth Asian School on Energy Conservation in Buildings was a deviation from the earlier schools organized jointly by the Asian Institute of Technology (AIT) and the King Mongkut's Institute of Technology in the field of solar energy harnessing and applications. However, it follows and caters to the present demand of "rational use of energy" in all the economic sectors of the region.

The Proceedings published by the Energy Technology Division of AIT contains the following 19 papers presented by lecturers during the school:

- A National Training Policy for Energy Conservation in Residential and Commercial Buildings (Anne DUPORT)
- Economic Appraisal of Energy Conservation: Micro and Macro Perspectives (Bertrand CHATEAU)
- Policy of the French Agency for Energy Management for Residential and Commercial Buildings (Thierry MERAUD and Jean-Pierre TRAISNEL)
- Analysis of Energy Consumption Trends and Patterns of Buildings in ASEAN Countries (Thierry MERAUD)
- Atmospheric Radiation (Robert H.B. EXELL)
- Lighting and Daylighting in Buildings (Surapong JIRARATANANON)
- Nocturnal Cooling (Piyawat BOON-LONG)
- The Basics of Energy Management and Control Systems (Pierre F. PARENT)
- Management of Electrical Energy (Surapong JIRARATANANON)
- Building Energy Performance Prediction (S.K. CHOU)
- Computer Codes for the Energy Analysis of Buildings (S.K. CHOU, Y.K. LEE and M.N.A. HAWLADER)
- Adaptation and Use of CASAMO-CLIM, a Microcomputer Program (L. LEJEMBLE, P. BREJON and D. CAMPANA)
- TECHNICAL NOTE: Basic Algorithms of Simulation of CASAMO-CLIM (Jean-Pierre TRAISNEL and Brahmanand MOHANTY)
- Controlling Heat Gains of Traditional Style Houses in Hot Humid Climates (Truengjai BURANASOMPHOB)
- Design of Air-Conditioning System for Large Buildings (Pibool HUNGSPREUGS)
- Building Design with Energy Factor: Practical Experience (Sumet JUMSAI, Philippe BOUIX and Brahmanand MOHANTY)
- Thermal Energy Analysis in Hospitals and Hotels (Prida WIBULSWAS)
- Fundamentals of Absorption Cycles: Heat Pumps (Jean-Claude MORA and Arshad UL HAQUE)
- Absorption Heat Pumps in Residential Sector (Brahmanand MOHANTY).

An overview of the Fifth Asian School and ten selected papers presented by the participants are also included.

The Proceedings is available from the Regional Energy Resources Information Center (RERIC). The prices are:

Developed countries US$30.00/copy
Developing countries US$22.50/copy.

Order and pre-payment should be made to:

The Director
RERIC/AIT
G.P.O. Box 2754, Bangkok 10501
Thailand.

AT Source

From P. 17

- Reflective articles on wider issues such as women and technology and the firewood crises.
- Book reviews, useful addresses and literature.

The March 1989 issue of **AT Source** contains the following main articles:

- AT-view: Firewood shortage in the Third World by Peter van der Hout.
- Energy and Power: Carbonized cotton stalk by Roland V. Siemons and Ahmed H. Hood.
- Agriculture: Social forestry in Mali by L. de Jong.
- Manufacture and Services: Deforestation and women by Inge Brouw.
- Cooking on Firewood by G. de Lepeleire.

The subscription rate is Dfl. 25 per year, from January 1990 Dfl. 35. For subscriptions and more information please write to:

AT Source
P.O. Box 41
6700 AA Wageningen
The Netherlands

Film on Anaerobic Digestion

The Directorate-General for Energy of the Commission of the European Communities has produced a film on "Anaerobic Digestion and Its Industrial Application to Biogas Production (research and development activities, pilot and demonstration plants, and industrial plants).

This film has been produced by "Comitato Nazionale delle Ricerche di Bologna–Italy–Sezione di Cinematografia Scientifica" with the assistance of various organizations, research institutes and industries of the EC member countries.

The film comes in the following versions: 16 mm (40 min long), video-boxes format 3/4 in U-matic, VHS, Betamax or 8 mm (PAL or SECAM standard) with commentary in English, French, Italian, German or Spanish.

To receive a copy of the film please send your order, stating the version you require, to:

Prof. Lucio Morettini
CNR–LAMEL
Via dell' Inferno, 5
I–40126 Bologna
Italy
Tel: 051 271276
Telex: 52350 Bologna
Telefax: 051 229702

Publications Received

ENERGY

Promoting Investment for Natural Gas Exploration and Production in Developing Countries, Basil N. Petrou, Industry and Energy Department Working Paper, Energy Series Paper No. 10, The World Bank Industry and Energy Department, PPR, Washington D.C., USA, January 1989, 27 p.

Recent Developments in the U.S. Power Sector and Their Relevance for the Developing Countries, Mohan Munasinghe and Arun Sanghvi, Industry and Energy Department Working Paper, Energy Series Paper No. 12, The World Bank Industry and Energy Department, PPR, Washington D.C., USA, February 1989, 90 p.

Nonindustrial Energy: Consumption and Supply in Cities of China, Lu Yingzhong, Qiu Daxiong, Lu Yingyun, Wei Zhihong, Yu Suhua and Tao Jun, Manuscript Report 213e, IDRC-MR213e, IDRC, Ottawa, Canada, December 1988, 58 p.

BIOMASS ENERGY

Wood Based Energy System in Rural Industries and Village Applications - India, J.S. Juneja, Regional Wood Energy Development Programme in Asia GCP/RAS/111/NET, Field Document No. 18, Food and Agriculture Organization of the United Nations, Bangkok, Thailand, July 1989, v+93 p.

SOLAR ENERGY

Gunesle Devitilen Sogutma Sistemlerinin Analitik Irdelemesi ve Karsilastirmasi (An Analytical Analysis and Comparison of Solar Powered Refrigeration Systems), Mustafa Ozcan Ultanir, University of Ankara, Ankara, Turkey, 1989, xvi+148 p. (in Turkish).

Testing of Energy Equipment in Tropical Humid Climate: Solar Water Heater GIORDANO KSH 100/2, Final Report AIT/EP/89-2, B. Mohanty and P. Bouix, Asian Institute of Technology, Division of Energy Technology, Bangkok, Thailand, April 1989, 43 p.

Testing of Energy Equipment in Tropical Humid Climate: Solar Water Heater SDF MST 75, Final Report AIT/EP/89-3, B. Mohanty and P. Bouix, Asian Institute of Technology, Division of Energy Technology, Bangkok, Thailand, April 1989, 40 p.

Testing of Energy Equipment in Tropical Humid Climate: Photovoltaic Pump ELENE SP 100, Final Report AIT/EP/89-4, B. Mohanty and P. Bouix, Asian Institute of Technology, Division of Energy Technology, Bangkok, Thailand, April 1989, 60 p.

Testing of Energy Equipment in Tropical Humid Climate: Solar Collector TONIN Tonisol, Final Report AIT/EP/89-6, B. Mohanty and P. Bouix, Asian Institute of Technology, Division of Energy Technology, Bangkok, Thailand, April 1989, 42 p.

Diary of Events

- **October 16-18, 1989, Los Angeles, USA**

Energy Markets in the 1990s and Beyond

The conference is the 11th Annual North American conference of the IAEE.

For further information, contact:
Joan Walsh Cassedy
IAEE
1133 15th Street, NW, Suite 1000
Washington D.C. 20005, USA
Tel: (202) 293 5913

- **October 25-27, 1989, Tokyo, Japan**

International Symposium on Energy Systems, Management and Economics

For further information, contact:
Dr. Kenji Yamaji
Central Research Institute of the Electric Power Industry
1-6-1 Ohtemachi, Chiyoda-ku
Tokyo 100, Japan

- **November 24-25, 1989, Rugby, United Kingdom**

ITDG Biomass Forum 1989

The theme of ITDG Biomass Forum 1989 is Dung: its use as fuels, the fuel vs fertiliser debate and the future of biogas. It is intended as an exchange of experience and views between practitioners, academics and other interested parties.

For further information, contact:
Liz Bennett
ITDG
Myson House, Railway Terrace
Rugby, CV21 3HT
United Kingdom

- **December 11-13, 1989, Miami, Florida, USA**

9th Miami International Congress on Energy and Environment

The aims of the conference are dissemination and discussion of research results related to the environmental effects of energy sources and carriers, and the remediation of the environmental damage. In addition to the technical aspects of energy and environmental topics, the economics, planning and policies, and the social aspects will also be considered.

For further information, contact:
Ms. Lucille Walter
9 MICEE Coordinator
Clean Energy Research Institute
University of Miami
Coral Gables, Florida 33124
USA
Tel: (305) 284-4666
Fax: (305) 284-4792
Telex: 5193081 UOFMIAMI

- **January 29-February 2, 1990, Lake Buena Vista, Florida, USA**

14th Annual Conference on Energy from Biomass and Wastes

Cont. P. 20

Diary of Events

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The conference will be held by the Institute of Gas Technology (IGT) at the Hotel Royal Plaza in the Walt Disney World Village, Lake Buena Vista, Florida.

For this conference, IGT is seeking papers on original research, economic analysis, and case histories of commercialized systems on the following topics:

- Woody, herbaceous, and aquatic biomass production and procurement
- Biomass component separation and utilization
- Municipal solid waste processing, conversion, and utilization
- Wood combustion advances
- Cogeneration with biomass and wastes
- Thermal and biological gasification and liquefaction
- Hydrolysis and conversion of cellulosics
- Alcohols and other oxygenated fuels
- Integrated farm-scale and industrial systems
- Genetic engineering advances
- Chemicals from biomass and wastes
- Analysis and control of emissions

Special attention will be given at the conference to papers on innovative research development, papers submitted by companies and organizations that have designed and installed biofuels systems for commercial use, and papers by the operators of these commercial systems.

For details, contact:
Susan Robertson
IGT
3424 South State Street
Chicago, IL 60616
USA
Tel: 312/567-3881
Fax: 312/567-5209
Telex: 25-6189)

- **March 1990, The Hague, Netherlands**

Optical Materials Technology for Energy Efficiency and Solar Energy Conversion IX

The topics of the conference are: materials for solar energy systems; selectively transmitting coatings; materials and devices for radiative cooling; coating technology; solar energy instrumentation, etc.

For further information, contact:
ESIC - Europtica Services International Communications
16, av. Bugeaud
75116 Paris
France
Tel: 33 1 45 53 26 67
Fax: 33 1 47 04 25 20
Telex: 642632 ANRTF

- **April 1-4, 1990, Miami, Florida, USA**

1990 ASME International Solar Energy Conference

The topics covered by this conference are: solar and energy-efficient buildings; solar thermal conversions; panel on operating experiences in solar energy systems; testing and measurements; heating and cooling systems; thermodynamics and transport phenomena in thermally activated heat pumps; simulation and economic analysis; space solar power; energy fundamentals in solar systems; innovative solar energy systems; solar fuels, biomass conversion; student design panel on solar energy cars; and solar ponds.

For further information, contact:
Dr. Jan F. Kreider, P.E., Director
Joint Center for Energy Management
University of Colorado
Boulder, CO 80309-0428
USA
Fax: 303-492-7317

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Library and Regional Documentation Center, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The "RERIC News" is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership along with the other four regular publications namely: RERIC International Energy Journal (formerly: Renewable Energy Review Journal); RERIC Holdings List; Abstracts of AIT Reports and Publications on Energy; and RERIC Membership Directory. For further details contact:

Regional Energy Resources Information Center
Asian Institute of Technology
G.P.O. Box 2754
Bangkok 10501, Thailand
Telex: 84276 TH
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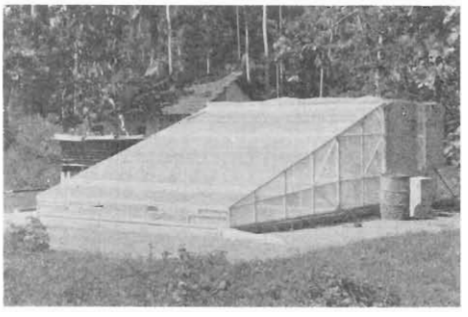
Fig. 1. View of the complete kiln.



Solar Timber Seasoning Kilns
NBRO-AIT Project in Sri Lanka

The Building Materials Division of the National Building Research Organization (NBRO) in Sri Lanka is currently engaged in research on the use of the solar kiln for seasoning secondary species of timber used in the building industry. One component of the NBRO research concerned the design and construction of an efficient solar kiln and was carried out in cooperation with the Asian Institute of Technology (AIT), Bangkok, Thailand.

Earlier Solar Dryers in Sri Lanka

Prior to the start of the NBRO-AIT project two types of solar kiln had already been introduced into Sri Lanka. The earlier of these was a forced air dryer designed by the Forest Products Laboratory, U.S. Department of Agriculture for Borwood Ltd

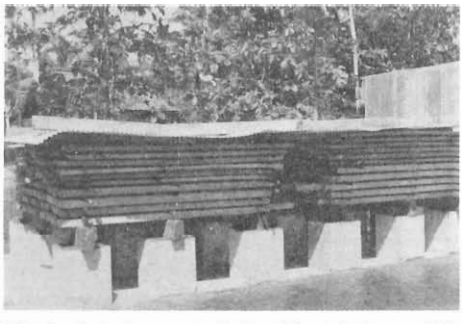


Fig. 2. Air drying stack. Rubber Wood (mixture of 2" x 4" rafters and planks).

and installed at their factory in Horana in 1983. The larger of two such kilns on the site has a capacity of 500 ft^3 of timber. It is a well researched and engineered system, but it is expensive, costing Rs 500,000 (US$16,700) for the solar system excluding the wood burner. In contrast, a major goal of the NBRO-AIT project was to develop a more economical unit for the smaller users, and for this an improved greenhouse type solar kiln (described next) seemed best.

The second type of kiln introduced into Sri Lanka was designed like a portable greenhouse having an aluminium frame covered with clear plastic sheet. It was developed by the Intermediate Technology Group, U.K., and was installed at the Wood Technology Section of the State Timber Corporation at Kaldemulla.

The New NBRO-AIT Project in Sri Lanka

The target group of users for the proposed solar timber kiln would be small sawmills rather than very small cottage industries or large scale industries. Seasoning would be mainly of secondary species of tim-

Con: P. 2

wind and sun compendium
Development of wind and solar energy for water pumping

CWD
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Wind Energy
Developing Countries

Energy Information Service, CSIRO
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INNERTAP

Solar Timber Seasoning Kilns: NBRO-AIT Project in Sri Lanka

From P. 1

ber used for building construction; the two main species would be rubber and coconut, which will remain available until the end of this century. These secondary species of timber are used as an alternative to primary species which have become increasingly scarce as a result of widespread deforestation.

The basic design concept is shown in Fig. 3. The stack of timber is supported 2 ft above the floor of the kiln on a 3x6 array of brick pillars 3 ft apart. The stack is built up with the help of crossbearers at the bottom, stickers between the layers of planks, and weights on the top of the stack. The height of the stack is 4 ft, thus the top is 6 ft above the floor.

The floor of the kiln is made of brick and cement, and is slightly convex so that any rain that may leak through the cover of the kiln does not remain in puddles. The floor extends from below the woodstack out to a distance slightly more than 18 ft from the front of the stack. It is painted with bituminous paint, so that, besides being waterproof to prevent moisture entering the kiln from the ground below, its black colour absorbs solar radiation.

The woodstack is protected from direct solar radiation by a cover of aluminium sheet and the black floor serving as a solar collector is covered by clear plastic sheet (of a type that can withstand deterioration by ultraviolet solar radiation), supported by an aluminium frame. The air is circulated inside the kiln by means of fans built into the frame. After being blown from the solar collector through the woodstack by the fans, the air returns via an airspace behind the woodstack and the space under the stack. There is no airspace between the ends of the stack and the sides of the kiln. Air vents, which can be opened and closed by varying amounts, are provided at the end of the solar collector and behind the woodstack for humidity control inside the kiln.

The cost of the solar kiln system

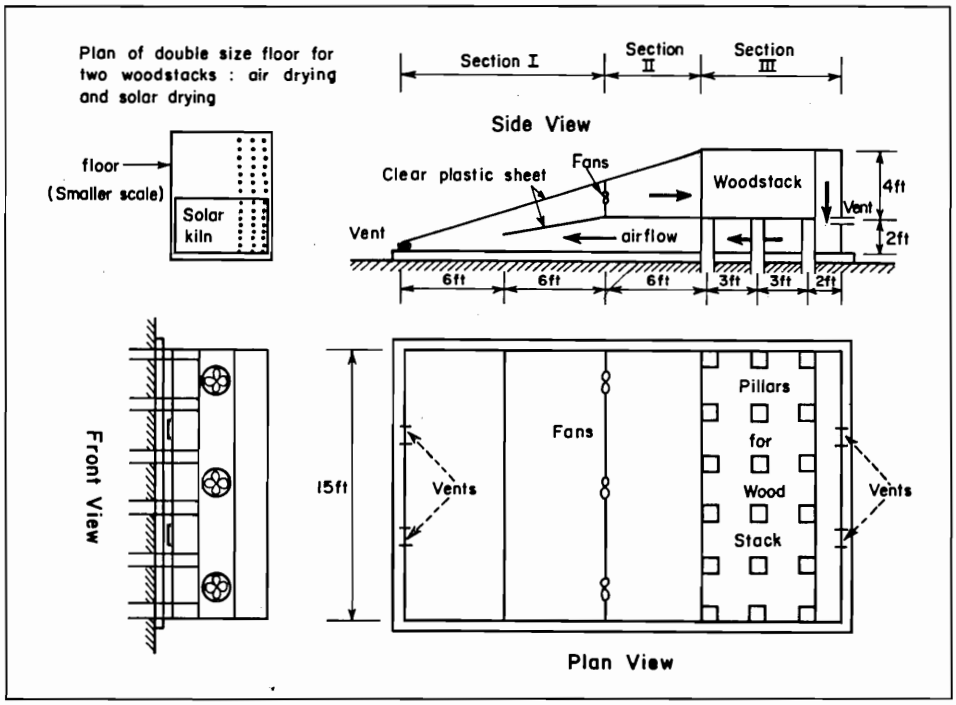


Fig. 3. NBRO-AIT solar timber kiln.

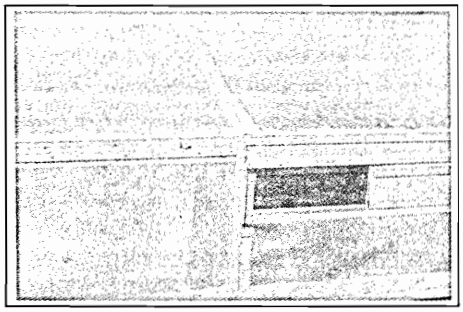


Fig. 4. Front inlet vent.

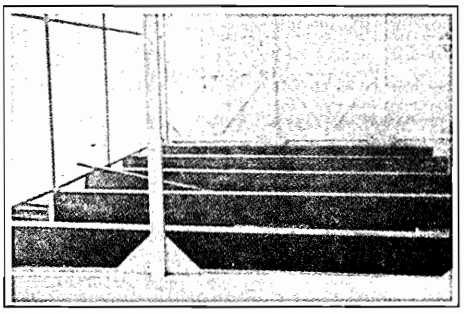


Fig. 6. Section III. View of timber cross bearers.

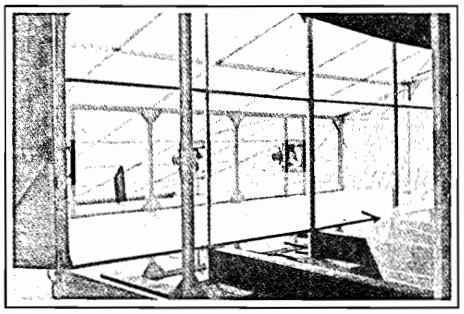


Fig. 5. Fans viewed from the wood stack compartment.

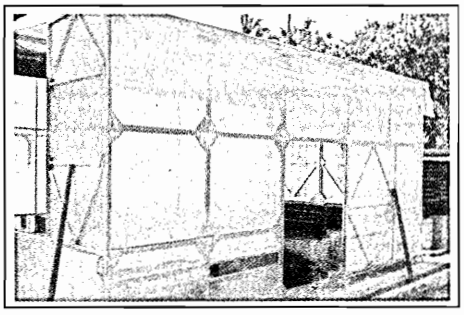


Fig. 7. Rear of kiln.

Table 1. Experimental results from NBRO-AIT kiln in Sri Lanka.

	Species				
	Rubber	Mahogany	Coconut	Ginisapu	Albezia
Thickness	1.5"	1"	2"	1"	0.75"
Initial moisture content	70%	45%	34%	40%	40%
Final moisture content	11%	14%	13%	9%	11%
Wet days	13	–	–	–	–
Clear days	25	16	18	14	12

A Photovoltaic Refrigeration System (PVRS) Design Program

Rural health centres, hospitals and clinics in developing countries cannot get access to electricity grids and even when these are available, in most cases the supply is not reliable. As a result, the control of vaccine at optimum potency level is very difficult to attain. The most appropriate and economical system for these medical centres is small-scale photovoltaic refrigeration systems (SSPVRS). However, a proper system components design based on site-specific data is important for the reliability of any SSPVRS. Fortunately, the design and performance analysis of SSPVRS can now be done in a simple manner using a computer software package, PVRS, which has been developed at the Development Technologies Unit (The University of Melbourne).

PVRS is a comprehensive small-scale photovoltaic refrigeration system analysis and design program for microcomputers. The program provides long-term monthly performance estimates for systems having battery storage. The method employed in the program is based on radiation statistics, utilizability and monthly-average hourly load and an analysis can be carried out for any location in which meteorological data are available.

For further information and demonstration disk, contact:

The Development Technologies Unit
Faculty of Engineering
The University of Melbourne
Parkville, AUSTRALIA 3052
Tel: +613 344-7180
Telex: AA 35185
Fax: +613 344-5104

was about Rs 88,000 or US$3,000 including the labour for fabrication.

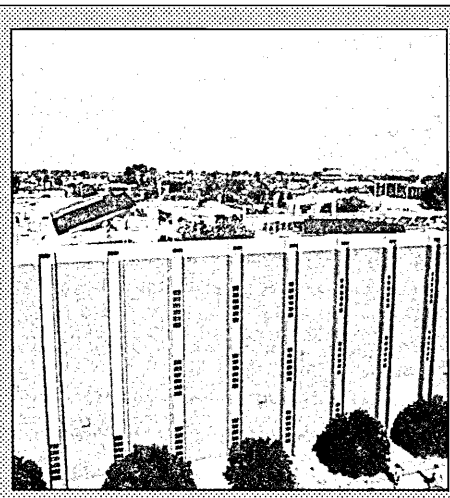
Summary of Experimental Results

Table 1 shows the results obtained in five separate test runs of the solar seasoning kiln. The first test run was done during a wet period when rain and cloud hindered the drying of the timber; 38 days were required to dry rubber wood from the exceptionally high moisture content of 70% down to 11%. This is inevitable at certain times of the year. The other test runs show that the performance of the kiln is satisfactory when the weather is not bad; at such times it takes about two weeks to dry timber that is one inch thick from a moisture content of about 40% to about 14%.

For further details about this project contact:

Prof. R.H.B. Exell
Energy Technology Division
Asian Institute of Technology
G.P.O. Box 2754
Bangkok 10501
Thailand

Solar Research Facility On-line USA



The University of Arizona has taken another bold step forward, opening the first fully solar-powered solar research facility in America. Everything from the air conditioners to lights and computers are powered by ARCO Solar modules, in combination with a very sophisticated Trace Inverter and battery storage.

The solar power system, engineered by Bill Cerrito of Photocomm, Inc. utilizes 96 large Genesis thin film modules configured in four sub-arrays, each of which demonstrates a different suntracking method.

The initial objective of the university's new Solar and Energy Research Facility is to monitor the performance of large thin film silicon solar modules in actual use. A fully-automated data acquisition system takes sensor data readings at one minute intervals. The 80386 based computer data analysis software is now under development and is expected to be on-line soon.

Major funding for the 3.5 kWp facility was provided by the State of Arizona, with additional contributions from the Salt River Project and Tucson Electric Power Company.

(Source: *ARCO Solar News*, Spring 1989, p.15)

Sectoral Energy Demand Studies in P.R. China, India, Indonesia, Maldives, Malaysia, Nepal, R.O. Korea and Thailand: Summary

These studies have been undertaken within the framework of the Regional Energy Development Programme of UNDP/ESCAP, sub-activity P11 "Sectoral Energy Demand Studies". Sectoral energy demand patterns of eight Asian countries: P.R. China, India, Indonesia, Maldives, Malaysia, Nepal, R.O. Korea and Thailand have been studied. Eight reports have been prepared by national teams of these eight countries*. A synthesis** of the results obtained for these eight countries was carried out at AIT with support from UNDP, ESCAP and the Government of France.

These studies represent the first comprehensive attempt to look at the roots of the energy demand dynamics in such a large variety of Asian developing countries; their populations ranging from a few hundred thousand to more than one billion, with extreme stages of development including one so called Newly Industrialized Country (R.O. Korea), and two countries among the least developed (Nepal and Maldives). It is therefore not surprising that great disparities exist in their energy demand pattern. This makes it difficult to give any summarised overview of these demand patterns.

The energy demand in this region is the fastest growing in the world. The consumption of coal, the dominant source of energy, is still progressing sharply.

Oil products are still widely used in sectors other than transport, as opposed to OECD countries that tend to reserve them for specific purposes for which there is no substitute, such as motor fuels or feedstocks.

Traditional fuels make up a significant share of the consumption, except in R.O. Korea; however, its consumption is only irregularly estimated in Thailand and Nepal.

There is no uniform pattern among the countries under study as to the relationship between energy demand and economic growth; for some countries, this relation has even been changing over time.

Industry is the main sector consuming commercial energy, with some key energy intensive sub-sectors, such as cement, fertilizer and steel absorbing a significant fraction of the total. Depending on the industrialization pattern, the other large energy consuming sectors vary among the countries. The energy demand of the industrial sector is growing much slower than industrial activity. These improvements in energy productivity are a result both of technical progress in achieving energy efficiency and of structural changes in industry. The magnitude of these structural changes, found mainly significant for Indonesia and R.O. Korea, are largely dependent upon the countries' industrialization pattern.

Road transport is the dominant mode in the energy demand of transport, with trucks absorbing about half of the total. In many countries, motorcycles consume a significant fraction of the gasoline demand. The average unit consumption of gasoline vehicles tends to decline over time, partly because of changes in the composition of the fleet (number of motorcycles growing more rapidly than other vehicles); the impact of other factors, namely changes in the average annual mileage and improvements in vehicle efficiency could not be assessed because of lack of data. The demand in this sector was found to be quite sensitive to price variations.

Most of the energy consumed in the household and commercial sector is going to households. Apart from China and R.O. Korea, where space heating is needed, cooking is the major end-use; the importance of cooking declines with the country's development as other energy uses, mainly for electrical appliances, become widespread. The large difference in the unit consumption per household between China and R.O. Korea, on the one hand, and the other countries on the other hand come mainly from space heating and a different mix in the cooking fuels used (e.g. differences in end-use efficiencies). In the commercial sector, the electricity demand is growing in all countries faster than its value added.

Many questions and uncertainties remain because of the many data gaps that may partly distort an understanding of the energy demand dynamics in these countries: insufficient coverage of the energy demand by industry sub-sector, especially that of the energy intensive ones; no systematic evaluation of the electricity self-generated in industry; uncertainties in the actual allocation of diesel to road transport, in the share of each type of road vehicle in the total consumption, and in the pattern of utilization of vehicles (annual mileage, load factors); poor coverage of water transport as well as domestic air transport, whose importance is growing rapidly (consumption figures are often included with those for international and military transport); absence of statistics on the distribution of energy consumption of the household and commercial sector between households and commercial activities; distribution of the consumption, by commercial activities, (hotels, offices, and trade, etc.) are seldom available,

* Reports to be published by ESCAP in early 1990.

** Prepared for the Regional Workshop on Sectoral Energy Demand Studies by B. LAPILLONNE, with the assistance of D. Patel Krishnamoorthy, Central Consultant Team for REDP, Division of Energy Technology, Asian Institute of Technology, Bangkok, 28 November - 1 December, 1989, ESCAP.

Energy Conservation - ISRAEL

The Importance of Energy Conservation

Energy independence – reduction of the economy's reliance on imported fuel – is a watchword of Israel's energy policy, as it is for many nations. Energy conservation constitutes an important and effective element in achieving this goal.

Energy conservation in Israel has three related meanings. The first is the efficient energy use by consumers – including industry, institutions, and households; by improving the efficiency of energy systems and preventing energy waste, one can achieve the same end results with lower energy inputs. The second meaning is reduction of the cost to the national economy of providing energy, by proper choice of energy resources; in this sense, indigenous energy sources such as solar, wind and oil shale contribute to energy conservation, as does conversion from oil to coal, when economically justified. The third meaning is the use of waste materials like municipal, industrial and agricultural waste and waste energy such as waste heat or excessive pressure.

The Ministry of Energy and Infrastructure's policy is to encourage the adoption of energy conservation measures which are beneficial to the national economy as a whole. About 10% of the ministry's development budget – US$2.0 million in the year 1988/89 – is employed by the Ministry of Energy Conservation Division to distribute information, provide technical advice, demonstrate innovative technologies, and support cost-effective conservation measures.

Cont. P. 6

even for electricity. Coverage of agriculture and fisheries is still very poor (fisheries were found to consume a significant amount of energy that never appears in the statistics); long delays in getting energy demand data, especially at the sectoral level.

Some countries have carried out long-term projections that may help in identifying some future energy demand issues. These projections should however be considered with caution since they were not all based on consistent and comprehensive scenarios within and among the countries. These projections deserve to be further worked out to strengthen the diagnosis of the energy demand dynamics in the region. According to the available projections for four countries, representing about 90% of the developing countries of the ESCAP region, the following results can be highlighted:

- Although the share of coal in the final consumption will decrease, the consumption of coal will likely double between now and 2010, in the range of 1.5-2 billion tons for the whole region. The question is whether such a tremendous figure can be reached taking into account local and global environmental constraints, as well as infrastructure limitations.
- The oil consumption will double over the same period, exceeding half a billion tons by the year 2010; the share of oil will only slightly increase.
- Electricity will be the main type of energy to significantly increase its market share: between 15 and 25% of the final energy will come from electricity in 2010.
- The consumption of gas will also progress quite a lot in all countries, being multiplied by a factor of 5, reaching the equivalent of about 130-150 Mtoe.
- The share of traditional fuels will decline everywhere (around 10% of total final energy on average); however, their consumption will approximately remain at the same level.
- Industry will still be the main consuming sector of commercial energy, absorbing almost half of the total consumption. In all countries, the share of industry will increase except in China.
- The household and commercial sector will see its role decrease sharply, whether all fuels are considered or only commercial fuels.
- The share of transport should increase mainly in countries where its role is still low, such as China and R.O. Korea.
- The demand for commercial fuels is projected to grow much slower than the GDP in Korea and China: the GDP energy intensity being respectively 40% and 60% lower in Korea and China in 2010. Much of this tremendous progress would result from a continuation of the energy productivity gain in the industry sector. This sector generating, in 2010, about twice as much output with the same amount of energy as now.
- In Thailand and Indonesia, the energy intensity of industry is also forecast to decrease as rapidly as 1-2.5%/year.
- In Malaysia and China the consumption of commercial energy per household should increase by 50% upto 2000 and double over the next 25 years, reaching a level still very low compared to OECD countries. In Korea, it should remain at about the same level as now. Because of substitutions between traditional and commercial fuels, i.e. from fuels with a low efficiency to more efficient fuels, the total consumption per household (including traditional fuels) remains stable (Malaysia, R.O. Korea) and even decreases in countries (China, Thailand) where households still utilize traditional fuels on a fairly large scale.

(Contributed by B. Lapillonne, Associate Professor, Energy Technology Division, Asian Institute of Technology, Bangkok, Thailand.)

Energy Conservation - ISRAEL

From P. 5

The ministry's major energy conservation-oriented activities include:

- Supervision of energy price levels.
- Distributing educational information about conservation to consumers and schools.
- Offering technical advice on conservation, through Conservation Advisory Centers.
- Initiating legislation, regulation and enforcement measures.
- Financial support for development of energy-saving technologies.
- Financial support for demonstration of energy-saving technologies not yet widely used in Israel, and publicizing the benefits of such technologies to encourage others to use them.
- Encouraging consumers to carry out efficiency tests of energy systems and to consider possible conservation options.

The Ministry of Energy Conservation Division's staff collaborates with the Israel Institute of Petroleum and Energy and the Israel Building Center; it also coordinates its programs with the Ministries of Industry and Commerce, Housing, Interior, Health, Agriculture, Education, Foreign Affairs and Defense.

Sectors with Greatest Potential for Energy Savings

Efforts to save energy focus on the following sectors of the economy:

- Utilities – generation, transportation and distribution of electricity, petroleum refineries.
- Space heating and cooling in buildings and water heating in institutions, hospitals, residences, stores and offices.
- Industry – all consumers, such as the chemical, petrochemical, food processing, paper, textiles, metal, electromechanical and electronics industries.
- Transportation of people and cargo.
- Water pumping systems.

Given sufficient incentive, these sectors could probably save about one million tons oil equivalent (TOE) annually, more than 10% of Israel's annual primary energy consumption.

Energy Utilities

The national electric utility is also the economy's fastest-growing consumer of energy. Improving the efficiency with which it uses energy is thus of major importance. The Israel Electric Corporation will be undertaking an energy survey of its electricity production facilities, transmission and distribution systems and the company's headquarters. The survey will look into the energy savings potentials and make recommendations on implementing the measures suggested.

In the Ashdod refineries, the possibility of installing a heat and power cogeneration system is being considered. The installation will serve as a demonstration project for a relatively large-scale cogeneration system. The combined gas and steam turbogenerators and waste heat boiler facility will produce 20 MWh plus 30 tons/hour of steam by using by-product refinery gas. The necessary investment will amount to US$20 million.

Currently 6 industrial steam-electricity cogeneration oil-fired plants produce about 500,000 MWh of electricity/year, most of it for integral usage. Excess electricity generated, about 27,000 MWh, is sold to the national grid.

The energy sector as a whole could conserve an estimated 100,000 TOE annually, with the refineries alone saving 60% of this figure.

Buildings

Space heating and cooling and residential appliances consume significant amounts of energy. As Table 1 indicates, substantial energy could be saved in this sector.

Table 1.
Potential for energy savings in existing buildings.

	Potential Savings	
	MWh/year	TOE/year
1. Solar water heaters	237,000	6,160
2. Heating	27,000	7,000
3. Air-conditioning	25,000	6,500
4. Thermal insulation		
Heating	50,000	13,000
Air conditioning	50,000	13,000
Total	389,000	101,100

Other ministry-sponsored activities in the building sector include:

- The insulation of 100,000 sq.m. of walls and roofs in existing buildings. The Ministry of Energy Conservation Division contributed 30% of project costs. The payback period of the project for the consumers is 3 years, on average.
- Replacement of 10,000 mercury street lamps in several cities with high-pressure sodium lamps of lower wattage.
- Installation of computerized energy management systems in 5 municipalities.
- Cooperation with the Ministry of Health to ensure the implementation of energy conservation measures in government hospitals.
- Creation of a plan for energy conservation in cold areas.

- Completion of a survey to assess the energy saving potential of heat pumps in water heating.
- Installation of a load shifting cooling storage system for air-conditioning at a sports center in the Jordan valley.

A special multi-year project for insulation in the relatively cold climate settlements of the northern Golan Heights will be completed this year. Results obtained thus far show an extensive improvement in energy savings, contributing to the standard of living.

Industry

Energy conservation measures in the industrial sector include:

- Preventing waste of energy in various forms: steam, electricity, fuel, compressed air, hot water, coolant water, etc.
- Detailed inspection of systems and equipment, including: furnaces and burners; steam systems; hot and chilled water and compressed air systems; heat exhangers; condensers; and cooling towers.
- Evaluating the possibility of installing cogeneration facilities in industrial areas, as well as individual factories.

A study of load shifting possibilities, mainly for central air-conditioning systems, was undertaken. The ministry, through its Conservation Division, promotes conservation in industry through the following means:

- Providing technical advice.
- Offering incentives for specific conservation measures.
- Mandating appointment of energy conservation officers, and monitoring of energy consumption in all large plants (i.e., those consuming more than 2,000 TOE/year) to determine possible ways of saving energy.

The ministry gives financial support to companies which undertake energy saving improvements, where these are found to be economically justifiable, with a grant equal to 15% of the total investment. Such grants have recently been implemented for the following types of projects:

- Improvements in the efficiency of steam boilers.
- Altering manufacturing processes to make them more energy efficient.
- Use of industrial waste as a substitute for fuel oil.
- Installation of heat recovery equipment.
- Energy management systems.
- Load shifting.

The Ministry of Energy Conservation Division together with the National Physics Laboratory are engaged in the following on-going activities:

- An energy consumption survey of industrial plants.
- Evaluation of energy conservation projects in industry.
- Follow-up on implementing the recommendations of several energy surveys in industrial plants.

The energy efficiency of about 1,000 steam boilers is routinely tested each year.

Transportation

Transportation accounts for about a quarter of Israel's total energy consumption, making this sector important for energy conservation efforts. An estimated 15-25% of this consumption could be saved by implementing various short- and medium-range measures.

Among the measures taken by the ministry are:

- The use of diesel-powered vehicles: The subject of private passenger cars and pickups which run on diesel-fuel is currently under inter-ministerial evaluation. At the Energy Ministry's initiative, small commercial vehicles from 2,300 kg total load can now use diesel engines (the previous minimum weight was 5,000 kg). The extension of this right to other small vehicles is currently under evaluation.
- An information campaign aimed at demonstrating ways to cut fuel consumption by 19-20% with simple driving rules.
- Incentives for fuel-saving devices: fuel consumption meters, electronic ignition systems, tire-pressure gauges, truck air deflectors, and others.
- Encouraging use of the optimal octane of gasoline in automobiles, a measure which increases energy efficiency.
- Improvements in public transportation (by distributing information maps with routes and making buses more comfortable).
- Monitoring of energy conservation and consumption in transportation and transport companies.
- Offering of incentives to institutional consumers (car fleets) to carry out conservation measures.
- "Energy labelling" of new automobiles.
- Improvement of vehicle maintenance.

Significant achievements have also been recorded in seagoing shipping, a substantial sector in this country.

Water Pumping Sector

In the last decade, electricity consumption for water pumping has grown faster than the actual amount of water pumped, reflecting the use of increasingly less accessible resources. The average amount of energy used to pump one cubic meter of water has increased from 1.1 kWh to 1.3 kWh. The importance of energy conservation in this large sector is therefore increasing.

Conservation measures in the water sector include:

- Repair and replacement of equipment with low energy efficiency.
- Increasing the efficiency of water systems.
- Installation of hydro-electric turbines (to utilize excess pressure, Table 2).
- Installation of sophisticated computerized control systems.
- Increasing the energy efficiency of sewage treatment and desalination plants.
- Shifting of water-pumping from periods of peak electricity demand to off-peak hours.

Table 2. Hydroelectric projects.

	Location	Installation Date	Capacity kW	Investment US$	Production of Electricity 1988 MWh
1.	Kibbutz Hagoshrim	9/82	200	200,000	1,140
2.	Dan Ma'aravi	7/83	2 x 900	1,300,000	7,300
3.	Tzomet Tahtona	3/84	300	300,000	960
4.	Revaya	3/85	200	340,000	360
5.	Kfar Baruch	6/86	1,000	550,000	1,700
6.	Ma'anit	4/87	200	100,000	800
Total			3,700	2,790,000	12,260

Recent ministry-supported projects include:
- Testing and calibration of 400 water pumps, in both the private and public sectors.
- Computerized energy management which will optimize the energy utilization of water pumps in the Jordan Valley, and the cities of Rishon Le Zion and Ramat Gan.
- A gravitation water pipeline that replaced 69 water pumps in the north from the Sea of Galilee to Kfar Porath.
- Utilization of geothermal water energy for heating greenhouses.
- Conducting energy surveys of water systems.
- Examination of the possibility of installing a 2.2 MW hydroelectric turbine in Kibbutz Kfar Hanassi in the upper Galilee.

The ministry has prepared a five-year, US$40 million plant, for investing in improving the energy efficiency of the water pumping sector. Implementation of the plan could save an estimated US$8 million per year.

Solar Energy

Solar water heaters have been installed in about two-thirds of Israeli homes; they are estimated to save 3% of Israel's total annual primary energy consumption and 8% of its electricity consumption. Since 1980, solar water heating systems have been mandatory on all new buildings of up to 9 stories (except in industrial plants and hospitals). In 1985, these regulations were updated: large apartment buildings must now have large solar systems; new hotels, boarding schools and other institutions must now have solar systems of a specified minimum size.

The ministry has promoted the conversion of central water heating systems powered by electricity or oil to solar water heating installations by offering grants of up to 10% of conversion costs. To ensure the quality of solar systems, the ministry has collaborated with the Israel Standards Institute in preparing mandatory spcifications for components and installation regulations.

The Ministry of Energy initiated the demonstration of concentration collectors for water heating in institutions, hotels, industry, hospitals and in the agricultural sector. Their concentration ratio is generally 2.5:1. The collectors are stationary with the tilt angle adjusted manually every season. The collectors supply hot water at 60-70 degrees centigrade with better efficiency than flat-plate collectors in the same temperature range. These systems, which have been installed in 16 locations, have a total collector area of 1124 sq.m. The energy output is about one billion kcal/year, with annual savings of about 250 tons of fuel. The installations are listed in Table 3.

A sun-tracking steam-generating solar system was installed at Kibbutz Nir Eliyahu consisting of 150 sq.m of concentrating collectors at 20:1 concentrating ratio. The energy saved is 64 million kcal/year, equivalent to 16,500 litres of fuel oil per year. The system has worked successfully since November 1985. Another larger facility of this type is being installed at the Hillel Yaffe Medical Center in Hadera.

A shallow solar pond on the roof of a nursery school in Petah Tikvah is in the process of being installed.

Construction of passive solar houses represents another energy saving solar technology. The ministry has given financial assistance towards the construction of about twenty such houses.

Photovoltaic Systems

The ministry supports the use of small photovoltaic (PV) systems at remote sites, where extension of the grid would be expensive, or where enhanced independence is needed. Among such projects are:
- Improvement of the individual free-standing photovoltaic systems for the small Mizpeh Klil village.
- Warning lights for air traffic on wind-measuring poles.
- Isolated water irrigation systems.
- Traffic lights.
- Lighting of urban crossroads and bus stations.
- Military installations.

Ministry support for the construction of such PV systems has equalled US$100,000.

Regulation and Enforcement

Regulations requiring energy conservation efforts and their enforcement have been shown to be effective in conserving energy. For example, regulations concerning

Table 3. Concentrating solar collectors for hot water generation.

Location	Installation Date	Collector area (sq.m)	Energy output (10^6 kcal/year)	Energy saving (litres of fuel per year)
Kibbutz Givat Haim	5/82	9.12	7,413	1,900
Kibbutz Alumot	11/82	32.48	24,211	6,220
Dovrat Dining Hall	3/82	23.15	20,700	5,300
Kibbutz Nir Itzhak	8/83	9.28	8,570	2,200
Kibbutz Usha	10/83	9.28	7,543	1,900
Kibbutz Ma'agan Michael	2/84	27.84	22,630	5,800
Etzion Hotel, Eilat	12/83	78.88	74,425	19,100
Shva Hotel, Eilat	10/84	90.48	85,370	21,900
Katzenstein Adler Industries	12/84	153.12	117,000	30,000
Holyland Hotel, Jerusalem	9/85	88.16	83,180	21,300
Givat Shmuel School	9/85	57.04	28,500	7,300
Kibbutz Alumim	11/85	62.78	49,300	12,700
Red Rock Hotel, Eilat	12/86	83.52	78,803	20,200
Givat Washington School	8/87	143.84	128,613	33,000
Kfar Batia School	9/87	141.52	128,327	32,900
Shfayim Hotel	2/88	113.68	101,645	26,100
Total		1124.17	966,230	247,820

solar water heaters have had a significant impact on energy consumption.

New regulations require "energy labels" on light bulbs, washing machines, cooking ovens, electric-space-heaters, and refrigerators. The labels' purpose is to help consumers choose the most cost-effective appliances, taking energy efficiency into consideration. Each label indicates power in watts; for light bulbs, brightness is indicated in lumens. Regulations requiring energy labelling of air-conditioners have not yet gone into force. The Israel Standards Institute is completing construction of the calorimetric rooms needed to assess the energy efficiency of these appliances – a project in which the Ministry of Energy and Infrastructure is participating. A calorimetric room for measuring the efficiency of refrigerators is already in operation.

On the ministry's initiative, purchase taxes on a number of energy saving products, such as solar water-heating systems, thermal insulation, fluorescent lamps, heat pumps, and thermostats, have been reduced.

Proper thermal insulation of buildings can lead to a saving of 20-30% in energy consumption for heating and air-conditioning. In 1984, new Israeli building standards for thermal insulation were introduced, and these were subsequently made binding for new construction.

Regulatory activities also extend to the industrial and public sectors. Energy consumers who use more than 300 TOE/year have been required in recent year to appoint an energy conservation officer, and to monitor their energy consumption.

Data concerning energy use in industrial plants is collected by the National Physics Laboratory, under a co-operation agreement with the ministry.

Information on energy consumption in other sectors, such as hospitals, local authorities, educational institutions, hotels, kibbutzim and government offices, is gathered using a computerized follow-up system. So far, information from about 2000 consumers has been collected.

Furthermore, all energy consumers that use more than 2000 TOE/year must undertake an energy conservation survey in order to assess their energy conservation potential. Such consumers have so far included: 150 factories, 48 kibbutzim, 12 hospitals, 28 municipalities and 50 consumers in the other sectors. To aid energy consumers in carrying out their survey, the ministry has prepared a list of recommended engineers. So far, that regulation has been enforced successfully in 97% of all industrial plants, 25% of all kibbutzim, 42% of all hospitals, 10% of all municipalities, and 50% of other major users.

According to the energy survey carried out thus far, the potential for energy conservation in the industrial sector equals 286,000 TOE/year, which is 13.6% of the annual consumption (2,100,000 TOE/year). In order to reach this potential, an investment of about 123 million US dollars is required. Furthermore, electricity savings could equal about 147,000 MWh per year, representing 8.8% of the annual electricity consumption of the factories that have participated in the surveys (1,672,000 MWh/year).

All steam boilers must be inspected every 14 months for combustion efficiency. The Ministry of Energy's Conservation Division licenses qualified inspectors, and uses a computerized system to follow-up the inspection results. Tests of more than 55% of the steam boilers in 1988 showed an average combustion efficiency of 89%. It should be possible to increase the average efficiency by 2%, saving 20,000 TOE/year.

(Source: *An excerpt from "Energy'88 – Energy in Israel: Data, Activities, Policies and Programs"*, Ministry of Energy and Infrastructure, Jerusalem, 1989, 95 p.)

ENERCON Views Total Energy Management as the Only Way to Get Big Energy Savings

The National Energy Conservation Centre (ENERCON) of Pakistan view the concept of Total Energy Management (TEM) as more than just a new name for energy conservation in industries. TEM is an integrated approach developed over the last ten years and studies have shown such an approach can save as much as 25-30% of energy costs through its on-going programs. A one-time energy survey, on the other hand, can reduce energy costs 8-10% through implementation of no cost/low cost measures and another 10-12% through capital improvements.

The primary feature of TEM is that energy conservation practices are integrated into all aspects of plant management. The major activities of TEM and the ways in which ENERCON can provide support for the TEM program are as follows:

Management Commitment: A strong, decisive commitment by top management is required to initiate and maintain an effective TEM program. Cessation of management's commitment will result in collapse of the program. ENERCON offers an Energy Management Seminar and accompanying manual to help top management of industries better understand the benefits of this program, to adapt the program to individual company needs, and to assist in its implementation.

Energy Accounting: A basic management tool that parallels the concept and usefulness of financial cost accounting. ENERCON provides assistance in the development of energy accounting formats and procedures as part of its Detailed Energy Survey Services. ENERCON maintains an information base for energy-related measuring instruments – an important prerequisite for energy accounting – and is developing a program through which selected industries may obtain instrumentation assistance.

Preliminary Energy Survey (PES): An energy management tool to provide the initial technical assessment of energy use patterns and energy management procedures. ENERCON has trained a large number of survey experts who can efficiently perform a PES. ENERCON can set up a PES for a company qualified under the ENERCON program.

Detailed Energy Survey (DES): A sophisticated management tool for

ECSP: A Program of USAID to Promote Energy Conservation in Developing Countries

The Office of Energy of the Bureau for Science and Technology of the U.S. Agency for International Development (AID) initiated the Energy Conservation Service Program (ECSP) in September 1983, realizing the fact that energy conservation represents an important economic and energy resource for developing countries. This four-year program, which is part of the Office of Energy's Energy Policy Development and Conservation (EPDAC) Project, is aimed at industrial operations, transportation, electric power generation and transmission, and the design and operation of commercial and institutional buildings.

The ECSP provides technical assistance, training, information, advisory services, and general guidance in establishing policies and programs to achieve greater energy efficiency. The following types of assistance are available:

- Design and implementation of sectoral energy consumption surveys in industrial, transportation, and electric power sectors, and in commercial/institutional buildings in developing countries;
- Economic and policy analysis of energy demand and conservation potential at the national level;
- Performance of detailed on-site surveys of major energy-using facilities;
- Classroom and on-site practical training of engineers and managers responsible for design, and maintenance of major energy-using facilities such as factories, power plants, buildings and transportation equipment;
- Preparation and dissemination of written and audiovisual materials to raise public awareness and provide technical information with the aim of enhancing energy efficiency;
- Advisory services to help host governments and private enterprises obtain financing for investments in improved energy efficiency; and
- Technical consulting services related to energy management problems in specific facilities.

For further information on this program, or to request assistance, contact the U.S. Agency for International Development Mission in your country. A summary of the activities carried out under the program is published regularly to communicate experience in the design and implementation of energy conservation policies and projects.

For further information about the activities please contact:

USAID mission in your country
or Hagler, Bailly & Company, Inc.
2301 M Street, N.W.
Washington, DC 20037, USA
Tel.: 202-463-7575
Telex: 710-822-1150 HABACO WSH

identifying and evaluating cost effective improvements for improving energy efficiency. ENERCON through its courses and publications trains and provides on-going support to energy survey experts throughout Pakistan.

Energy Conservation Training: It provides supervisors and employees the understanding and skills for effective implementation of energy saving measures. Formal training courses are presented by ENERCON throughout the year at various locations in Pakistan. Depending on the subject (e.g. Industrial TEM; Energy Surveyors Training; Steam System Efficiency; Electrical Systems I; Electrical System II, etc.), course durations range from one to several days. ENERCON maintains and operates the National Energy Information Centre which is available as a resource for energy related information and training including references, manuals, reports, periodicals and other information.

Capital Intensive Improvements: These are essential to increase the energy efficiencies of facilities, production equipment or processes that require significant capital expenditure. Capital costs for implementing these measures can be paid back rapidly by energy cost savings. Funding of these items should be of high priority since they have high payback rates at low risk. ENERCON can help interested parties obtain more information on local and foreign sources of financing. For certain capital-intensive energy-saving projects, ENERCON is funding bankable feasibility studies which can be used as the bases for qualification for loan money.

Monitoring and Evaluation: This provides continuing measurement of status and degree of success of implemented measures and enables management to assess the TEM program. It also provides a basis for resetting goals and priorities for future actions.

Implementations of Recommendations: All the parts of the TEM program come together under implementation. Only through implementation of energy saving recommendations, plus continuing follow through of the whole TEM program, can maximum savings and increased profits be realized. Implementation is the "bottom line".

As the National Energy Conservation Program develops, ENERCON will be preparing more informational and technical materials to assist manager and engineers in energy conservation.

For more information or assistance write to:

National Energy Conservation Centre (ENERCON)
33 Plaza (Buland Markaz) Blue Area,
F-6, G-6, Islamabad, Pakistan
Tel.813003-813009
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High Hopes for Fuel Cells Activities in Japan

About 250 symposiasts gathered in London to celebrate the 150th anniversary of the fuel cell's invention by William Robert Grove and also to discuss the present state of the art of its development and the prospects for commercial fuel cells in electric power generation. Although invented 150 years ago, it has only recently been receiving worldwide attention over the prospects of its commercial use in electric power generation, cogeneration (heat and electricity) and vehicular propulsion. Mounting present day concern for the environment has boosted interest in the fuel cell's development. With the fuel cell the electrochemists have long aspired to escape the thermodynamic efficiency limitations of heat engines by converting the chemical energy of fuels directly into electrical and thermal energy, thus improving fuel economy and reducing pollution.

Despite thirty years' effort in Japan, progress has been significant only in the last decade, claims Prof. Noboru Itoh of Chuo University, Tokyo. He assigned a central role to the Moonlight Project, begun in 1981 by the government. State and private institutions have worked on this project, founding their researches on American experimental plants. The Japanese have concentrated on three types of cell: the phosphoric acid fuel cell (PAFC), molten carbonate fuel cell (MCFC) and the solid oxide fuel cell (SOFC).

Outlining government R&D, Itoh spoke during the symposium of a 1 MW PAFC for electrical utilities. One such system has been installed at Kansai Electrical Power Co's Sakaiko power station and another at Chubu Electric Power Co's Chita 2 plant. The former installation has given 2000 h operation and the latter more than 1000 h. Two 200 kW PAFC systems are being developed for on-site generation. The fuels are methanol and towns gas respectively. The methanol-fuelled cell would suit out-of-the-way places such as islands and the gas-fuelled cell would be amenable to cogeneration for such establishments as hotels and restaurants.

Turning to work by the New Energy Development Organization (NEDO) on MCFCs, Itoh reported outputs of 10 kW obtained with new Hitachi and Toshiba electrolytes in 1986, but acknowledged that technical problems still dog these cells. A subsequent programme under the Moonlight Project umbrella is intended to yield a 100 kW fuel cell stack by 1991 and a 1 MW pilot generating plant by 1995.

He went on to describe private sector R&D on PAFCs, principally by electric power and gas companies. Tokyo Gas Co and Osaka Gas Co both participate in undertakings of the Gas Research Institute (GRI), USA. Osaka Gas has done trials in restaurants. Itoh said that this system had

Cont. P. 12

High Hopes for Fuel Cells: Activities in Japan

From P. 11

run for 15,600 h. Tokyo Electric Power Co (TEPCO) has, since 1983, been testing a 4.5 MW system developed by United Technologies Corp (USA). Rated output has been achieved.

Tobuku Electric Power Co is working on a 50 kW Fuji cell and Hokkaido Electric Power Co is doing likewise on a methanol-fuelled 100 kW Mitsubishi cell. US cells are being used, as in TEPCO's 200 kW installation from International Fuel Cells (IFC).

Private sector 10 kW MCFC systems are engaging the attention of Ishikawa jima-Harima Heavy Industries, Mitsubishi Electric and Fuji Electric. This trio has taken a 10 kW MCFC from the laboratory to commercial development.

SOFC R&D also draws the interest of some corporations. Mitsubishi, for instance, has designed a cell capable of about 10 MW and will evaluate it in conjunction with TEPCO. Mitsubishi has plans in the making for a study of kilowatt-order cells within the next few years. Tokyo Gas and Osaka Gas have been testing a 3 kW Westinghouse SOFC since 1987. Fundamental research on the SOFC has recently begun in Fuji Electric, Fujikura, Sanyo and other organizations.

The general manager of fuel cell development at Osaka Gas, Dr. Noburu Hashimoto, told the symposium in some detail about his company's efforts to render on-site fuel cells commercially viable. He stressed energy conservation and low NO_x as merits of fuel cells and he gave the NO_x data shown in Table 1.

Hashimoto enlarged on the on-site projects briefly alluded to by Itoh. For example, he mentioned that three IFC PC25 natural-gas-fuelled "pre-prototype" units are planned for delivery in 1991 and 1992. The batch will consist of ten units for Osaka Gas, ten for Tokyo Gas and one for Toho Gas. The units will be monitored to gather operational data leading to commercialization commencing in 1993.

Table 1. Fuel cell NO_x data (at 5 percent O_2).

FC PC25 pre-prototype	200 kW	PAFC	<2 ppm
MELCO (Moonlight Project)	200 kW	PAFC	6 ppm
Fuji Electric	50 kW	PAFC	<2 ppm
Westinghouse Electric	3 kW	SOFC	<2 ppm

A Moonlight Project exercise also mentioned by Hashimoto was the MELCO 200 kW unit that was installed last July at the Hotel Plaza, Osaka. Moreover, about seventy Fuji test units of 50 or 100 kW each are destined for three Japanese gas companies between 1990 and 1992. Tokyo Gas, Osaka Gas and Toho Gas are collaborating with Fuji in their field testing. The technology has been developed under the Moonlight Project. Market launch is planned for 1993.

Some twenty other units of 50 to 200 kW apiece are also scheduled, reported Hashimoto. Figure 1 shows the way he expects costs to fall for on-site PAFC systems.

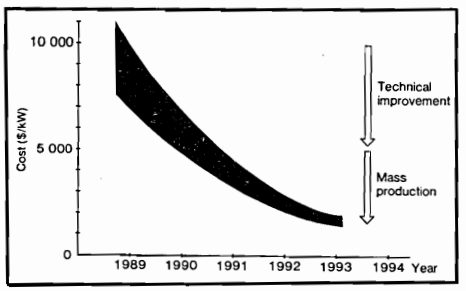


Fig. 1. Expected cost reduction for PAFCs.

He went on to refer in more detail to the Westinghouse SOFC projects. Following tests of a 3 kW experimental unit in 1987 and 1988 by Tokyo Gas and Osaka Gas, a 25 kW unit has this year gone on trial by Kansai Electric Power, Tokyo Gas and Osaka Gas. Envisaged is a 25 kW cogeneration system for Tokyo Gas and Osaka Gas.

Summing up, Hashimoto said that Japan's three major gas companies had been eagerly promoting the development and commercialization of on-site fuel cells, and that they would continue to do so. He expected the PAFC on the market around 1993, followed by the SOFC 'several years later'.

TEPCO's approach to fuel cells was described by Yutaka Usami. He told of his company's stress on PAFCs as the outcome of its judgment that these were the most promising types. MCFC and SOFC technologies were seen as successors that could not be brought into "practical use" until the PAFC system had provided the groundwork.

In the late 1970s TEPCO discerned a need to supplement large central power stations with generators dispersed to be near consumers, said Usami, and fuel cells had been deemed the most promising new generators for the purpose. Hence the import in 1980 of the 4.5 MW experimental plant from the USA. Much had been learnt from operation of this plant, paving the way for an 11 MW

Table 2. Operating records of TEPCO's 200 kW PAFC plants (till August 1989).

	Air cooled	Water cooled	
	Sanyo Shin-Tokyo	IFC Shin-Tokyo	Shibaura
Start up	Sep 1987	Oct 1988	Mar 1989
Cumulative generation, h	4274	1762	633
Max continuous gen, h	835	575	265
Rated power operation, h	83	1305	114
Starts/stops	101	33	16
Cumulative gross, kWh	495,282	318,201	68,170

Wastes Fuel Tarlac's Largest Sugar Facility, Philippines

Nothing goes to waste at Central Azucarera de Tarlac (CAT). Consider: Sugarcane is milled to extract juice which is processed to become refined sugar; molasses, a by-product of sugar, is fermented to produce alcohol which is sold to rum makers; carbon dioxide which results from the fermentation of sugar is recovered, liquefied and sold to softdrink bottlers; and the yeast used in the fermentation of molasses is also recovered, dried and sold to feed dealers.

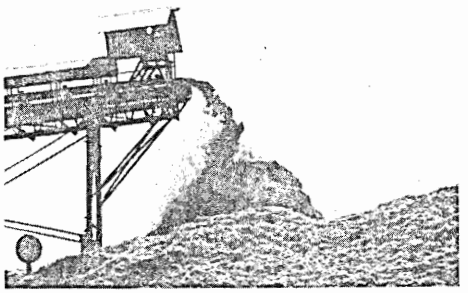
Bagasse, cane trash and distillery slops are used as fuels to generate power for the facility's integrated operations.

These facts were revealed by Engr. Felix Ramos, chief of CAT Industrial Services Division in an interview for *Energy Alternatives*.

Established in 1928, CAT is the biggest sugar producer in Tarlac province. It sits on the 6,000 hectare Hacienda Luisita in San Miguel, Tarlac.

At its present rate of sugar production, CAT mills 7,000 tons of cane yielding 2,100 tons of bagasse daily. From the mill, bagasse is conveyed and directly fed into the boilers' combustion chamber.

The heating value of bagasse, according to Ramos, depends on its moisture content and on cane quality. Freshly milled bagasse contains about 52% moisture and 3% sugar. When burned in this condition, a pound of bagasse can produce 2.35 lbs. of steam.



Tons of bagasse expelled from the mill daily.

Cane trash, on the other hand, is first converted into biofuel before being fired into the boilers. There are six steps involved in this process:

- Cane trash is manually gathered two to three days after cane cutting to give it time to dry.
- The trash is piled into rows 1.5 ft wide and 2 ft high. Proper piling is necessary for the smooth and efficient mechanical baling which will be done the following day.
- Baling is done by eight baling machines two of which are powered by tractors of 60 HP each. The other six have built-in 17.5 HP Wisconsin engines. The machines produce an average of 5.4 bales/minute and can cover 3 ha/day with each hectare yielding about 1,500 bales.
- The baled trash is either piled for future use or brought to the shredder where it is shredded to desired sizes by electric motor-driven shredders.
- The shredded trash is then transported by rubber belt conveyor to the boiler area where it is mixed with bagasse. The mixture is now ready for firing.

Although the process required substantial investment, CAT management decided to embark on cane trash fuel production in 1982 after an initial study clearly demonstrated its advantages.

Cane trash fuel conversion benefitted CAT in two major ways. First, it lessened the company's dependence on imported bunker oil for its fuel needs. Second, it eliminated the need for cane burning, which is commonly practised to ease cutting during harvesting, but which, according to Ramos, often results in the production of low grade sugar and poor quality molasses. Besides, unburnt cane has a higher heating value than burnt ones. With the use of converted cane trash as fuel, these problems were substantially minimized.

The heating value of cane trash is also dictated by its moisture content. A pound of cane trash with 30% moisture will give out 5040 Btu/lb but will require 345 Btu to evaporate and superheat the moisture. The net energy gained then is 4695 Btu/lb. When moisture content is lowered to 15%, a pound of trash will still give 5040 Btu but will require only 142 Btu to evaporate and superheat its moisture content. Hence, the resulting net available energy is 4898 Btu/lb.

CAT also uses the wastes that come from its distillery plant to fuel operations. Slops from the distillery plant are allowed to flow into the de-yeasting plant where the yeast used in fermenting alcohol is recovered. The remaining effluent is allowed to flow into the bio-digesters. After 15 days, biogas is produced and fed to the boilers. At present CAT produces 3,924 to 4,905 cubic feet of biogas daily. This is equivalent to 2,061 to 2,576 litres of bunker oil.

With the use of bagasse, cane trash and biogas as fuels, CAT has already been able to reduce its bunker oil use from 30 million to 8.5 million litres. Just last year, CAT was able to use 1,311,887,500 lbs. of steam from bagasse alone. This meant displacing 48,588,426 lbs. of bunker oil and saving just over 153.5 million P (1 US$ ≈ 21.4 pesos).

(Source: *Energy Alternatives*, Vol.V, No.4, October-December 1989, pp.1, 8.)

Toshiba plant employing fuel cells made by IFC, USA. This plant is being erected at Goi power station. Testing is planned to begin in 1991.

TEPCO joined forces with Sanyo to develop a 100 kW system for on-site generation. Plant was installed at Shin-Tokyo power station and began trials in 1987. Since then, two more 200 kW systems have been imported from IFC for testing at Shin-Tokyo power station and in the basement of the Kadenko building at Shibaura, Tokyo. Their operational records, as presented by Usami, are shown in Table 2.

(Source: *Modern Power Systems*, MPS Review, December 1989.)

Regional Wood Energy Development Programme in Asia GCP/RAS/131/NET Project Advisory Committee Meeting

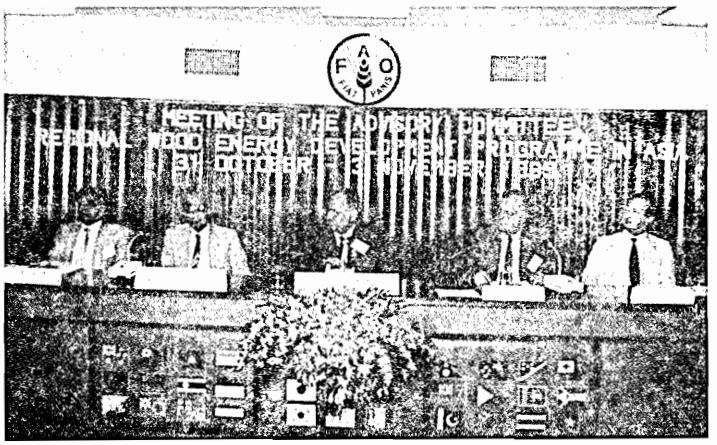
Bangkok, Thailand
30 October - 3 November, 1989

The first meeting of Project Advisory Committee for the Extension Phase of the project "Wood Energy Development in Asia (GCP/RAS/131/NET)" was held in Bangkok during 30 October - 3 November, 1989.

The purposes of this meeting were:

1. To discuss the progress of regional and national wood energy activities, plans for the future and the needs for assistance.
2. To discuss the Plan of Operation of the Extension Phase.
3. To review the work plan of activities for Phase II of the project.
4. To explore opportunities for strengthening TCDC activities and mechanisms for a sustained regional cooperation.

The meeting was attended by 19 high level representatives from the Forestry and Energy Agencies from all the eleven project member countries (Bangladesh, Bhutan, India, Indonesia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam). Observers from International Agencies (ESCAP, IDRC, F/FRED, BUN, AIT, APDC) and resource persons from institutes within and outside the region, actively involved in wood energy programme, also participated in the meeting.



Left to right: Mr. R.S. Gujral (CTA), Mr. L.J.J. Silva (FAO ADG/RR), Mr. Abeedulah Jan (Chairman), Mr. C. van Tooren (The Netherlands), Mr. M. Trossero (FAO HQRS/Rome).

The Committee *inter alia* discussed the report of the Project Evaluation Mission of October 1988, the Draft Interim Report for the period 1985-89, the Project Plan of Operations and the Work Plan for 1989–1993.

The committee noted its great satisfaction over the project's gains during the last four years, particularly in establishing a viable network, training and the dissemination of information.

Coal/Bagasse Power Plant to Meet Electricity Demand

Some 320 kg by-product per tonne of sugar cane emerges from the sugar production process. Ile de la Reunion, a sugar production company in France, produces 700,000 t of this biomass annually from 2.2 million tonnes of cane. The biomass has a calorific value of some 1900 kcal PCI/kg, which is superior to most of the lignites exploited world-wide, but is only generated seasonally between June and December.

The expansion of Ile de la Reunion has created marked growth in electricity consumption, rising from 280 million kWh in 1978 to 760 million kWh in 1988 – a rate of something over 10 per cent annually. EDF, the French power utility, forecasts a doubling of consumption in the period to 2005.

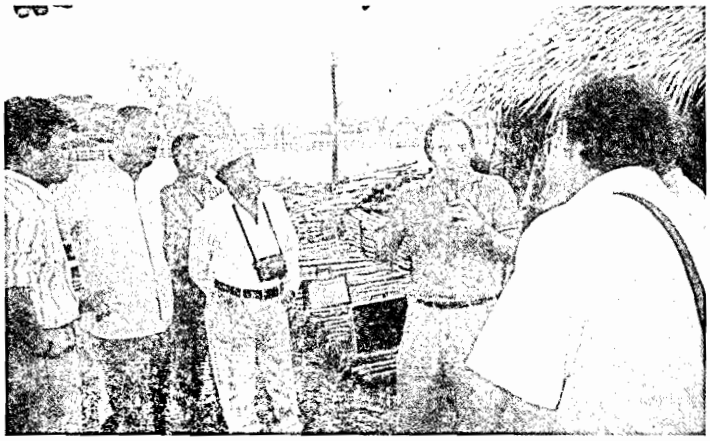
The foundations of a new thermal power station which will operate on both coal and sugar-cane biomass and generate steam and electricity have been laid at Bois Rouge on the Ile de la Reunion. The station allows most of the by-product from cane-sugar production to be utilized while generating coal-based electricity for the entire year. Consumption of cane biomass will be some 200,000 t and that of coal about 100,000 t annually. This production will meet the energy needs of the local sugar production company, Sucreries de Bois Rouge, and supply the island with electricity.

The design includes two boilers producing 130 t/h of steam at 80 bar and 520°C and two turbo-alternator sets, each rated at 31 MW. The project will cost about US$80 million.

The station will go into operation in July 1992 at the start of the sugar season. It will be managed by a local company in which the three French groups are participating.

Both the French coal company CDF and EDF have now decided to extend their technological collaboration to similar projects in countries which have available biomass and where electricity is in strong demand, including the Philippines, Brazil, Indonesia and Thailand.

(Source: *Modern Power Systems*, Vol. 9, No. 11, November 1989.)



Field visit to a mangrove charcoal production site (Thailand).

The project's Plan of Operations for the extension phase has been endorsed by three countries namely, Thailand, Pakistan and Bhutan and the representatives from the remaining countries were requested to consider the Plan of Operations for implementation.

The committee endorsed the project's Work Plan and activity schedule with minor observations and also suggested their prioritization for different project outputs, giving a high priority to strengthening regional cooperative network, national wood energy policies and strategies and methodologies of improved tree production systems for energy purposes.

In their country status reports, the delegates presented consolidated statements on national efforts on wood energy production and conservation. It was clear that in almost all countries, there is a greater realization of the significance of wood energy resources by the national governments. Most countries have initiated an energy stock taking exercise, to identify existing energy sources and their relative weight in the energy portfolio. Many sectors of development, such as agriculture, rural development, energy and environment are becoming increasingly associated with wood energy development programmes. Some countries have initiated the preparation of Tropical Forestry Action Plans and Forestry Master Plans aimed at *inter alia* increasing woodfuel production on a sustainable basis. Most countries emphasized the need to improve the database and to strengthen aspects related to people's participation in wood energy production and conservation.

Field visit to mangrove plantations (Thailand).

Amongst the important recommendations of the committee are those related to strengthening of National Coordination Committees (NATCOMS) and the establishment of technical expert groups, initiation of studies on woodfuel marketing and technical assistance to national programmes in wood energy production and its efficient utilization. The Committee observed that the Tropical Forestry Action Plan was an important initiative undertaken by many member countries and recommended that the concerns of wood energy should be included in national planning explicitly and that RWEDP should assist in Tropical Forestry Action Plan activities related to fuelwood energy.

Further information regarding the meeting is available in the following publications:

1) Advisory Committee Meeting, *Wood Energy News*, Vol. 4, No. 3, December 1989, pp.2-3.
2) *Project Advisory Committee Meeting Report*, Bangkok, Thailand, 30 October - 3 November, 1989, Regional Wood Energy Development Programme in Asia GCP/RAS/131/NET, FAO, Bangkok, December 1989, 45 p.
3) *Status of Wood Energy Development in Asia: Country Status Reports* (Bangladesh, Bhutan, India, Indonesia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam), papers presented at Project Advisory Committee Meeting, Bangkok, Thailand, 30 October - 3 November, 1989, Regional Wood Energy Development Programme in Asia GCP/RAS/131/NET, FAO, Bangkok, December 1989, 192 p.

Wave Power for Tasmania: Considered Economic in the Long Term

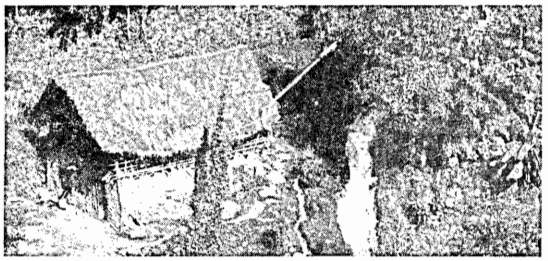
The Tasmanian Government is to sign a US$5 million contract to build an electricity generating station based on wave power later this year. The 1.2 MW station will be on King Island in Bass Strait north of Tasmania.

The design will be based on Norwegian company Norwave's Tapchan system. A tapered channel directs water into an elevated reservior. Electricity is generated as the water flows through a turbine back to the sea.

King Island currently relies on diesel-generated electricity. The Tasmanian Hydro Electricity Commission (HEC) believes that while the cost of the wave power station is considerable, it is more cost effective in the long term than diesel power. Construction will take three years.

(Source: *Modern Power Systems*, Vol. 9, No.8, August, 1989.)

Improved Hydro-powered Mills Benefit Rural Communities in Nepal



Water mills have been used in Nepal for many centuries.

Using water power in milling is an ancient tradition in Nepal. Innovation in water-power use has both ancient and modern sources, as Nepali artisanal manufacturers have worked side-by-side with foreign experts in developing lower cost, sustainable technology for poor rural communities.

There are 25,000 to 30,000 water mills operating in Nepal today. There is also a considerable domestic market for husked rice and mustard oil, in the past processed mainly by diesel mills established by wealthier farmers and businessmen. The oil price rises of the 1970s made the diesel mills even more expensive and difficult to sustain. As a result, local and international aid agencies interested in extending crop-processing benefits to poorer farmers began work on improving traditional hydro-powered mills (ghattas) to undertake these operations.

Nepali urban manufacturers worked with the agency experts adapting metal cross-flow turbine designs to suit local manufacturing conditions, and producing a construction 'kit' for village craftsmen to improve ghattas. This kit is called the Multi-Purpose Power Unit (MPPU), and is made entirely out of metal.

One manufacturer, A.M. Nakarmi, developed an intermediate solution to the high-efficiency/low-cost problem by designing a metal turbine based on traditional ghatta blades. The Nakarmi design includes parts which are made out of wood, and only the metal parts have to be bought as part of the kit: this reduces mill capital costs by 30 per cent, which has permitted poorer entrepreneurs in more remote areas to establish oil-pressing and rice-hulling facilities. Over 200 MPPU mills have been installed (out of 600 'upgraded mills). Another 80 improved ghattas have been installed by local craftsmen using Nakarmi construction kits.

Improved mills have saved time and effort in processing food grains, which has freed women in particular to participate more in other income-generating activities and in child care. Some of the improved mills are being used to generate electricity to provide lighting during off-peak periods, at 27 per cent per installed kilowatt of the capital cost of government-run larger hydro plants. The government has greatly assisted the spread of mill innovation by licencing the private sale of electricity and, through its Agricultural Development Bank, by providing subsidies and credit for mill upgrading.

(Source: *Appropriate Technology*, Vol. 16, No.3, December 1989)

Fuel from Wastes

Garbage-to-Fuel Process Found Economic over Landfilling

Municipal garbage is transformed into a fine grained carbon fuel, analogous to lignite, in a partial-combustion process developed by Frontier Industries Inc. (Burlington, Iowa). Frontier has built a 10-ton/h (feed), commercial-scale plant that produces 300-350 lb of fuel from each ton of organic waste. The product may be sold as powder or briquettes for industrial fuel.

Non-organic material is separated from the waste, which is then shredded into particles of 1/2 in. or less and fed into the top of a vertical combustion column. The material moves down to the bottom of the column, where it is burned by process offgas, but the air intake is controlled to permit only partial combustion. Volatiles are driven off about halfway down, separated from particles in a cyclone, then stripped of residual organics in an afterburner.

The plant costs US$5-6 million and the processing cost is US$20/ton of solid waste, but the company says the saleable fuel product and self-fueled feature give it an economic advantage over landfilling.

A Sludge-to-Fuel Process Competes with Landfilling

Landfilling of sewage sludge can be eliminated by a new process unveiled by Still Otto GmbH (Bochum, W. Germany), the company claims. Wet sludge is dried in an indirectly steam-heated disk dryer at 100°C that reduces the water content from about 80% to less than 5%. The dried sludge is pyrolyzed in an electrically heated rotary drum at 300-400°C, to produce solid (40-60%) and liquid (22-35%) hydrocarbons that may be sold for fuel, plus a gas phase containing hydrocarbons and water.

A 1.75 m.t/h (dry sludge) pilot plant, subsidized by state and federal governments, will debut at Heiligenhaus, near Düsseldorf, in early 1991. While gross costs are calculated at about US$220-245/m.t. dry sludge, the company reckons net costs (after fuel sales) will compete with those of landfilling.

(Source: *Chemical Engineering*, Vol. 96, No.11, November 1989.)

Quarter of a Million Turbine Owners

During the past decade close on a quarter of a million Danes have become the owners of 2,580 wind turbines – either through direct ownership or through the country's system of wind plant cooperatives.

This statistic is just one of many contained in the latest report to come out of the Danish energy ministry. Following the withdrawal of state subsidies to wind plant installations in August, the report represents the official status of ten years of political success which has resulted in wind energy becoming a significant part of the Danish power supply system. Over the years the energy ministry has each month charted the progress of wind power development in Denmark. The report reveals:

- until they were withdrawn at the end of August, subsidies to the tune of US$4.5 million were granted to 225 wind turbines in 1989;
- a total of 1,154 turbines have been granted subsidies between 1986-89;
- of these, only 193 were wind turbines installed by individual landowners, indicating that over 80 per cent of the wind turbines installed over the past four years are owned by investor groups;
- between 1979-89 wind energy has received US$39.2 million in subsidies; and
- the average size for wind turbines granted subsidy in 1989 was 158 kW.

The energy ministry has established that on average between 50 and 80 families make up a wind plant cooperative. In which case around 48,000-76,000 individuals have become the owners of 961 wind turbines in the last four years. In addition, 193 machines have been erected as "owner installations."

Prior to that period, 1,425 machines were installed between 1979 and 1986. And many turbines were also installed before 1979 without subsidy, indicating that the number of turbine-owning Danish households is today probably well over 100,000. Since an average Danish household comprises 2.2 people, it can be seen that close on a quarter of a million Danes – one twentieth of the population – own windmills today.

(Source: *Wind Power Monthly News Magazine*, Vol.6, No.1, January 1990, p.11.)

UNDP Helps India Establish Its Wind Energy Centre

With the assistance of US$1.2 million from the United Nations Development Programme (UNDP), a Wind Energy Centre will be established in Bangalore, capital of India's Southern State of Karnataka.

The increasing demand for energy, the rapid depletion of conventional sources of energy and their increasing production costs have led the Indian Government to attach high priority to the development of non–conventional sources such as solar, wind and biomass. The Centre, when established, will serve as a focal point for harnessing and utilizing wind energy. A broad estimate has indicated that India's wind energy resource is more than 50,000 MW, of which at least 20,000 MW is considered exploitable.

(Source: *Modern Power Systems*, Vol. 9, No. 7, July 1989.)

PSED to Fund Upto 50 Percent of the Cost of Private Power Feasibility Studies

The Private Sector Energy Development (PSED) Program has established a feasibility study fund in an effort to promote privately financed, owned and operated energy/power facilities. As of January 1, 1990, the Feasibility Fund had received five proposals for assistance: two hydropower, one combined cycle, one coal-fired, and one waste-to-energy project in four different countries. The total generating capacity of the five projects is 700 MW.

The Fund will share up to 50 percent of the cost of pre-feasibility and feasibility studies of private energy or power projects that best meet the Fund's evaluation criteria. Eligibility criteria for application to the Fund are: 1) the applicant must be a U.S. or developing country company, with 51% ownership in the U.S. or a developing country; 2) the project must be a private energy/power project with equity investment in an A.I.D.-assisted country; 3) the applicant must share at least 50 percent of the cost of the pre-feasibility or feasibility study; and 4) the project must meet World Bank environmental standards.

Assistance from the Fund will come in the form of a forgivable no-interest loan. If the feasibility study leads to financial closure of the prospective project, the portion of the study paid for by the Fund would be refunded to the U.S. Treasury over a three-year period. If the prospective project does not proceed to financial closure within three years, the loan is forgiven.

Applicants will be accepted on a first-come, first-served basis. The Fund will remain open until the funding available is exhausted. Application forms can be obtained from the Private Sector Energy Development Program.

(Source: *Private Power Reporter*, USAID, February 1990.)

Recent World Bank Activities in Energy

Industry and Energy Department Working Paper

Energy Series Paper No. 7
(Revised October 1989)
The World Bank
1818 H Street, NW
Washington, D.C., 20433, USA
(1989, 70 p.)

The International Bank of Reconstruction and Development (IBRD), the International Development Association (IDA) and the International Finance Corporation (IFC) together comprise the World Bank Group. They share the common objective of raising the standards of living, promoting substantial economic development, and alleviating poverty in the developing countries by channeling financial resources to them and by providing policy and technical advice. Energy serves as one of the foremost catalysts for economic development and expenditures for energy are an important part of developing countries budgets. The Bank therefore channels significant resources to the energy sector. This paper explains the role of the World Bank Group in energy and, specifically, the projects it has undertaken in the oil, gas, and electric power subsectors. The project listings are based on compilation by the Energy Development Division. The Bank has undertaken coal projects but they have not been included for purposes of this report.

The World Bank is the single most important official source of external capital for energy development in the developing countries. Bank annual energy lending (including credits from the International Development Association) has quadrupled from US$1 billion in fiscal year 1977 (FY77) to almost US$4 billion in FY89. The Bank's energy lending has totalled about US$38 billion over the past 40 years. In the Bank's approach to project financing, it has emphasized the review of sector objectives, priorities and investment options.

The first part of the paper describes the role of the World Bank in energy and, in doing so, it first gives a brief summary of the Bank and its types of energy loans. It discusses the Bank's energy role, including policy formulation, structural adjustment and sector loans, power sector operations, coal, oil and gas operations, and the Energy Sector Management Assistance Program (ESMAP). The paper finally points out how firms can collaborate with the Bank and, to help in this understanding, it summarizes the cycle that a project goes through from the very first steps to its completion.

The Annexes contain information on oil, gas and power projects and energy sector loans. Specifically, they provide project descriptions, loan amounts and fiscal years of Board approval. Through FY88 oil and gas, power and energy sector loans are shown in separate lists. Starting with FY89 energy loans are listed as a group because several loans have components covering all aspects of energy.

International Association for Solar Energy Education

The International Association for Solar Energy Education (IASEE) was founded in Göteborg, Sweden, December 22, 1989.

The purpose of IASEE is to promote solar energy education worldwide by means of:

- publication of a Newsletter,
- organization of international meetings, and
- topical activities.

"Solar energy" here means direct use of the sun's energy as well as other renewable sources of energy. Furthermore, IASEE aims at establishing a network of National Contact Persons, and a number of NCPs have been appointed by the Organizing Committee so far. Several more will be appointed during 1990. It is planned that NCPs will be elected by National Sections in the future.

IASEE Newsletters are published quarterly by Dr. Blum, Univ. of Oldenburg, in January, April, July and June with deadlines the 10th of the preceding month; the first was sent out in January 1990.

Everyone with an interest in the field of solar energy education is invited to become a member of IASEE. The yearly membership fee is US$5, but members in countries with convertible currency are requested to add US$2 to help cover the "international" costs for members in countries with non-convertible currency. Individuals as well as institutions can be members in IASEE; institutions are asked to add a voluntary sum.

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CCRERT Calls for Global Co-operation

The China Center of Rural Energy Research and Training (CCRERT) under the leadership of the Chinese Academy for Agricultural Engineering Research and Planning of the Ministry of Agriculture of the People's Republic of China is able to carry out research and training in special technologies and various disciplines concerning renewable energy. Apart from a solid technological work force, the Centre is equipped with an experiment hall, experiment and testing laboratories, modern electronic teaching facilities, a computer centre, a library, a reading room, a lecture hall, office buildings, dormitories and a canteen, etc., which amount to more than 5000 m^2. The Centre also houses an installation for teaching and practising the fields of development analysis and utilization systems for renewable energy, utilization technologies for biomass energy, solar energy, wind energy and energy conservation.

The Centre has recruited quite a few famous experts and specialists from the USA, the Netherlands, New Zealand and Japan as consultants and guest teachers. It has sent experts to Southeast Asian and African nations to provide technological training and consultancy services concerning utilization of biogas and solar energy resources.

In the past, the Centre has held practical training courses on "The Method for Zoning and Planning of Rural Energy", "Research and Analysis for Energy Utilization and Conservation", "Engineering Technology for Large Scale Biogas Projects and its Application" and quite a few others for engineers and technicians in different Asian and African countries. These courses have greatly influenced rural energy development in China and other developing countries.

In the future, the Centre plans to expand its research and training activities on renewable energy resources and is willing to contact/cooperate with both Chinese and foreign relevant organizations, academic institutions, universities, research centres, companies, experts, scholars and entrepreneurs, so as to make its contribution to the development and utilization of renewable energy resources in the World.

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(Source: *Biomass*, Vol. 20, No. 1&2, 1989.)

Publication Patterns in the Field of Renewable Energy An Analysis of Indian Energy Abstracts

Milind C Shukla
Tata Energy Research Institute
New Delhi-110 003, India

This publication analyzes the published output on renewable energy research from India during 1980-1988. The conclusions of this study are as follows: 1. Journals (70%) are the major forum of information dissemination, with conference proceedings (26%) taking second position; 2. Only 25.3% of the energy literature from India is published in journals that are included in the Science Citation Index database; 3. Analysis of periodicals showed that most of the renewable energy literature is concentrated among a few most productive journals and the rest is scattered among many journals. The first 14 journals, when arranged according to the decreasing order of productivity, accounted for 64% of the articles and the remaining 36% was found to be scattered over 179 journals; 4. Solar energy and biomass are the most important areas of research in the field of renewable energy. The significant sub-areas of research under solar energy are solar thermal utilization (50%), photovoltaics (19%), solar collectors and concentrators (19%), solar insolation, etc. (6.5%), and heat storage (6%); 5. Regarding biomass research, biomass production/social forestry (54%), and biogas production and related aspects (32%) were the major sub-areas. However, very little work has been reported in other sub-areas, especially in the area of improved *chulha*; 6. *The Indian Energy Abstract* abstracted documents that had originated from 593 organizations. These included universities (38%), research institutes and national laboratories (33%), public sector undertakings, both central and State government departments (14%), colleges (6.5%) and private enterprises (5.71%); 7. Analysis of authorship revealed that 3,009 papers were contributed by 1,820 authors (average contribution per author being 1.6). Lotka's Law of scientific productivity was applied to the data on authorship and the value of the exponent was found to be 2.28.

(Source: *Indian Energy Abstract*, Vol. 8, No.1, Jan-Mar, 1989.)

Energy Policies in Asia: A comparative study

N.J.D. Lucas, J. Ambali, E. Chang, M.S. Forbes-Ricarte, R.M. Shrestha
Energy Technology Division
Asian Institute of Technology
Bangkok, Thailand
McGraw-Hill Book Co.-Singapore
ISBN 0-07-099141-3
1987, xv+480 p.

This book originated as a United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP) activity which was contracted to the Asian Institute of Technology (AIT) in Bangkok, Thailand. This study charts various Asian countries' adjustments to the various stresses created by the violent oil price changes; and tries to help promote regional understanding and cooperation in energy matters.

This volume comprises a Comparative Analysis chapter and 12 individual country energy policy profiles, all similarly structured, to facilitate comparison. The profiles examine each country's structural changes, their changing patterns and causes of energy demand (in both form and quantity), the origin and success of oil substitution, the development of local energy resources, and public investment. This examination is made at both the policy and implementation levels. The impact of the second oil price hike is also examined.

More than 40 experts helped develop and write this work, inclusive of project and in-country advisors. Both national and international data, including some from the United Nations and the International Monetary Fund, have been used in the research.

Each chapter is clearly structured and written, and extensively documented and profusely illustrated with tables, figures and charts.

For further information about the study please contact:
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Thailand.

International Energy Policy Seminar on Energy Development in South-East Asia and Cooperation with the European Communities

Pattaya, Thailand
27 February - 3 March 1989
B. Lapillonne (Ed.)
Centre International de Formation en Politique Energétique (CIFOPE)
3, Rue Henri Heine
70516 Paris, France

An International Seminar on Energy Policy was organized by the International Training Center for Energy Policy (CIFOPE) in cooperation with the Energy Technology Division of the Asian Institute of Technology (AIT), from February 27 to March 3, 1989 in Pattaya, Thailand.

The theme was Energy Development in South-East Asia and Cooperation with the European Community. More than one hundred and fifteen participants attended this meeting. The participants came from European and ASEAN countries, Laos, India, Japan, South Korea, or represented international organizations such as ESCAP, APENPLAN, the World Bank, the European Investment Bank, l'Institut de l'Energie des Pays ayant en commun l'usage du français, the Commission of the European Communities (General Energy Directorate) as well as the French public authorities, Ministère des Affaires Etrangères (Direction de la Coopération Scientifique, Technique et du Développement), Ministère de l'Industrie et de l'Amenagement du Territoire (Direction Gé nérale de l'Energie et des Matières Premières), Ministère de la Recherche et de la Technologie, Agence pour la Coopération Technique, Industrielle et Economique, Agence Française pour la Maîtrise de l'Energie.

Proceedings of the seminar were published for CIFOPE by the Regional Energy Resources Information Center (RERIC) of the Asian Institute of Technology, Bangkok, Thailand. The proceedings contain three papers on energy demand, five papers on oil and gas (production and markets), five papers on electricity, seven papers on energy supply and demand options for the future, eight papers related to transfer of technology and expertise, three papers on financing of energy projects, and nine papers on cooperation between Europe and South–East Asia. Syntheses of the seminar, keynote address, the seminar program and the list of participants are also included.

Publications Received

BIOMASS ENERGY

* *Rice Residue Utilization Technology: International Market Prospects for U.S. Industry*, Report No. 88-02, a report of the Office of Energy, Bureau for Science and Technology, United States Agency for International Development, Washington, D.C., prepared by Louisiana State University Agricultural Center, Baton Rouge, Louisiana, January 1988.

* *Potential for Private Investment in Rice Residue Power Generation: Indonesia 1987, Preliminary Analysis*, Report No. 88-05, a report of the Office of Energy, Bureau for Science and Technology, United States Agency for International Development, Washington, D.C., May 1988.

* *A Prefeasibility Assessment of the Potential of Wood Waste Power Systems for the Indonesian Wood Products Industry, Phase I Report*, a report of the Office of Energy, Bureau for Science and Technology, United States Agency for International Development, Washington, D.C., November 1988, viii+53 p.+App.

* *Electric Power from Sugarcane in Costa Rica: A Technical and Economic Analysis*, Report No. 88-18, a report of the Office of Energy, Bureau for Science and Technology, United States Agency for International Development, Washington, D.C., July 1988.

* *Electricity and Ethanol Options in Southern Africa*, Report No. 88-21, a report of the Office of Energy, Bureau for Science and Technology, United States Agency for International Development, Washington, D.C., in Cooperation with U.S. Trade & Development Program, September 1988.

* *Woodfuel Supply and Environmental Management*, Industry and Energy Department Working Paper, Energy Series Paper No.19, The World Bank Industry and Energy Department, The World Bank, Washington, D.C., July 1989, 30 p.

* *The Malawi Charcoal Project: Experience and Lessons*, Industry and Energy Department Working Paper, Energy Series Paper No. 20, The World Bank Industry and Energy Department, The World Bank, Washington, D.C., January 1990, 63 p.

* *Project Advisory Committee Meeting Report, Bangkok, Thailand, 30 October - 3 November, 1989, Regional Wood Energy Development Programme in Asia GCP/RAS/131/NET*, Food and Agriculture Organization of the United Nations, Bangkok, December 1989, 45 p.

* *Status of Wood Energy Development in Asia: Country Status Reports (Bangladesh, Bhutan, India, Indonesia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam)*, papers presented at Project Advisory Committee Meeting, Bangkok, Thailand, 30 October - 3 November, 1989. Regional Wood Energy Development Programme in Asia GCP/RAS/131/NET, Food and Agriculture Organization of the United Nations, Bangkok, December 1989.

ENERGY

* *Power Shortages in Developing Countries: Magnitude, Impacts, Solutions, and the Role of the Private Sector*, A Report to Congress, U.S. Agency for International Development, Washington, D.C., March 1988, 73 p.

* *Domestic Energy Pricing Policies*, Rangaswamy Vedavalli, Industry and Energy Department Working Paper, Energy Series Paper No. 13, The World Bank Industry and Energy Department, The World Bank, Washington, D.C., April 1989, 62 p.

* *Financing of the Energy Sector in Developing Countries*, Anthony A. Churchill and Robert J. Saunders, Industry and Energy Department Working Paper, Energy Series paper No.14, The World Bank Industry and Energy Department, The World Bank, Washington, D.C., April 1989, 10 p.

* *African Energy Programme: A Perspective of a Regional Project Network*, Rogers W'O Okot-Uma, Series Number CSC(89)ENP-28, Project Document 272, Commonwealth Science Council (Marlborough House, Pall Mall, London SW1y 5HX, U.K.), July 1989, vii+75 p.

* *Sectoral Energy Demand-Studies: Users Guide for DBA and VOID Programs*, Regional Energy Development Programme (RAS/86/136), United Nations Development Programme and Economic and Social Commission for Asia and the Pacific, Bangkok, November 1989, 50 p.

* *MEDEE - S, English version of "Modèle de demande en énergie pour les pays du Sud, CEC, 1987" (Energy Demand Model for the Developing Countries)*, United Nations Development Programme and Economic and Social Commission for Asia and Pacific in collaboration with Commission of European Communities, Regional Energy Development Programme (RAS/86/136), ESCAP, 1989, 403 p.

ENERGY CONSERVATION

* *Technical Advice for Energy Conservation in an Industrial Building*, J.P. Traisnel and B. Mohanty, Division of Energy Technology, Asian Institute of Technology, Bangkok, Thailand, March 1989.

SOLAR ENERGY

* *SOLAR 89 Conference: Renewable Energy in Manufacturing*, November 30 - December 2, 1989, University of Queensland, St. Lucia, Brisbane, The Australian and New Zealand Solar Energy Society (P.O. Box 124, Caulfield East, Australia 3145), 1989.

Cont. P. 22

Diary of Events

- **March 19-21, 1990, Washington, D.C., USA**

Energy Technology Conference and Exposition

For more details contact:
ETC, Government Institutes
966 Hungerford Drive
Suite 24
Rockville, MD 20850-1714
USA

- **March 19-22, 1990, Sao Paulo, Brazil**

Hydro 90

The Conference will be organized by the Power Utilities of the State of Sao Paulo - Brazil, and Hangzhou Regional Centre for Small Hydropower of the Ministry of Water Resources of the People's Republic of China.

The aim of this International Conference is to provide a technical forum for the exchange of information and present solutions for the concepts of hydro power applied to regional and rural development.

The Programme of the Conference will cover the following themes:

* Policies, Regulatory Issues, Planning and Economics;
* Financial Aspects and Marketing;
* Engineering and Technology;
* Turbine/Generator Sets;
* Civil Engineering;
* Operation and Maintenance;
* Environmental Aspects and Multipurpose Use; and
* Structuring and Country Case Studies.

For more information contact:
Mr. Moises Ari Zilber
Al. Ministro Rocha Azevedo, 25
01410 - Sao Paulo - SP
Brazil
Tel: (011) 287-4316, 283-5354
Telex: 1123824 CESP BR
Telefax: (011) 283-554

- **March 19-22, 1990, Austin, TX, USA**

The National Solar Energy Conference

The National Solar Energy Conference consists of two major solar events:

– SOLAR 90 features the 19th American Solar Energy Society Annual Conference and the 15th National Passive Solar Conference. The Annual Conference sessions will include papers on: Solar Radiation Measurement; Photovoltaic Technologies/Applications; Solar Heating; Solar Thermal; Hot Water; Solar Education Programs; and Solar Fuels and Chemicals.
The Passive Conference sessions will include papers on: Daylighting; Architecture; Interior Environments; Building Performance; Sustainability; Occupancy; Guidelines; and Case Studies.

– SOLTECH 90 features: Annual Meeting – Interstate Solar Coordination Council; Annual Meeting – Solar Energy Industries Association; Photovoltaic Annual System Symposium – Sandia Na-

Course on Information Repackaging and Consolidation

The Library and Regional Documentation Center (LRDC), Asian Institute of Technology (AIT) recently conducted the first of three annual five-week training courses on Information Repackaging and Consolidation for librarians and information scientists from Asia. The training is supported by a grant from the International Development Research Centre (IDRC) of Canada. Thirteen staff members from information centers and projects supported by IDRC in China, India, Laos, Malaysia, Nepal, Sri Lanka and Thailand attended the first course, in January - February 1990.

The first course emphasized manual methods of repackaging. In response to requests from the trainees, however, extra course hours were added to cover additional subjects such as word processing, desktop publishing, and the use of CD-ROM in SDI and current awareness services.

The participants, a group of senior information managers, shared their own experiences while learning new methods.

This course is to be repeated in 1991 and 1992. Those interested in attending a future course on these important aspects of information management should request further details from:

H.A. Vespry
Director
Library and Regional Documentation Center
c/o Asian Institute of Technology
G.P.O. Box 2754
Bangkok 10501, Thailand
Tel: 529-0100 to 13, 529-0041-3
Cable: AIT Bangkok
Telex: 84276 TH
Fax: (66) (2) 529-0374

Publications Received

From P. 21

WIND ENERGY

* *Performance Tests on the CWD 108D Pump without Air chamber,* P. Kompier, Consultancy Services Wind Energy Developing Countries (P.O. Box 85, 3800 ab Amersfoort, Holland), July 1989.

* *Performance Tests on the CWD 81D Pump without Airchamber,* P. Kompier, Consultancy Services Wind Energy Developing Countries, July 1989.

tional Laboratories; Solar Thermal Program – Solar Energy Research Institute and Sandia National Laboratories; and Solar Building Programs – Solar Energy Research Institute.

Some of the topics to be included in SOLTECH 90 are: photovoltaics; solar thermal power; and solar buildings.

For more details on SOLAR 90 contact:

American Solar Energy Society
2400 Central Ave., Suite B-1
Boulder, CO 80301
USA
Tel: 303-443-3130
Fax: 303-443-3212

For more details on SOLTECH 90 contact:

Solar Energy Industries Association
1730 No. Lynn Street, Suite 610
Arlington VA 22209
USA
Tel: 703-524-6100
Fax: 703-527-2833

- **March 19-23, 1990, Williamsburg, VA, USA**

AGU Chapman Conference on Global Biomass Burning: Atmospheric, Climatic, and Biospheric Implications

For more details contact:

AGU Meetings
2000 Florida Ave., N.W.
Washington, D.C. 20009
USA
Tel: (202) 462-6900

- **March 25-31, 1990, Rome, Italy**

2nd International Conference, Progress in Solar Ponds

The conference is organized by Agip Petroli, ISES Italian Section, Eniricerche and sponsored by Ancona University.

For more information contact:

Sergio Folchitto
c/o Agip Petroli S.p.a.
Risven Mesin
Via Laurentina
449-00144 Rome
Italy

- **March 28-30, 1990, University of East Anglia, Norwich, United Kingdom**

British Wind Energy Association Annual Conference

For more information contact:

BWEA 12
Climatic Research Unit
School of Environmental Sciences
University of East Anglia
Norwich NR4 7TJ
United Kingdom

- **April 3-5, 1990, Manchester, United Kingdom**

Metering Apparatus and Tariffs for Electricity Supply

For more details contact:

Christina Dagnall
IEE Press Office
Savoy Place, London WC2
United Kingdom
Tel: 01-240-1871

- **April 10-12, 1990, Chicago, IL, USA**

Global Warming - A Call for International Coordination

For more information contact:

Dr. Sinyan Shen
c/o Supcon International
One Heritage Plaza
Woodridge, IL 60517
USA

- **April 23-27, 1990, Jönköping, Sweden**

Elmia Energy & Environment 90

Elmia Energy & Environment 90 is an international trade fair on energy, air, water, waste products and recycling. The subjects covered are energy; water supply and conservation; control of air pollution; waste disposal; the recycling of paper, plastic and scrap metal, etc. The latest research findings will be presented during the conferences and theme-based sessions at the exhibition.

For more information contact:

Elmia
Box 6066, S-550 06 Jönköping
Sweden
Tel: +46-36-11 90 60
Telex: 701 64
Telefax: +46-36-16 46 92

- **April 23-27, 1990, Paris – La Défense, France**

ME190

ME190, Technical Seminars on Energy Management in Industry and the Tertiary Sector Engineering and Services, is organized by the Agence Française pour la Maîtrise de l'Energie (French Agency for Energy Management) with the support and assistance of the Association Technique pour l'Efficacité Energétique (ATEE).

For more information contact:

Jean Lefebvre
Comité ME190
Agence Française pour la Maîtrise de l'Energie
27 Rue Louis Vicat
75737 Paris cedex 15
France

- **May 7-11, 1990, Gatlinburg, TN, USA**

Twelfth Symposium on Biotechnology for Fuels and Chemicals

The Symposium will present new research in biotechnology to provide alternatives that will have an impact on the future economic production of fuels and chemicals.

For more details contact:

Elias Greenbaum
Twelfth Symposium on Biotechnology
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831-6194
USA

- **May 12-13, 1990, Karachi, Pakistan**

Energy Conservation Symposium 1990

The topics of the symposium are: energy conservation in the industrial sector, in buildings and agriculture, and in transport; prospective technologies in energy systems; energy conservation in the power sector; and policy issues.

For more information contact:

Secretary
Energy Conservation Symposium 1990
ENAR Petrotech Services (Pvt) Limited

4th Floor, Karim Chambers
Merewether Road
P.O. Box No. 8912
Karachi, Pakistan
Tel: 515071-75, 513126
Telex: 24546 PERAC PK
Fax: 510615

- **May 18-19, 1990, Scarborough, United Kingdom**

The Generation Gap

For more details contact:
Ms. Judith Higgins
Conference Organiser
The Institute of Energy
18 Devonshire Street
London W1N 2AU
United Kingdom
Tel: 01-580 0008

- **May 21-23, 1990, Amsterdam, The Netherlands**

European Energy Week

For more details contact:
Europaplein
1978 GZ Amsterdam
The Netherlands
Tel: 020-549 1212
Telex: 10613
Fax: 020-464469

- **May 28-30, 1990, Trondheim, Norway**

The European Applied Research Conference on Natural Gas

For more details contact:
Norwegian Petroleum Society
Gas Group
P.O. Box 6050
N-7003 Trondheim
Norway

- **June 14-18, 1990, Beijing, China**

International New and Renewable Energy Conference

The conference is organised by Chinese New Energy Professional Committee and China Energy Research Society. The sponsors of the conference are: State and Science Technology Commission of the People's Republic, Ministry of Energy, Hawaii Natural Energy Institute, USA and Japan Solar Energy Society.

Fore more details contact:
China Energy Research Society
Huayuan Road 3 Haidian
Beijing 100083
Tel: 201887 Ext. 285
Telex: 222362 FHBJ CN
Fax: (01) 2012880, 8314661

- **July 2-20, 1990, Paris, France**

Electricité Solaire pour les Zones Rurales et Isolées

The training course in Solar Electricity will be organized by UNESCO. The course is intended for French-speaking engineers, teachers, managers and students from developing countries.

For more details contact:
SIDEF
2 bis, Jules Breton
75013 Paris
France

- **September 10-13, 1990, New Orleans, LA, USA**

First International Symposium on Oil and Gas Waste Management Practices

The topics of the Symposium will cover: technology and research, regulations and policy and risk assessment, and economic considerations, on waste management.

For more details contact:
EPA Oil & Gas
c/o GRCDA
P.O. Box 6126
Silver Spring
Maryland 20906
USA
Tel: 301-585-2898
Fax: 301-589-7068

- **September 23-28, 1990, Reading, United Kingdom**

World Renewable Energy Congress

The topics to be covered by the congress are: Photovoltaics; Solar Thermal; Material Science; Wind Energy; Biomass; Passive and Low Energy Architecture; and Climatology, Meteorology and Related Topics (including Geothermal, Wave and Tidal, Ocean Thermal Energies, Mini-hydro and Hydrogen Production).

For more details contact:
Prof. A.A.M. Sayigh
Chairman of the Congress
Department of Engineering
University of Reading
Whiteknights
P.O. Box 225
Reading RG6 2AY
United Kingdom
Tel: (0734) 318588
Telex: 847813 RULIB G
Fax: (0734) 31383

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Library and Regional Documentation Center, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The "RERIC News" is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership along with the other four regular publications namely: RERIC International Energy Journal (formerly: Renewable Energy Review Journal); RERIC Holdings List; Abstracts of AIT Reports and Publications on Energy; and RERIC Membership Directory. For further details contact:

Regional Energy Resources Information Center
Asian Institute of Technology
G.P.O. Box 2754
Bangkok 10501, Thailand
Telex: 84276 TH
Tel: 5290100-13 Ext. 2873
Fax (66-2) 5290374

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Transportable Solar Pack for Remote Aboriginal Communities

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In recent times, aboriginal people in Australia have tended to move away from cities and towns to homeland centres or outstations. The conventional approach to providing power for these remote communities – the diesel generator – has been less than satisfactory, requiring expensive transport of fuel by road and frequent maintenance. Furthermore, diesel generators cannot be moved easily, and their output cannot be adapted to changes in community size.

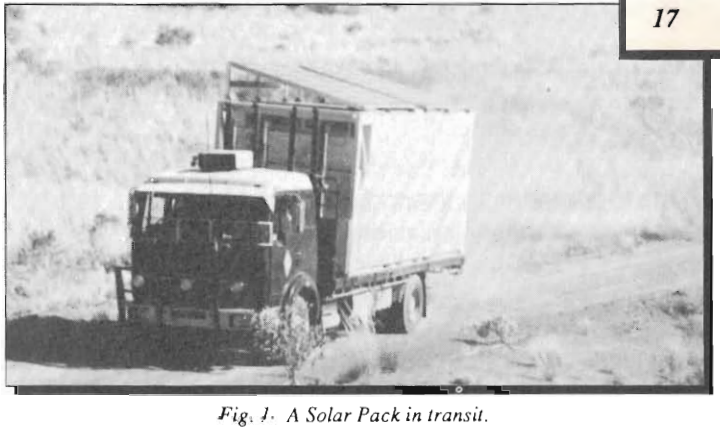

Fig. 1. A Solar Pack in transit.

In early 1984, the State Energy Commission of Western Australia and the Department of Aboriginal Affairs approached the Solar Energy Research Institute of Western Australia (now the Murdoch University Energy Research Institute) with a view to examining options for providing services to small, often nomadic, remote aboriginal communities. After considerable consultation, it was concluded that a solar-powered system, provided it was relatively mobile, would be a practical means of providing essential services.

The National Energy Research, Development and Demonstration (NERD&D) Program and the Department of Aboriginal Affairs provided funding for the project. The project team developed a standard Solar Pack unit consisting of an insulated shipping container with solar panels on the roof (Fig. 1), and containing a large battery bank and electrical appliances. The unit was designed to allow for minimum maintenance requirements and instruction to users. The photovoltaic array can vary in size from 500 to 1350 W of peak electrical output. The batteries consist of deep-cycle lead-acid traction cells and the system voltage is 24 V DC. An electronic controller and switchgear prevent overcharging of the battery bank during periods of excess solar radiation, and ensure that non-essential loads are disconnected during periods of poor solar radiation. The system is totally quiet, and is designed for loads of 3-5 kWh/day.

The first Solar Pack was designed and constructed for the Ngurawaana community in the Pilbara region of Western Australia. It was installed in March 1985 and has operated satisfactorily, with no maintenance, since then. Seventeen of the units have now been installed in Western Australia, the Northern Territory and South Australia. The system consists of the following equipment:

- a 100 W VHF receiver for communicating with the flying doctor and other vital services.

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wind and sun compendium
Development of wind and solar energy for water pumping
CWD
Consultancy Services
Wind Energy
Developing Countries

Energy Information Service, CSIRO
Incorporates news from the Energy Information Service, CSIRO and Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).
INNERTAP

Transportable Solar Pack for Remote Aboriginal Communities

From P. 1

- two chest-type refrigeration units with a total capacity of up to 460 litre for food, medicines and vaccines. Each refrigeration unit uses two compressor-condenser - evaporator units controlled by one thermostat. The compressors operate on 24 V DC and are powered by brushless DC motors.
- fluorescent lighting in the form of standard 20 W fittings which operate directly from a 24 V power.
- a small inverter to convert low-voltage DC power to mains voltage AC power (240V–50Hz) for use with conventional television, video recorder and small power tools, and a mains-powered battery charger for 12 V automotive batteries.

Fully loaded and operational, the Solar Pack weighs approximately 6 tonnes and fits on the back of a truck. At the destination, the Solar Pack is aligned so that the solar panels face north, lowered with jacks, and mounted on two steel rails. The latter are then bolted to the sides of the container to ensure stability in cyclonic winds (Fig. 2). External cables can be run underground from the unit to free-standing lights if required. The acceptance and performance of the units have been good. The only maintenance involves topping up the batteries once a month.

The standard Solar Pack is used for food preservation, e.g. bread, dairy products and meat. Other bulkier foods essential to the diet, such as vegetables and fruit, require more storage space but not the very low temperatures.

Two types of cooling system are used for food preservation according to the regions. A DC-powered evaporative cooler, utilizing the insulated container as a store, is suitable in dry arid regions. The cooler uses a minimum amount of energy because it is thermostatically controlled and its fan speed varies according to the amount of heat to be removed. Testing showed that, with an outside temperature of 40°C, only 500 Wh/day were used to keep the inside temperature at 25°C.

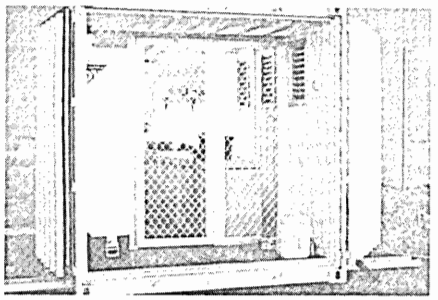

Fig. 2. View of interior of Solar Pack.

Moisture is also introduced into the air, which helps keep the vegetables and fruit fresh.

In the hot, humid regions of Australia the more energy-intensive process of vapour compression is the best choice. Here, DC-power demands of a 3 m^3 coolroom, mounted inside the container, are 3-5 kWh/day – significantly lower than those of a conventional coolroom, but equivalent to the entire output of a standard Solar Pack's array. Therefore, in instances where vapour compression is required, a larger array must be installed or an auxiliary source of power is necessary.

A Mini Pack – a smaller version of the Solar Pack, but of equal power – was developed for regions inaccessible to 10 tonnes trucks. The whole unit weighs less than 1 tonne, and can be transported, with solar arrays folded and bolted down, on a four-wheel-drive utility.

A basic Solar Pack unit, consisting of an 840 W photovoltaic array, two refrigerators, two lights, a 450 VA inverter, a battery charger, a 12 V radio outlet, batteries, controller, switchboard etc., costs about US$ 40,000. Assuming that the batteries would require replacement after 5 years, and the balance of the system after 20 years (with no residual capital value), the annual running costs would be about US$1.15/kWh. This assumes an average energy delivery of 5 kWh/day, and an interest rate on borrowed capital of 12%.

For further information please contact:

Dr. W.L. James
Murdoch University Energy Research Institute
Murdoch University
South Street, MURDOCH WA 6000
Australia, Tel: (09) 332-2211

Electricity from Solar Thermal Showing Great Promise in the Desert

Luz International has managed to do what few expected could be done before the turn of the century: generate electricity from the sun on the sunbaked flats of the Mojave Desert east of Los Angeles at competitive rates.

At Luz's Mojave facility, parabolic mirrored troughs 9 feet high and 40 feet long concentrate the sun's rays onto oil-filled tubes that run parallel to the mirrors along their focus. The oil circulates to a generating station, where it heats water to produce the steam that powers an electricity-producing turbine. During peak periods, the system converts 22 percent of sunlight into electricity – more than double the efficiency of commercial photovoltaic cells. Some prototype solar dishes could do even better.

Luz has enjoyed fast growth since it built its first 14 MW plant in 1984, spending US$750 million to bring its generating capacity upto 194 MW. The future looks even brighter now that it has contracted with Southern California Edison to build five 80 MW plants in Mojave (each covering 240 acres) by 1994. Together, Luz's plants will produce enough electricity to meet the needs of 750,000 people.

The company's exponential growth stems from three major factors, viz. a) a 1982 California ruling that public utilities must purchase electricity from renewable energy firms to stimulate the development of decentralized and environmentally clean independent power projects and that prices set up by the state utilities commission for purchase of this power take into account the costs utilities avoid by not building and fueling new power plants, b) Luz's ability to generate the most electricity when utilities need it most – on hot, sunny days, and c) the reliability of Luz's energy "feed"; Southern California Edison, like any utility, pays

Mud Jar Solar Water Heater – An Ingenious yet Low-cost Design

In India, the average cost of a family-size solar water heating system is about Rs. 9000 (approx. US$ 550). Some subsidy is being given by the Government, but solar water heating systems are still a rarity. In India, as in many developing countries, the manufacture of these systems would involve heavy import of system components thereby making the product more expensive than in the wealthier nations. As a result, the market for solar water heating systems in several developing countries in Asia, Africa and Latin-America has yet to appear to any significant extent even though the benefits of the systems are already recognized.

To overcome the above impediments, a low-cost solar water heater, based on rich traditional wisdom and utilizing locally available resources, has been fabricated and tested by Dr. A. Jagadeesh, President of the Society of Science for the People.

Fig. 1. Mud jar solar water heater.

Dr. Jagadeesh was aware that mud utensils are widely used in rural areas in India for cooking, and in Northern India tea is served in small clay pots in railway stations. In both cases, people handle the mud pots with ease even though the contents inside are hot. This proves the efficacy of mud as an insulator. He had observed too that in rural areas it is customary to keep the cooked rice warm and dry by spreading on a cloth with straw beneath it during functions.

Utilizing these two principles a low-cost or "everybody's" solar water heater was designed (Fig. 1.). Four oil tins each of capacity 15 litres are connected together through a 3 cm diameter metal pipe for transfer of water. The tin at the end is fitted with a tap. All the tins are coated outside and inside with black paint. A mud jar of capacity 70 litres is coated inside with a thin layer of

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a higher price for a steady, predictable supply of power, which Luz provides, by burning natural gas on cloudy days and at night, and producing less than one-sixth as much carbon dioxide per kWh as a normal coal-fired plant.

Luz's latest plant produces electricity at 11.4 cents per kWh, below the 12.4 cents electricity costs from the newest nuclear plants. Further improvements should bring that figure down to 7.9 cents in December 1989, when the first of the five 80 MW units comes on-line. If a 160 MW plant were ever built, Luz is confident that its generating costs would fall to 6.3 cents per kWh. Economies of scale and more efficient design get credit for bringing costs in-line with those of clean-coal technologies.

As opposed to the frequent criticism for using too much land made against any form of solar power, Luz's solar troughs occupy only 2,600 sq. feet of land for every GWh of electricity they produce – one third less than the 3,900 sq. feet that coal-fired power plants use when coal mining is factored in. However, land use really isn't much of an issue because most solar thermal plants will be in regions unsuited to agriculture or much of anything else – deserts. It is estimated that fulfilling the electricity needs of Los Angeles with solar thermal energy would require 150 sq. miles of solar troughs, which equals 1 percent of the nearby Mojave Desert or one third of its largest current tenant, Edwards Air Force Base.

The remarkable thing about Luz is its success in an arena where other solar thermal options have failed – the market place. Low oil prices, reduced electricity demand, severe cut backs in government R&D funds, and the evaporation of tax credits and favorable contracts may have deterred other companies from exploring the solar option, but Luz just keeps rolling along.

The potential for solar thermal power plant is vast. The desert sun with the existing trough technologies could provide electricity for up to one quarter of the U.S. population. Brazil, India and other tropical and subtropical nations could attain even higher levels.

As public concern increases over acid rain, urban smog, and the greenhouse effect, government support for solar power may be revived in the form of tax breaks and favorable contracts. National and international discussions on the greenhouse effect could conceivably lead to a "carbon tax" that would force up the price of coal, gas and oil. Also California may initiate fees on new generating plants that produce air pollution or it may reserve a portion of its electricity contracts for power providers that don't produce carbon dioxide. As the real cost of fossil fuel rises, the economic climate for solar thermal and other solar technologies may improve. Soon it will be proven that "renewable energy" is no longer a "money-losing" game.

(Source: Extracted from *Turning Turbines – and Profits – in the Desert* by Nicola Lenssen. *World Watch Magazine*, Vol. 2, No. 5, September-October 1989, p. 42.)

Mud Jar Solar Water Heater – An Ingenious yet Low-cost Design

From P. 3

cement to block the pores. The jar is fitted with a tap at the bottom to draw hot water. The outer part of the mud jar is covered with a 10 cm layer of thick straw with a black polythene sheet stretched over this so that the whole system is airtight. Above the clay lid, a bamboo basket covered with thick straw and black polythene sheet is placed so that it will minimize heat losses at the opening. A similar arrangement is provided to cover the tap at the bottom of the jar after each use. A rubber pipe is provided to transfer the hot water from tins to the mud jar.

The tins are filled with water at around 8 a.m. and hot water is transferred to the mud jar at 4 p.m. After this operation the rubber tube is removed from the mud jar to prevent heat losses.

Experiments showed that during the summer and winter hot water temperatures of 60°C and 50°C, respectively are obtainable. During a period of 15 hours storage, an average temperature drop of five degrees was found. As such, the stored water will be fit for use the next morning. All the components in the above arrangement are available locally and the technology involved is quite simple.

This solar water heater costs Rs.200 (US$12) in India. Where water requirements are high the number of tins and the size of the mud jar can be increased. In some developing countries thick mud jars which can store even 500 litres of water for drinking purposes are still in use. This simple solar water heater also contributes to eliminating fuelwood for heating water besides preventing air pollution in rural areas and saving electricity in urban areas. Needless to say, this simple low-cost solar water heater will be a boon to rural areas of Africa, Asia, Latin America etc.

(Source: Extracted from *Everybody's Solar Water Heater* by Dr. A. Jagadeesh, President of the Society of Science for the People, Nellore, Andhra Pradesh, India.)

Current Research in Solar Energy at the Energy Technology Division

Prof. R.H.B. Exell of the Division of Energy Technology of the Asian Institute of Technology (AIT), Bangkok, recently delivered a lecture to the Faculty and students of the Division. The purpose of this lecture was to inform them of the previous work and the on-going research programs in the field of solar energy undertaken by the Division.

The research activities were broadly classified into four categories, viz. a) climatology and radiation, b) solar drying, c) solar refrigeration, and d) collector testing.

Climatology and Radiation

Some work has been done on mapping of solar energy over south-east Asian countries in the form of masters and doctoral theses. Mention of two books, viz. "The Availability of Solar Energy in Thailand", AIT Research Report No. 63, and "Simulation of Solar Radiation in a Tropical Climate with Data for Thailand", AIT Research Report No. 115, was made by Prof. Exell. While the first is a comprehensive survey of solar radiation (for Thailand) viewed as a natural source of energy, the other one describes a compact random model for the computer simulation of daily totals of solar radiation and hourly solar radiation fluxes, and these are expected to be applicable over the entire south-east Asian peninsula. Dr. Chumnong, who obtained his PhD degree from the Division, developed a method to determine solar radiation on the ground from geostationary satellite images. Another PhD student is currently working on solar radiation mapping using low resolution images from the polar orbiting satellites. Success of this work will enable scientists/meteorologists to perform solar radiation mapping with acceptable reliability at low cost.

Solar Drying

The subject of drying rice and timber was touched upon with a mention of the design principles and specific advantages of this application of solar energy.

Rice Dryer

Slides were shown of some of the rice dryers tested at various sites in Thailand, including one in the Energy Park of the Division. The major advantage of using these dryers over normal sun drying is that drying can be carried out even in the wet season; for economic use the dryer should be used for drying other crops also.

In this connection mention was made of "Solar Rice Drying Project (Thailand)", AIT Research Report No. 171, and of the RERIC publication "AIT Portable Solar Dryer Construction Manual".

Timber Kiln

The primary objective of building a simple solar timber kiln (with aluminium frame & plastic sheet) for various species of wood under the NBRO-AIT Solar Kiln Project in Sri Lanka was to reduce cost compared with costs using the available designs from other countries. Installation of another similar timber kiln at the Thai Plywood Co. in Bangkok solved the company's problem of drying wood (to be used for door frames). Mention was also made of similar solar timber kilns installed at many locations in Bangladesh.

Solar Refrigeration

The major developments in this field have been in the PV-powered compression type and the solar heated absorption type refrigeration systems. Developments in ammonia-water absorption refrigeration made at AIT have been reported in "Design and Testing of a Solar Powered Refrigerator", AIT Research Report No. 126. The system appears to be economically attractive and could have good commercial prospects. Recently work

on activated charcoal-methanol refrigeration was started with the financial assistance of USAID. At present, one PhD student is working on its further development. While on the subject, Prof. Exell mentioned that the Division had developed an "Environmental Chamber" for testing refrigerators used to store vaccines in remote places. A training program of two weeks duration on PV Solar refrigeration and its maintenance organized by the Division with the financial assistance from WHO would commence in July 1990.

Collector Testing

The Energy Park (under supervision of Mr. Phillipe Bouix) attached to the Division has a project on the long-term performance testing of solar collectors coming from different manufacturers all over the world. The huge suntracking solar collector test bed installed in the ET Park and equipped with necessary data-processing facilities can test four collectors simultaneously and hence enable comparison of their performances. Testing may be done under the standard testing methods, e.g. ASHRAE, DIN, etc.

Dr. Supachart, who recently obtained his PhD degree from the Division, developed a method (conceived initially by Prof. Saunier) to measure the performance parameters of solar collectors under variable weather conditions. Standard testing needs steady radiation.

Building Physics Taking a New Shape with Daylight and Sun

Since the infusion of the concept of energy-conscious design into building architecture, there has been a revolutionary change in the physics of the buildings meant for human residence. Now architects have to respond to the opportunity daylight and sun offer as an energy source so as to impart to these new solar residences a benign form, especially when faced with the severe climates of the northern latitudes.

One such story of achievement is the building of four residence halls for Strathclyde University, Glasgow (housing for 376 University students) located on a triangular site formed by High Street and Rottenrow. The work was carried out by the German research and engineering company Kaiser Bautechnik with the assistance from Glasgow architects GRM Kennedy & Partners under a design-and-build contract at a cost of £5.7 million from the University. The severe climate of Glasgow at a northern latitude of 55°N will put the systems to a real test.

At the research centre at the Frauenhofer Institute near Freiberg, Kaiser Bautechnik have developed the technology of harnessing daylight, as against sunlight, energy for space heating. The research, carried out in conjunction with Weitzman Institute in Israel and UCLA in California, holds the promise of a possible revolution in both thermal and visual aspects of building.

Physics, rather than conventional aesthetics, determined the ultimate appearance of the student housing at Strathclyde: elevations and sections reflected the science of daylight energy. Understandably, the buildings' northern elevation of redbrick with panels of rock-faced relief is as solid as a Scottish castle. The wall is visually thick, representing nearly half a meter of brick skin, 150 mm of glasswool insulation and dense concrete block inner leaf, giving a total "U" value of 0.22. In contrast, the south elevation is nearly entirely glazed. Made by Steinmetz of Germany, the "energy wall" consists of an integrated sandwich of glazing, specially treated translucent polycarbonate insulation and roller blinds held in front of a dark painted blockwork inner leaf. The system is potentially simple, daylight energy transmitted by the glass through the polycarbonate insulation, is stored within the dense blockwork, and released slowly into the building interior as heat.

Much depends upon the blinds which are computer-controlled (but can be manually overridden to allow views out) to allow the wall to absorb or reflect heat thereby maintaining temperatures between 18 and 21°C. The blinds are designed to provide overnight insulation or protection when there is no outside radiation, and in the summer they shade the blockwork to prevent overheating.

The intelligent wall is controlled by 4 different sensors – one on the outside which measures daylight radiation, the others to measure the temperature of the external wall surface, the air temperature and room temperature. The roller blinds react to the sensor readings, or to the demands for a blindless window view made by students within their individual rooms.

As with all new systems, performance will need to be carefully measured and hence these residences are currently being monitored by Strathclyde's own Energy Studies Unit, with a grant under the EEC's Energy Demonstration Scheme, to judge the results in terms of both energy saving and urban design. Although independent energy analysts predict optimistically that the system can provide 100% of the overall heat required, Kaiser Bautechnik have guaranteed to provide 80% of the total heat required, which saves the University about £70,000 in annual heating bills. If this project is successful, it would represent one of the most significant breakthroughs in building physics this century: daylight could provide the space heating for buildings even at northern latitudes. The scale of the discovery will have implications in terms of fossil fuel use and the associated problem of the Greenhouse Effect.

(Source: *Interface*, 1990)

Biogas Research Activities at the Renewable Energy Center Cantho University, Vietnam

The Renewable Energy Center (REC) was founded in October 1987 at Cantho University, Vietnam. REC is continuing the activities on biogas research previously carried out by the biogas group formed in March 1985 as a component of the Biological Nitrogen Research Center.

Research Activities

Principal results of biogas research activities carried out by REC during 1985-1988 are as follows:

Family Use Digesters

12 prototypes of cylindrical type digester with rubber gas drum were built. During 1987, another cylindrical type digester with ferrocement gas drum was tested taking into account the users' suggestions. This type of digester was favorably valued by government agencies in 1989. At present, 90 digesters of this type are in operation.

25 m^3 Digester

Three 25 m^3 digesters with fixed ferrocement gas drum have been developed by REC and are functioning in Dongnai, Tyninh and Cantho in Vietnam.

Feeding Materials for Biogas Plant

Experiments using hyacinths as feeding materials in coordination with pig manure have been carried out. The biogas production efficiency was found to be even higher than that using pig manure alone.

Biogas Utilization

Research has also been carried out on using biogas for domestic cooking and lighting. Cooking time was reduced by 50% when using biogas. Biogas was found to stop proliferation of flies and to decrease the number of parasite eggs. 80% of biogas can be substituted for diesel fuel in running a motor.

Slurry Utilization

The slurry obtained after biogas fermentation can be used as nutrients for plants and also as feed for poultry, fishes and shrimps.

VAC Cycle

A closed farming system with orchards-fish pond-animal raising in coordination with a biogas plant offers an integrated home economy particularly in rural areas or suburban areas.

Propaganda and Training

REC has organized training on biogas for 38 biogas technicians, 100 family heads and workers. The training has dealt with the operation and repair of digesters.

A video film on the advantages of biogas digesters was produced by REC and shown on the Cantho TV station.

REC has actively participated in the evaluation of 3 types of digesters: the Indian type, the Chinese type and the ferrocement type.

For further information on REC activities please contact:

Dr. Do Ngoc Quynh
The Director
Renewable Energy Center
Cantho University
Cantho-Haugiang
Vietnam

Solar Drying Efforts in Bangladesh

One of the many important applications of solar thermal energy is solar drying. Drying is probably the most simple and inexpensive method of preserving foods. It is particularly important for the developing countries of the tropics to preserve various foods and agricultural items. A box type direct solar dryer is found particularly effective for applications at the rural level as the dryer is simple in operation and can be constructed out of cheap and locally available materials. The development and application of this kind of solar dryer units could go a long way in serving this end.

Dr. M. Akhtaruzzaman, an Associate Professor of the Department of Farm Power & Machinery, Bangladesh Agricultural University, has long been associated in the field of solar drying in Bangladesh and contributed much to the development of direct solar dryers (box type, mixed mode type etc.). He has dealt with both theoretical aspects as well as prototype development of these dryers. Interested readers may get more details of his work either from his paper titled "Thin Layer Solar Drying of Rough Rice" published in Solar Energy, Vol. 42, No.2, pp.167-171, 1989, or by writing to:

Dr. M. Akhtaruzzaman
Associate Professor
Dept. of Farm Power & Machinery
Bangladesh Agricultural University
Mymensingh, Bangladesh

Wood for Fuel in Asia under RWEDP

The Regional Wood Energy Development Programme (RWEDP) in Asia is a regional cooperative project being executed through the agency of FAO and financial aid from the Government of the Netherlands. The 2nd phase of the project spans a period of 4 years (1989-1993) and aims at the development of woodfuel resources to meet the energy needs of households and small-scale processing enterprises of the participating countries, viz. Bangladesh, Bhutan, Burma, India, Indonesia, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam. The project has been operational since March 1985. In the first four years, a network of forestry and energy institutions (governmental and non-governmental) actively involved in wood energy development, was established. Training, information exchange and technical assistance in social forestry, tree production and energy conversion techniques were the main activities in the first phase (1985-1989) of the project. Based on the experiences in the first four years the RWEDP work programme for the second phase (1989-1993) has been designed with more attention to improved planning and intersectoral linkages.

Past Experiences

Over 50 percent of total energy consumption in Asia is derived from wood fuels. In addition to being the main and often only accessible fuel, woodfuels have represented an important source of income for large numbers of poor people in Asian developing countries. It was felt therefore that the programme should consider this income generating potential in addition to the alleviation of negative effects resulting from fuelwood shortages.

Innovative strategies are being developed in the sectors most seriously concerned, i.e. the forestry and energy agencies. In forestry, social forestry programmes have been initiated in most countries, agroforestry systems are being developed and improved, the importance of small-scale processing of forest and tree products is increasingly realized, and training and research programmes are being adapted so as to generate and disseminate the new skills and knowledge required for such strategies. Similarly, in the energy sector, the importance of "new and renewable" sources of energy is acknowledged and reflected in the creation of special divisions for rural energy planning, and the development of new ways of planning and implementing energy projects. Development support to such innovations and exchange of experiences in the implementation of these will continue to be the main objectives for the RWEDP activities planned for 1989-1993.

New Strategies

In its second phase, the following wood energy development strategies will be emphasized:

- Identification of needs, opportunities and priorities for wood energy development, in line with national energy policy objectives. Pilot studies and training in methodologies for the collection, processing and interpretation of empirical data, as the basis for the setting of priorities, projection of results and allocation of resources for action programmes, will be supported.
- Improvements in the production of woodfuels, including improved sustainability, through support to the development and expansion of forestry extension programmes, with an emphasis on local level participatory planning approaches, local organizational and institutional improvement, and the design and adaptation of appropriate technical arrangements in tree production and processing of woodfuels.
- Improvements in the distribution and conversion of woodfuels through improved marketing arrangements, and involvement of relevant sectoral expertise (small-scale enterprise development and home economics/extension) in the planning and implementation of improved conversion activities in rural and urban households and in small-scale processing enterprises.
- Support for coordination between agencies and institutions involved in planning and implementation, policy formulation, training and research, through the design of an

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Wood for Fuel in Asia under RWEDP

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interagency wood energy development programme, workable arrangements and methods for monitoring and evaluation, and regular communication at country level.

- Strengthening the network for sustained regional cooperation through promotion of TCDC and improved interagency coordination and collaboration with national and regional networks.

Role of RWEDP

A regional project covering 11 countries with limited manpower and financial resources, can only provide catalytic support to the actual development of the innovative strategies indicated above, through collaboration with projects and institutions in the participating countries. Documentation and dissemination of such innovations, technical assistance in programme planning and implementation, and in training are the major ways in which RWEDP proposes to support country programmes.

RWEDP neither has the resources nor the mandate to fund larger field programmes. However, support can be provided for the formulation of proposals for larger programmes, to be funded from other sources.

Project Activities

The major activities of the project are as follows:

- Review of current policies, strategies and approaches applied in member countries;
- Promotion of inter-country exchange of information, experiences and materials;
- Analysis of wood energy flows and systems; diagnostic studies on key issues and dissemination of results;
- Development of methodologies for the collection and analysis of data and improvement of database for policy and programme planning;
- Assistance in the preparation of models for micro-plans;
- Assistance and collaboration with pilot projects in participatory planning in woodfuel production and conversion;
- Documentation and dissemination of successful experiences in production, marketing and conversion of woodfuel;
- Evaluation of forestry extension strategies and methods;
- Training through national workshops, assistance in design of training courses, study visits and short-term fellowships in agroforestry, forestry extension and wood energy conversion; and
- Preparation of field manuals, training and teaching materials in forestry extension and wood energy conversion.

Training

Annually, an updated information bulletin on regional and national training activities organized or supported by RWEDP is distributed and made available on request by the project.

Networking and Newsletter

Focal points and correspondents have been designated in all member countries. They assist in coordinating wood energy and related activities at the national level and also advise on the regional activities.

The Wood Energy Newsletter, issued quarterly, supplies information on network activities in the member countries and news and notes on innovative programmes/activities. Increasingly, the contents of the newsletter are based on contributions from the participating countries, and readers are invited to contribute their own experiences or comments on earlier issues. The circulation of the newsletter is presently about 2,500 with an increase to 3,500 foreseen.

Country Focal Points

Bangladesh	: Chief Conservator of Forests
Bhutan	: Director General, Forest Department
Burma	: Director General, Forest Department
India	: Secretary, Department of Non-Conventional Energy Sources
	: Secretary, Ministry of Environment and Forests
Indonesia	: Director, Bureau of Planning, Ministry of Forests
Nepal	: Director General, Forest Department
Pakistan	: Inspector General of Forests
Philippines	: Department of Environment and Natural Resources
Sri Lanka	: Chief Conservator of Forests
Thailand	: Director General, Royal Forest Department
	: Secretary General, National Energy Administration
Vietnam	: Director, Wood Processing and Supply Union, Ministry of Forestry

For further information please contact:

Chief Technical Adviser
Regional Wood Energy Development Programme in Asia
FAO/RAPA
39 Maliwan Mansion
Phra Athit Road
Bangkok 10200
Thailand
Cable: FOODAGRI TH
Telex: 82815 FOODAG TH
Fax: 2800445
Tel: 2800760; 2817844 (ext. 114)

Foundation for Woodstove Dissemination

The Foundation for Woodstove Dissemination (FWD) was formed as a follow-up to the first International Stove Dissemination Workshop in Wolfheze, the Netherlands, in 1983. The objective of the workshop was to re-assess stove activities and recommend appropriate strategies to enhance wide-scale dissemination of improved stoves in developing countries. The establishment of FWD was the key outcome of this gathering.

Structure

FWD has a decentralized structure with a strong emphasis on enhancing the institutional management and technical capability of its network members. The primary actors of the network are the seven regional Focal Points that are managed by key local stove agencies with a solid track record in stove development and dissemination.

The FWD Focal Points are:

Central and South America
Dr. A. Cáceres
Centro Mesoamericano de Estudios sobre Tecnologia Appropiada
CEMAT
P.O. Box 1160
Guatemala City
Guatemala

China
Mr. Wang Mengjie
Chinese Center of Rural Energy Research and Training
CCRERT
Road South
Changping 102200
Beijing 100014
People's Republic of China

East Africa
Mr. A. Awori
Kenya Energy and Environment Organization
KENGO
P.O. Box 48197
Nairobi
Kenya

Indian Sub-Continent
Mr. Y.K. Sharma
Consortium on Rural Technology
CORT
D-320 Laxmi Nagar
Delhi 11009
India

South-East Asia
Mr. A. Sudjarwo
Yayasan Dian Desa
YDD
P.O. Box 19, Bulaksumur
Yogyakarta
Indonesia

Southern Africa
Mr. D. Hancock
Zimbabwe Energy Conservation Network
ZERO/ZECON
P.O. Box 5338
Harare
Zimbabwe

West Africa
Dr. Youba Sokona
Environment et Développement du tiers-monde
ENDA-TM
B.P. 3370
Dakar
Senegal (interim)

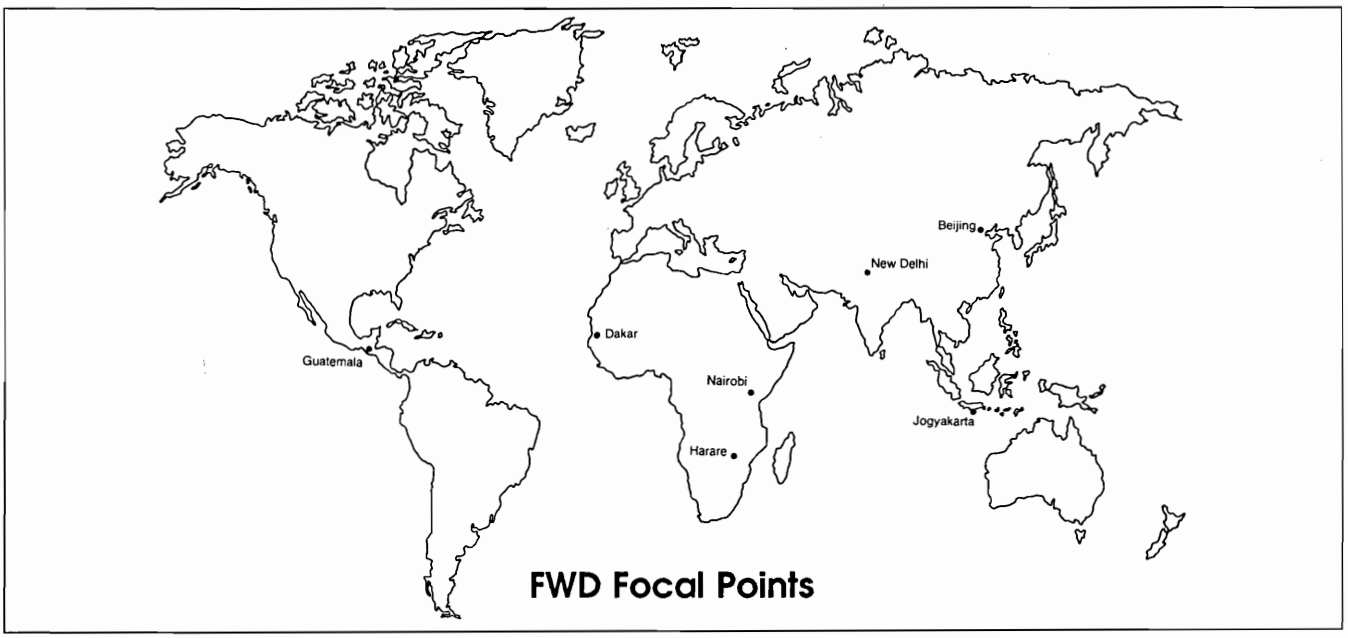
Objectives

The main objectives of FWD are to:

- Facilitate the exchange of information on cookstoves, particularly between stove agencies in the South.
- Assist stove agencies in developing countries to improve the quality of the information generated on cookstoves.
- Assist development agencies (mainly voluntary and grassroots organizations) in the South to formulate and initiate regional programmes and, where necessary, national-level stove activities.

FWD also aims to strengthen the capacity of developing countries in the planning, initiation and management of improved cookstoves projects; to

Cont. P. 10



FWD Focal Points

Energy Forecasting Model

A computer model developed at Simon Fraser University promises to reduce much of the guesswork, and at the same time open up exciting new possibilities for industrial planning and forecasting. The model is the end result of two years of development work and testing by Dr. Mark Jaccard, an energy economist in the natural resources management program. A typical 20-year forecast of energy consumption in the B.C. pulp and paper industry under various growth, price and environmental policy scenarios took two hours to run on the old mainframe version. This more powerful micro version can do the same thing in two minutes.

For further information please contact:

Dr. Mark Jaccard
Simon Fraser University
Burnaby, B.C. V5A 1S6
Tel: (604) 291-4219

(Source: *Bio-Joule*, Vol. 12, Issue 3, January, 1990)

Foundation for Woodstove Dissemination

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foster efforts to develop standardized research methodologies of cookstoves programmes; and to formulate and implement intra-regional research projects on cookstoves in developing countries.

Activities

Since it was founded in 1983, FWD has undertaken, through its network of Focal Points, a wide range of activities in stove dissemination, training, project development and cookstove programme evaluation and monitoring. Past activities of FWD are:

Seven National Surveys

These surveys assessed the impact of improved cookstove programmes in Burkina Faso, Guatemala, India (2), Kenya, Indonesia and Niger.

International Stoves Workshops

Two international stoves workshops were organized by FWD. The first was held in Wolfheze, the Netherlands, in 1983 and the second was held in Antigua, Guatemala, in 1987.

Programme Development

FWD has been instrumental in initiating two major regional programmes on wood energy in Asia, and East and West Africa.

Research Projects

FWD has initiated world-wide research projects on issues of concern for stove agencies in developing countries.

Training Course

The third Regional Training Course on Biomass Energy Development held in Nairobi during 4-22 June 1990 was organized by the Regional Wood Energy Programme for Africa (RWEPA) of the Kenya Energy and Environment Organizations (KENGO), the FWD's Focal Point for East Africa.

The training course covered the stove production technology for urban and rural communities; alternative biomass energy technologies; improved charcoal production methods; and project planning, implementation, monitoring and evaluation.

Newsletter

FWD publishes Stove News with financial support from DGIS, the Netherlands. This newsletter provides a forum for the rapid exchange of information, news, field activities and research findings. Initially, Stove News will be published every three months. The first issue of Stove News came out in April, 1990.

For more information please contact:

Mr. S. Karekezi
Executive Secretary, FWD
c/o P.O. Box 30979
Nairobi, Kenya

Get Your Generation Systems Assessed by UNITAR

The UNITAR/UNDP Centre on Small Energy Resources is carrying out a technological assessment of power generation systems suitable for rural areas of developing countries, upon request from a bilateral development agency. In this respect, the Centre is interested in being contacted by manufacturers, development organizations, research centres and end-users involved in the development, testing and/or utilization of power generation equipment, and who are willing to provide technical and economic data on the equipment utilized, and to share information on the results of their operation in developing countries.

The technologies for which information is required (in the range 5-500 kW) are:

- Steam boilers (coal-fired, biomass-fired) and steam engines;
- Gas turbines;
- Diesel generators;
- Gasifiers and producer gas engines;
- Biogas engines;
- Mini- and micro-hydropower schemes;
- Wind generators;
- Photovoltaic generators;
- External combustion engines (Striling cycle).

The final output of the study will be a report containing an updated picture of cost and performance of available energy technologies. This will be distributed to international donor agencies and decision-makers in developing countries, with the aim of assisting them in making the most proper decisions when implementing new energy projects in rural areas.

Established in 1984, the Centre works in the collection and dissemination of information on small-scale energy resources, and in the establishment of contacts between develop-

ADB Provides Emergency Power Rehabilitation Loan to Western Samoa

The Asian Development Bank approved an interest-free US$500,000 loan to Western Samoa for an Emergency Power Rehabilitation Project. The loan is for a term of 40 years, including a grace period of 10 years, at a service charge of one per cent per annum.

The main objective of the loan is to replace cyclone-damage power generation units at the Salelogaga power plant on the island of Savaii and to provide a new shed to house the units. The damage was caused by cyclone Ofa in February 1990.

Two new diesel generating units of 300 kW each, together with the retained 480 kW unit recently reconditioned, and the 300 kW unit currently under repair, will result in a total installed capacity at 1,380 kW and firm capacity of 510 kW. Firm capacity is expected to be the same as it was before the cyclone. The pre-cyclone load demand levels should be reached within 12 months. The project is estimated to be completed by 1 March 1991.

(Source: *Asian Development Bank News Release*, No. 65/90, 17 May 1990.)

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ing countries and institutions of private companies working in the field.

Those interested in providing information may contact:

The Director
UNITAR / UNDP Centre on Small Energy Resources
Via del Corso, 303
00186 Rome, Italy
Tel: (06) 6841524
Fax: (06) 6841528

(Source: *Network News*, Vol.4, No.3, May-June 1990, p.9)

CEEETA
Research Centre for Energy, Transport and Environment Economics

CEEETA is a non-profit association, founded in 1985, at the Higher Institute of Economics, within the Technical University of Lisbon, Portugal.

Its efforts are devoted to applied research and teaching in the fields of Energy, Transport and Environment Economics. The staff is mainly composed of professors and assistants from the Higher Institute of Economics. There are, currently, 10 senior professors and researchers in economics and engineering, 15 research assistants and 50 specialists in energy, transport and environment problems.

Activities

CEEETA has been engaged in a considerable number of activities. Some of the main projects have included:

- Guide on energy utilization and conservation
- Environmental impacts of the 1984 National Energy Plan
- Databases on energy
- Development of the mini-hydro in Portugal
- Implementation of the Valoren program in Portugal
- European year of the environment in Portugal
- Energy and environment in Portugal
- Wind energy
- Implementation of environment policy in Portugal
- Industry and environment in Portugal
- Financing of environment policy in Portugal
- Demonstration projects on photovoltaics in Portugal
- Modeling of the Portuguese energy systems
- Regional energy planning in Portugal and in Brazil.

Institutional Relations

In Portugal CEEETA cooperates with government departments having responsibilities in the fields of energy, environment, natural resources and regional planning. The main projects conducted for these institutions are the Valoren program, the regional plans for two Portuguese regions, a data bank on energy and environment and studies aiming to define an environment policy for Portugal.

At an international level, CEEETA maintains close ties with a number of Directorate Generals of the Commission of the European Communities. Some of the main research areas now in progress are studies on modeling and environmental impact, regional planning in Portugal and Brazil, renewables, rational use of energy in Brazil.

CEEETA also has close and regular contacts in progress with some European universities by virtue of teaching and research activities, i.e. Université Paris X (Nanterre), Université de Grenoble, Institut Polytechnique Fédéral de Lausanne, Escuela Superior de Administración y Dirección de Empresas of Barcelona and Universität Karlsruhe.

For more details please contact:

CEEETA
Centro de Estudos em Economia da Energia dos Transportes e do Ambiente
Universidade Técnica de Lisboa
Rua Miguel Lúpi, 20
1200 Lisboa
Portugal
Tel: (01) 601043

Round-Table Conference for Promoting New Energy and Energy Conservation Cooperation

Bangkok, Thailand
1 February 1990

The Round-Table Conference for Promoting New Energy and Energy Conservation Cooperation, held in Bangkok on 1 February 1990, was organized by the Committee for Promoting New Energy and Energy Conservation Cooperation (Japan) in association with the Japan External Trade Organization (JETRO), Bangkok, Thailand.

The purposes of the Conference were to discuss and exchange views regarding rapid and effective co-operation in the field of new energy technology and energy conservation technology.

The meeting was attended by 19 Japanese members of the Committee for Promoting New Energy and Energy Conservation Cooperation who were representatives from: New Energy and Industrial Technology Development Organization (NEDO); Ministry of International Trade and Industry; New Energy Foundation (NEF); The Energy Conservation Center, Japan (ECC); and Engineering Advancement Association of Japan (ENAA).

The 25 Thai representatives in attendance were from: National Energy Administration (NEA); Petroleum Authority of Thailand (PTT); Electricity Generating Authority of Thailand (EGAT); Provincial Electricity Authority (PEA); National Economic and Social Development Board (NESDB); Board of Investment (BOI); Research and Development Institute, Kasetsart University; King Mongkut's Institute of Technology Thonburi (KMITT); Asian Institute of Technology (AIT); Energy Research and Training Center, Chulalongkorn University; Energy Conservation Center of Thailand (ECCT); Industrial Finance Corporation of Thailand (IFCT); Department of Industrial Promotion; Federation of Thai Industries (FTI); Technological Promotion Association (Thai-Japan); Metropolitan Electricity Authority (MEA); Department of Mineral Resources (DMR); Thailand Institute of Scientific and Technological Research (TISTR).

The energy situation in Japan and the basic outline of Japan's energy policy were presented. Conference discussion topics were:

- energy demand and supply constraints in the 1990s;
- constraints on fossil fuels in dealing with global environmental problems;
- promotion of R&D and propagation of new energy and the rational use of energy;
- suitable constitution ratio of primary energy sources; and
- potential contribution of international cooperation in the field of global energy problems.

Presentation and discussions on research and development work on new energy resources took place and included:

- Photovoltaic power generation;
- Solar thermal utilization;
- Geothermal energy;
- Ethanol and methane production;
- Fuel cells technology;
- Biomass energy;
- Mini-hydro power;
- Wave power generation;
- Wind power generation; and
- Methanol synthesis and utilization.

For more details on the Conference please write to:

Mr. Shiro Mizutani
Director General
Planning Department
New Energy and Industrial Technology Development Organization (NEDO)
Sunshine 60, 29F
1-1, 3-Chome, Higashi-Ikebukuro
Toshima-ku, Tokyo, 170, Japan

Third Co-ordinator's Meeting/User Training Workshop

Road Town, Tortola
British Virgin Islands
24 - 28 June 1990

The Caribbean Energy Information System (CEIS) is a regional co-operative network for the exchange of information on energy and its use amongst Caribbean countries. CEIS started its operation in 1987. At present CEIS consists of twelve English speaking Caribbean countries, namely: Antigua & Barbuda, Barbados, British Virgin Islands, Guyana, Dominica, Grenada, Jamaica, Montserrat, St. Kitt-Nevis, St. Lucia, St. Vincent and Trinidad & Tobago.

Its main objective is to provide member countries with services which enable them to monitor developments in technologies and applications essential to programmes concerned with energy supply, conversion and use.

CEIS in collaboration with the International Development Research Centre, Canada; the Scientific Research Council, Jamaica; and the Documentation Centre, British Virgin Islands organized the Third Co-ordinator's Meeting/User Training Workshop at Road Town, Tortola, British Virgin Islands during 24-28 June 1990. Discussions at the meeting focused on:

- Main problem areas relating to the operations of the CEIS at the national level;
- Report of Liaison Officers of the National Focal Points relating to their contributions to the Regional Focal Point and impact of the system at the national level;
- Promotional plans for CEIS;
- Discussion on cooperative efforts; and
- Plan of activities for new Work Plan (1990-1991).

The participants of the meeting were the Liaison Officers from National and Regional Focal Points of the CEIS network; representatives from regional institutions, and international organizations and agencies

The Third International Conference on Practical Applications for Environmental and Energy Efficiency Management

Bangkok, Thailand
17-18 July 1990

The Conference will be organized by:

- The Energy Conservation Center of Thailand (ECCT);
- International Institute for Energy Conservation (IIEC);
- United Nations Environment Programme (UNEP);
- United Nations Development Programme (UNDP);
- Asian Institute of Technology (AIT);
- Office of National Environment Board (ONEB);
- King Mongkut's Institute of Technology Thonburi (KMITT);
- Chulalongkorn University (CU);
- Technology Transfers Center (TTC), Ministry of Science Technology and Energy; and
- Sitra Co., Ltd.

Objectives

The objectives of the conference are to:

- provide a forum for presentation of practical applications of technology which can help in saving some of the problems associated with energy and environmental impact in the local and global economy.
- bring together individuals working in energy and environmental areas to share experiences and ideas for future cooperation and success.
- discuss and recommend future directions and strategies in the Energy and Environmental sectors of Thailand.

Programme Contents

The Conference consists of: Common Session; Energy and Environment Sessions; Technology Application Sessions; and Panel Discussion. The details of each session are as follows.

Common Session

– Energy, Environment and Development by Dr. Amulya Reddy, Chairman/Department of Management Studies, Indian Institute of Science.

– Environmental Control – Necessary Evil or Challenge? by Mr. Curt Cederholm, World Environment Center.

– Energy and Environmental Situation in Thailand by Dr. Prida Wibulswas, Professor of Energy Technology, King Mongkut's Institute of Technology Thonburi.

Session A: Energy and Environment

– Water Resources Development Concerning Energy/Environment Impact by Dr. Charin Tongkasame, Manager, Pal Consultant Co., Ltd., Advisor to ECCT.

– Elimination of CFC's and Impact on the HVAC industry by Mrs. Rashanee Engpanyalert, Manager, Business Development, Jardine Matheson (Thailand) Ltd.

– Energy Efficiency: Least Cost Utility Planning by Mark J. Cherniack, Director, Asia Office, International Institute for Energy Conservation.

– A Case Study of Air Quality Legislation in Los Angeles, California by Mr. Dennis W. Lamb, World Environment Center.

– Cogeneration with Advanced Pollution Control by Mr. Jacques Matheron, Groupe CdF, French Coal Board.

Session B: Technology Application

– Computer-Assisted Design for Energy Efficiency in Buildings by Dr. Vladimir Bazjanac, University of California in Berkeley, USA.

– Building Automation and Energy Management by Mr. Ang Kim Poh, Residential Engineer, Vidhayakom Co., Ltd.

– EGAT Experience in Photovoltaics by Mr. Chaya Jivacate, Assistant Director, Thermal Power Plant Engineering Dept., Electricity Generating Authority of Thailand.

– Low NO_x Burner by Mr. Maurice Idoux, Director of Pillard, France.

– Energy Saving Motors and Motor Control Systems by Assoc. Prof. Gothom Arya, Faculty of Engineering, Chulalongkorn University and T.N. Incorporated Ltd.

– High Fuel Efficiency and Less Environment Impact in the Automobile Industry by Mr. Ron Endley, Managing Director, Swedish Motors.

– Shared Saving Scheme for Energy Efficiency by Mr. Claud E. Eley, President, Performance Management Group, USA, and Lemco Engineers Thailand, Ltd.

Panel Discussion

– Energy Efficiency in Thai-

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with a special interest in the area of information systems.

For more details regarding the meeting please contact:

Mrs. Mona Whyte
Project Manager, CEIS
Scientific Research Council
P.O. Box 350, Kingdom 6
Jamaica, W.I.
Tel: (809) 927-1779/71771-4
Fax: (809) 927-5347

VTT Symposium 107 Low-grade fuels, Vol. 1 and VTT Symposium 108 Low-grade fuels, Vol. 2

12-16 June 1989
Helsinki, Finland
Edited by
Maija korhonen
Technical Research Centre of Finland (VTT)
(Vuorimiehentie 5, SF-02150 Espoo, Finland)
1990, 2 Volumes
ISBN 951-38-3567-7; 382 p. : Vol. 1
ISBN 951-38-3568-5; 461 p.+Appendix: Vol. 2

Fuels such as lignite, peat, wood, industrial byproducts, waste, etc., are in many areas important local energy sources. However, they have often a high moisture or ash content or a difficult ash behaviour, which make them low-grade fuels, although their organic constituents may be of prime quality. Their significance varies greatly in different countries. In Finland, for example, the proportion of wood, wood waste and peat, which are the only indigenous fuels, is significant in supplying about 15% of the total energy consumption. Efficient improvement of the utilization technology and reduction of emissions to the environment are also crucial objectives of national energy research programmes of many countries.

This Symposium on Low-Grade Fuels was organized by the Technical Research Centre of Finland in cooperation with the Finnish Ministry of Trade and Industry. The occasion gathered together specialists from 19 countries, both from East and West, to exchange experiences and information about their low-grade fuels. The common goal was to minimize operational problems and environmental consequences of using these difficult fuels.

The programme consisted of an Introductory session and of technical sessions on Combustion of Low-Grade Fuels, Gasification of Low-Grade Fuels, Behaviour of Low-Grade Fuels during Handling, Ash Behaviour, and Environmental Aspects Related to the Utilization of Low-Grade Fuels. Poster presentations were also held.

Requests for purchase of the Proceedings of this VTT Symposium may be sent to:

Government Printing Centre
P.O. Box 516
SF-00101 Helsinki
Tel: +358-0-566-0266
Telex: 123458 Vapk sf
Fax: +358-0-566-0374

The Third International Conference on Practical Applications for Environmental and Energy Efficiency Management

From P. 13

land by Mr. Prapath Premmani, Secretary General of National Energy Administration.

– Energy Policy in the 7th Development Plan by Dr. Piyasvasti Amranand, Director of The National Energy Policy Office.

– Power Development Plan by Mr. Viroj Nopkhun, Director of Economic Policy Department, EGAT.

– Energy/Environmental Impact and Benefit by Dr. Dhira Phantumvanit, Director, Natural Resource and Environment, Thailand Development Research Institute Foundation (TDRI).

– Environmental Concerns and Issue by Mr. Pisit Na Patalung, Secretary General, Wildlife Fund Thailand.

Date and Venue

The Conference will be held from 17 to 18 July 1990 at Central Plaza Hotel, Bangkok, Thailand.

For more details contact:

The Energy Conservation Center of Thailand
c/o National Energy Administration
17 Rama I Road, Patumwan
Bangkok 10330, Thailand

SLEMA Journal

SLEMA Journal is published quarterly by the Sri Lanka Energy Managers Association. The topics of the articles published in SLEMA Journal are: energy planning and policy issues; energy efficiency, demand, management and conservation; renewable sources of energy; energy in transportation; energy substitution; and training and eduction on energy.

The March 1990 issue of SLEMA Journal contains the following main articles:

- Energy conservation in the tea industry of Sri Lanka by A. van der Knijff.
- Conversion factors in the energy balance.
- Sri Lanka energy balance 1987 (revised).
- Sri Lanka energy balance 1988.

For subscription and more information please write to:

Sri Lanka Energy Managers Association
Energy Unit
Ceylon Electricity Board
P.O. Box 540, Colombo, Sri Lanka

Publications Received

BIOMASS ENERGY

Biomass Combustion Technologies, REUR Technical Series 2, Arno Strehler (Ed.), CNRE Guideline No. 1, Food and Agriculture Organization of the United Nations, 1988, 88 p.+App.

Organic Recycling in Asia and the Pacific, Regional Office for Asia and the Pacific, Food and Agriculture Organization of the United Nations, RAPA Bulletin, Vol. 5, 1989, iii+66 p.

Liquid Fuels From Biomass, J.F. Molle (Ed.), Report and Proceedings of CNRE Technical Consultation, Saint-Remy-les-Chevreuse, France, 2-4 December 1988, CNRE Bulletin No. 20, Food and Agriculture Organization of the United Nations, 1988, 163 p.

Non-waste Technology, Volume 1, Maija Korhonen (Ed.), VTT Symposium 102, Technical Research Centre of Finland, Espoo, Finland, 1989, 457 p.

Non-waste Technology, Volume 2, Maija Korhonen (Ed.), VTT Symposium 103, Technical Research Centre of Finland, Espoo, Finland, 1989, 372 p.

Trace Elements Removal from Hot Flue Gases, Wahab Mojtahedi and Ulla-Maija Mroueh, Technical Research Centre of Finland, Research Report 663, Espoo, Finland, 1989, 57 p.+App.

The Status of Liquefied Natural Gas Worldwide, Kay McKeough, Industry and Energy Department Working Paper, Energy Series Paper No. 25, The World Bank Industry and Energy Department, PRS, Washington D.C., USA, March 1990, 21 p.

Population Growth, Wood Fuels, and Resource Problems in Sub-Saharan Africa, Douglas F. Barnes, Industry and Energy Department Working Paper, Energy Series Paper No. 26, The World Bank Industry and Energy Department, PRS, Washington D.C., USA, March 1990, 16 p.

ENERGY

Development of European Agricultural Energy Data Bank, REUR: CNRE/REIS/89, Final Draft, European Cooperative Networks on Rural Energy (CNRE) and Rural Energy Information Systems (REIS), Food and Agriculture Organization of the United Nations, April 1989, 37 p.

Development of European Agricultural Energy Data Bank: Appendicies, REUR:CNRE/REIS/89 Appendicies, Final Draft, European Cooperative Networks on Rural Energy (CNRE) and Rural Energy Information Systems (REIS), Food and Agriculture Organization of the United Nations, April 1989, 61 p.

Low-grade Fuels, Volume 1, Maija Korhonen (Ed.), VTT Symposium 107, Technical Research Centre of Finland, Espoo, Finland, 1990, 382 p.

Low-grade Fuels, Volume 2, Maija Korhonen (Ed.), VTT Symposium 108, Technical Research Centre of Finland, Espoo, Finland, 1990, 461 p.+App.

Properties of Acoustic Energy Quantities, Seppo Uosukainen, Technical Research Centre of Finland, Research Report 656, Espoo, Finland, 1989, 222 p.+App.

Capital Expenditures for Electric Power in the Developing Countries in the 1990s, Edwin A. Moore and George Smith, Industry and Energy Department Working Paper, Energy Series Paper No. 21, The World Bank Industry and Energy Department, PPR, Washington D.C., USA, February 1990, vii+108 p.

A Review of Regulation of the Power Sectors in the Developing Countries, Peter A. Cordukes, Industry and Energy Department Working Paper, Energy Series Paper No. 22, The World Bank Industry and Energy Department, PPR, Washington D.C., USA, February 1990, 170 p.

Summary Data Sheets of 1987 Power and Commercial Energy Statistics for 100 Developing Countries, Jose R. Escay, Industry and Energy Department Working Paper, Energy Series Paper No. 23, The World Bank Industry and Energy Department, PRE, Washington D.C., USA, March 1990, vi+102 p.+Annex.

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AT source

1990

The quarterly magazine AT-Source publishes articles in the field of appropriate technology in order to help local organizations in the Third World.

The June-special issue of AT-Source focuses on the environment in developing countries. Two aspects of the environmental issue are examined in particular: degradation of the Sahel and urban waste. There is a special emphasis on participation and environmental protection.

AT-Source identifies practical initiatives for participatory environmental management that can be adopted by local organizations. With regard to desertification, the planting of trees with the help of water harvesting techniques and the application of wind-breaks is suggested. The collection of waste, organized by women, the improvement of the latrine emptying service and the management of the sanitation service in large cities with slums is dealt with in the section on urban waste.

An extensive list of references and recommended literature is provided.

AT-Source is published both in English and French. Information and a free issue can be obtained from:

Editorial staff AT-Source
P.O. Box 41
6700 AA Wageningen
The Netherlands

2nd AIT-WHO Training Course on Solar Refrigerators Repair and Maintenance

4-15 February, 1991
Asian Institute of Technology
Bangkok, Thailand

The 2nd AIT-WHO Training Course on Solar Refrigerators Repair and Maintenance will be organized by the Division of Energy Technology, Asian Institute of Technology (AIT), in collaboration with EPI of WHO-SEARO and WHO-HQ.

Aim of the Course and Methodology

The course aims to increase the number of suitably trained repair and maintenance technicians capable of installing and keeping the solar powered refrigerators in good working order. Rapid expansion of the cold chain infrastructure including the use of solar refrigerators necessitates the training of more cold chain technicians. The course follows the EPI scheduled programme of instructions and training materials which is particularly orientated for hands-on experience.

Language

The language of the course is English. The candidates should have ability to understand, speak and write English language.

Application

The number of participants is limited to 20. Applications using pre-registration form should reach AIT **not later than 30 November 1990.** Acceptance will be on **first come first served** basis, hence, candidates should send applications as soon as possible.

Date and Venue

The course will be held from 4 to 15 February 1991 at the Division of Energy Technology of AIT.

Candidates/sponsors interested in the course should ask for more details from:

Dr. Supachart C.
Division of Energy Technology
Asian Institute of Technology
G.P.O. Box 2754, Bangkok 10501
Thailand
Fax: (662) 529 0374

2nd AIT-WHO Training Course on Solar Refrigerators Repair and Maintenance
Asian Institute of Technology
Bangkok, Thailand
4-15 February, 1991

PRE–REGISTRATION FORM

Name: _____ Sex: _____
(Surname/Family Name) (Other Names)

Employer's Name: _____
& Address (if any)

_____ _____ _____
Telex Fax Telephone

Candidate's Position: _____

Sponsoring Agency: _____
(if applicable)

Place & date of birth: _____

Nationality: _____ Passport No.: _____

Date of issue: _____ Place of issue: _____ Expiry date: _____

Education: _____

Compression Refrigeration Training Course Attended (date, place):

_____

Experience of repairing refrigerators (in Years): _____

NOTE: *Accommodation and full boarding (breakfast, lunch and dinner) cost at AIT is US$35 per day which is optional.*

Date: _____ Place: _____ Signature: _____

NOTE: Application to reach Dr. Supachart C., AIT before 30 November 1990.

Diary of Events

- **July 9-13, 1990, London, United Kingdom**

Principles of Wind Energy Conversion

A short course for engineers and scientists new to the interdisciplinary field of wind energy technology or experts in only one area of the field seeking *inter alia*:

– a practical grounding in the fundamentals of mathematics, aerodynamics, mechanics, control, eletricity and materials involved in the design and development of wind energy technology;

– an update on new and prospective developments in the WECS field.

For more information contact:
Pamela Manser
Continuing Education Centre
321 Sherfield
Imperial College
London SW7 2AZ
United Kingdom
Tel: +71-225-8667
Fax: +71-225-8668
Telex: 929484

- **July 22-25, 1990, Denver, USA**

5th Pacific Rim Coal Conference

For more information contact:
5th Pacific Rim Coal Conference
P.O.Box 454
E. Brunswick, NJ 08816
USA

- **July 22-26, 1990, Honolulu/ Waikoloa, Hawaii**

Hawaii Hydrogen 90: 8th World Hydrogen Energy Conference

For more information contact:
Hawaii Hydrogen 90
Hawaii Natural Energy Institute
2540 Dole Street
Holmes Hall 246
Honolulu, HI 96822
USA
Tel: (808) 948-8890
Telex: 6502782483 MCI
Fax: (808) 946-4235

- **July 22-27, 1990, Honolulu, USA**

8th World Hydrogen Energy Conference

For more information contact:
Mary Kamiya
Conference Coordinator
Hawaii Natural Energy Institute
University of Hawaii
2540 Dole St
Holmes Hall 246
Honolulu, HI 96822
USA

- **July 23 - August 3, 1990, Honolulu, Hawaii, USA**

5th Circum -Pacific Energy and Mineral Resources Conference

For more information contact:
Timothy Lauer
Unocal International Oil & Gas Division
P.O.Box 7600
Los Angeles, CA 90051
USA
Tel: (213) 977-7253

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Publications Received

From P. 15

Energy Performance of Buildings: Validation of Softwares and Case Studies, Jean Pierre Traisnel, Brahmanand Mohanty, and Qaisar T. Asmad, AFME-AIT Contract No. 8.09.0039, Asian Institute of Technology, Division of Energy Technology, Bangkok, Thailand, February 1990, 60 p.

A Review of the Treatment of Environmental Aspects of Bank Energy Projects, David Butcher, Industry and Energy Department Working Paper, Energy Series Paper No. 24, The World Bank Industry and Energy Department, PRE, Washington D.C., USA, March 1990, ii+50 p.

ENERGY CONSERVATION

Energy Conservation and Renewable Energies for Greenhouse Heating, REUR Technical Series 3, Christian von Zabeltitz (Ed.), CNRE Guideline No. 2, Food and Agriculture Organization of the United Nations, 1988, 167 p.

SOLAR ENERGY

Solar Drying of Agricultural Products, W. Muhlbauer (Ed.), Proceedings of CNRE Technical Meeting, Stuttgart, Federal Republic of Germany, 9-11 September 1987, CNRE Bulletin No. 19, Food and Agriculture Organization of the United Nations, 1988, 149 p.

Utilization of Solar and Geothermal Energy for Heating Greenhouses, Chr. von Zabeltitz and K. Popovski (Eds.), Report and Proceedings of Joint CNRE Workshop, Adana, Turkey, 11-14 April 1988, CNRE Bulletin No. 20, Food and Agriculture Organization of the United Nations, 1988, 143 p.

Solar Water Heating Systems for Rural Areas, S. Kyritsis (Ed.), Report and Proceedings of CNRE Workshop, Naxos, Greece, 1-3 June 1988, CNRE Bulletin No. 22, Food and Agriculture Organization of the United Nations, 1988, 138 p.

Energy Design in Buildings: Passive Solar Energy Low-cost House, N.J. Monerasinghe and Jean Pierre Traisnel, AFME-AIT Contract No. 8.09.0039, Asian Institute of Technology, Division of Energy Technology, Bangkok, Thailand, February 1990, 41 p.

GEOTHERMAL ENERGY

Geothermal Energy Resources and Their Use in European Agriculture, REUR Technical Series 4, K. Popovski (Ed.), CNRE Study No. 2, Food and Agriculture Organization of the United Nations, 1988, 110 p.

Diary of Events

From P. 17

- **July 28-31, 1990, Minneapolis, USA**

27th National Heat Transfer Conference

For more information contact:
American Institute of Chemical Engineers
345 E.47th Street
New York, NY 10017
USA

- **August 9-10, Denver, USA**

Course on Oil and Gas Property Evaluation

For more information contact:
AAPG Education Department
P.O.Box 979
Tulsa, OK 74101-0979
USA
Tel: (918) 584-2555

- **August 19-23, 1990, Denver, USA**

World Congress of the International Solar Energy Society

For more information contact:
American Solar Energy Society
2400 Central Avenue
Suite B1
Boulder, CO 80301
USA
Tel: 303-443-3130

- **August 19-25, 1990, Jerusalem, Israel**

Workshop on Utilization of Solar and Renewable Energy for Agriculture

For more information contact:
K. Kocsis
FAO/CNRE
Via delle Terme di Caracalla
00100 Rome
Italy
Tel: 57871

- **August 20-24, 1990, Kailua Kona, USA**

Annual Meeting of the Geothermal Resources Council and International Symposium on Geothermal Energy

For more information contact:
GRC
P.O.Box 1350
Davis, CA 95617
USA

- **August 23-24, 1990, Bergen Norway**

Conference on Market-Based Energy Planning for Developing Countries

For more information contact:
SAF Center for Applied Research
Norwegian School of Economics and Business Administration
Breviken 2
5035 Bergen
Sandviken
Norway
Tel: 47-5-959500
Telex: 40642 NHHN
Fax: 47-5-258874

- **September 2-20, 1990**

Workshop on Materials Science and Physics of Non-Conventional Energy Sources

For more information contact:
International Centre for Theoretical Physics
P.O.Box 586
34100 Trieste
Italy
Cable: CENTRATOM TRIESTE

- **September 10-11, 1990, London, United Kingdom**

1st International Conference: Minimum Facilities Approach to Oil and Gas Production

For more information contact:
Nadia Ellis
IBC Technical Services
Bath House
3rd Floor
56 Holborn Viaduct
London EC1A 2EX
United Kingdom
Tel: (01) 236-4080
Telex: 888870
Fax: (01) 489-0849

- **September 10-12, 1990, Chester, United Kingdom**

Automotive Power Systems, Environment and Conservation

For more information contact:
P.M. Thomas
Automobile Division
Institution of Mechanical Engineers
1 Birdcage Walk
London SW1H 9JJ
United Kingdom
Tel: (01) 222-7899
Fax: (01) 222-9881

- **September 10-14, 1990, Madrid, Spain**

1990 European Community Wind Energy Conference and Exhibition

For more information contact:
H.S. Stephens & Associates
Conference Organizers
Agriculture House
55 Goldington Rd.
Bedford MK40 3LS
Spain

- **September 11-14, 1990, Arles, France**

2nd European Conference on the Mathematics of Oil Recovery

For more information contact:
Yolande Rondot
Institute Fraçnais du Pétrole
P.O.Box 311
92506 Rueil-Malmaison Cedex
France
Tel: 47-49-02-14
Telex: IFPA 203050 F
Fax: 47-49-04-11

- **September 17, 1990, London, United Kingdom**

Energy Policy Seminar No.3

For more information contact:
British Institute of Energy Economics
9 St. James's Square
London SW1Y 4LE
United Kingdom

- **September 18-21, 1990, Munich, West Germany**

International Conference on Applications and Efficiency of Heat Pump Systems in Environmentally Sensitive Times

For more information contact:
BHRA
Fluid Engineering Centre
Cranfield
Bedford MK43 OAJ
United Kingdom
Tel: 0234-750422
Telex: 825059 BHRA G
Fax: 0234-750074

- **September 19-21, 1990, Reading, United Kingdom**

NORTHSUN '90

The conference is organised by World Renewable Energy Organization and UK-ISES. The topics of the conference are utilization, evaluation, and application of solar system at high latitudes.

Special emphasis will be placed on passive building design and energy conservation in high latitudes.

For more details contact:
Prof. A.A.M. Sayigh
WREC, Dept of Engineering
University of Reading
Whiteknights, P.O. Box 225
Reading RG62AY, UK
Tel: (0734) 318588
Telex: 847813 RULIB G
Fax: (0734) 313835

- **September 23-28, 1990, Reading, United Kingdom**

World Renewable Energy Congress

The topics to be covered by the congress are: Photovoltaics; Solar Thermal; Material Science; Wind Energy; Biomass; Passive and Low Energy Architecture; and Climatology, Meteorology and Related Topics (including Geothermal, Wave and Tidal, Ocean Thermal Energies, Minihydro and Hydrogen Production).

For more details contact:
Prof. A.A.M. Sayigh
Chairman of the Congress
Department of Engineering
University of Reading
Whiteknights
P.O. Box 225
Reading RG6 2AY, UK
Tel: (0734) 318588
Telex: 847813 RULIB G
Fax: (0734) 31383

- **September 25-28, 1990, Washington, D.C., USA**

WINDPOWER '90 : CLEAN ENERGY FOR A NEW DECADE

Windpower'90 is sponsored by the American Wind Energy Association. The topics of the conference are: wind characteristics; technology research and development/manufacturing; windfarms/operations and maintenance; applications; national programs; and energy policy.

For more information contact:
AWEA
1730 N. Lynn St., #610
Arlington, VA 22209 USA
Tel: 703-276-8334
Telex: 6503304640 MCI UW

- **September 27-28, 1990, Turin, Italy**

Seminar on Efficient Solar Thermal Systems in Buildings Design and Operation

For more information contact:
Mr. R. Gardner
CEC, DG XVII/D/1
200, rue de la loi
B-1049, Brussels
Belgium
Tel: (32) 2 235 96 33
Telex: 21877 COMEUR B
Fax: (32) 2 235 01 50

- **September 30- October 4, 1990, St. Louis, USA**

Industrial Power Conference

For more information contact:
Gemma Tansey
ASME
345 East 47th St.
New York, NY 10017
USA
Tel: 358-0-4513580
Telex: 125161 htkk sf
Fax: 358-0-4513419

- **October 1-4, 1990, Belo Horizonte, Minas Gerais, Brazil**

The First International Conference on Power Distribution

IEEE-Brazil Council, IEEE-Rio de Janeiro Section and the CODI - Brazilian Distribution Committee will organize the First International Conference on Power Distribution.

The Conference will provide a forum to share information on all aspects in the field of Power Distribution. Particular emphasis will be given in the techincal program to emerging technologies and methodologies aiming at cost reduction, better service quality and safety increase.

For more information contact:
Carlos Augusto Leite Brandão
ISIDEE Organizing Committee Chairman
Companhia Energética de Minas Gerais - CEMIG
Divisão de Engenharia de Operação e Manutenção da Distribuicão
Av. Barbacena, 1200 - 16° andar - Ala Al
Belo Horizonte - 30161 - Minas Gerais - Brazil
Tel: (031) 349-2623
Telex: 311124-311268-311439-391273 e 391846
Fax: (031) 3494691

- **October 1-5, 1990, Kuala Lumpur, Malaysia**

Fourth International Conference on Small Hydro

The conference is organised by Water Power & Dam Construction. The themes of the conference are: Assessing the real needs of developing countries; International co-operation; Implementing technology transfer and training; Environmental impact studies; Site selection and feasibility studies; Problems of remote sites; Low cost civil works; Small and micro hydro machinery; Using indigenous technology and materials; Standardization of machinery and construction.

For more information contact:
Ms Lindsey Maskell
Conference Assistant

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Diary of Events

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Water Power & Dam Construction
Quadrant House
The Quadrant, Sutton
Surrey SM2 4AS
United Kingdom

- **October 5-8, 1990, Wuhan, China**

First International Conference on Energy Conversion and Energy Sources Engineering

The First International Conference on Energy Conversion and Energy Sources Engineering will be held at Huazhong University of Science and Technology, located in Wuhan, China.

For more details contact:
Prof. Chongqi Wang
Dept. of Power Engineering
Huazhong University of Science and Technology
Wuhan, China

- **Otober 7-8, 1990, Caserta, Italy**

Solar Energy and Hydrogen

For more infomation contact:
Academician Emilio O.Vicario
Segretaria Organizzativa della Sezione Italiana dell' IAHE
Aven Luigi Settembrini
NR6
81100 Caserta
Italy
Tel: 0823-327222

- **October 9-12, 1990, Frankfurt am Main, West Germany**

7th International Solar Forum: Relational Use of Energy and Renewable Resources of Energy in Regional and Municipal Domains

For more information contact:
Deutsche Gesellschaft für Sonnenergie e.V.
Augustenstrasse 79
8000 München 2
West Germany

- **October 10-12, 1990, Atlanta, USA**

13th Energy Engineering World Congress

For more information contact:
Association of Energy Engineers
Suite 340
4025 Pleasantdale Road
Atlanta, GA 30340
USA

- **October 21-23, 1990, Banff, Canada**

Canadian Wind Ernergy Conference'90

Leading companies and organizations active in renewable energy, suppliers of equipment for electrical generation, and leading environmental organizations will be exhibiting their latest information products and services.

For more information contact:
Nancy Phillips
Conference Coordinator
Passmore Associates International
23 Rockwood Street
Ottawa, Ontario K1N 8L8
Canada
Tel: (613) 234-3602
Fax: (613) 234-089

- **November 11-14, 1990, Belo Horizonte, Brazil**

First International Conference on Power Distribution

For further information contact:
PERFIL-Assessoria Empresarial Ltda.
Rua Henrique Shaumann, 286-conj. 21
05413-Sao Paulo
Sao Paulo-Brazil
Tel: (0055) 011-853-7511
Fax: (0055) 011-853-7799
Telex: 11-833499 PFLA BR
or
Belo Horizonte
Av. Afonso Pena, 3924-conj. 710
30130-Belo Horizonte-MG
Brazil
Tel: (0055) 031-225-0922
Telex: 392413 PFLA BR

- **November 26-28, 1990, Phoenix, USA**

Fuel Cell Seminar

For more information contact:
Ann Beightol
655, 15th St. N.W.
Suite 300
Washington, D.C. 20005
USA

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Library and Regional Documentation Center, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The "RERIC News" is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership along with the other four regular publications namely: RERIC International Energy Journal (formerly: Renewable Energy Review Journal); RERIC Holdings List; Abstracts of AIT Reports and Publications on Energy; and RERIC Membership Directory. For further details contact:

Regional Energy Resources Information Center
Asian Institute of Technology
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Bangkok 10501, Thailand
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Fax (66-2) 5290374

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Vol. 13 No. 3 September 1990

Training Course on Solar Refrigerator Repair & Maintenance

During 9-20 July 1990, a total of 15 participants coming from Bhutan, Tuvalu, India, Indonesia, Kiribati, Laos, Maldives, Nepal, Sri Lanka and Thailand, were trained in the installation, maintenance and repair of PV powered refrigerators at the facility set up in the Energy Park of the Energy Technology (ET) Division of Asian Institute of Technology (AIT), Bangkok. The course consisted of lectures, demonstrations and extensive hands-on exercises.

Solar powered refrigerators have been increasingly used for storing vaccines in rural dispensaries located in areas where electricity grids are not available. However, satisfactory implementation and operation of such a facility required technicians fully trained in installation, maintenance and repair to ensure proper techno-

logical and logistic management of the refrigerators. To achieve this goal in South East Asia and the West Pacific, the Expanded Programme on Immunization (EPI) of the World Health Organization (WHO) recognized the need to establish a training center for solar power refrigeration. The Asian Institute of Technology (AIT), which was approved by WHO as a regional testing institution for refrigerators, was finally selected as the location for the center. WHO agreed in principle to help AIT to develop the activities at the start of this project (marked by the above training programme) with the aim of making the center self-sustaining in running future training courses. The July programme was organized by the ET Division of AIT in collaboration with EPI of WHO-SEARO and WHO-HQ and followed the EPI schedule programme of instructions and training materials which is particularly oriented towards hands-on experience.

A course evaluation was conducted by asking participants to complete a questionnaire. The results showed that the course was well appreciated; some of those who had participated in other overseas courses rated this course as "very good" and

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INNERTAP

Incorporates news from the Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

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Small Greek Island Gets Warmer Life with Solar Energy Plant

The Greek island of Gavdos, a five-square-mile triangle covered with juniper bushes, is the only place in Europe to rely completely on solar energy all year round.

A photovoltaic power plant set up by Siemens of West Germany in co-operation with the state-owned Public Power Corporation (PPC) produces 20 kilowatts at peak operating periods, supplying the 60 islanders with electricity for lighting, refrigerators, televisions and a telephone network.

Although the PPC is committed to electrifying all inhabited Greek islands, Gavdos remained a low priority. It lies in the Libyan Sea, 24 miles south of Crete, and is often cut off in stormy weather. Its population was diminishing steadily as families moved away.

However, since the photovoltaic plants started up in 1987, migration has halted and a small summer flow of tourists is gradually increasing.

The central generator, which serves two small villages, consists of 160 solar modules arranged in eight parallel rows on a south-facing hillside. Another six isolated homes are equipped with independent solar panels. Among them are the island's two taverns, each with a 700-watt peak output, enough to keep tourists supplied with cold drinks.

The 144 circular solar cells, which convert sunlight directly into electricity, are made of monocrystalline silicon sliced to a thickness of half a millimetre. They have a 10 cm diameter and an output of 130 watts each. Mounted on the modules beneath highly transparent tempered glass, their expected lifespan is about 10 years.

A derelict windmill was restored to house a specially designed four-quadrant solar inverter to convert direct to alternating current for operating low-consumption domestic appliances. It is claimed to be 90% efficient. A small computer monitors the system, transferring information automatically to a floppy disc which is sent to Athens every month for the PPC to analyze.

Lead-acid storage batteries are housed in an adjoining dry stone building similar to the islander's houses. The 250 units can store a five-day power supply, the maximum length of time that Gavdos, the southernmost point of Europe, is likely to be without sunshine.

The plant, designed by a Greek architect who specializes in solar projects, was constructed with a view to fitting in with the landscape. It cost US$432,000, one third of which was covered by the European Community.

Once the central generator started each family was presented with a refrigerator, television and lighting fixtures designed to consume at least 50% less energy than the usual household appliances. The 11-watt light bulbs burn as brightly as a normal 75-watt bulb, while the television uses 38 instead of 120 watts and the refrigerator 70 instead of 150.

An islander checks the plant every week and a PPC technician visits occasionally to regulate the batteries. Short circuits in the grid caused problems at first, but last winter the power supply was maintained without a break.

Other remote regions of Greece are unlikely to become fully dependent on photovoltaics, however. The limitations are already clear on Gavdos, for there is not enough power available for appliances like cookers, washing-machines and air-conditioners which consume larger amounts of electricity.

Expanding the solar generator would be costly since expensive monocrystalline cells are still preferred for large-scale power generation. Solar cells made from amorphous silicon, which is thinner, less pure and considerably cheaper, are widely used for calculators and watches but it will be some time before they can replace the sturdier, more light-absorbent monocrystalline variety.

The PPC wants to put a wind generator on Gavdos. "Wind is the obvious way to meet increasing demand. It's cheaper than photovoltaics in Greece, and it's complementary because it's abundant in the winter," says George Betzios of the PPC's alternative energy department.

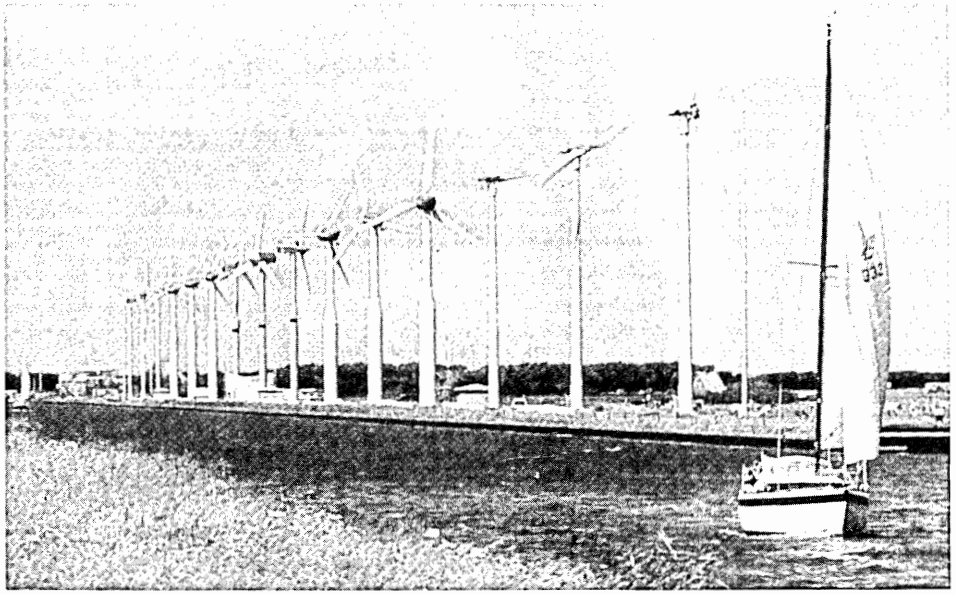
A pilot wind-solar project by Siemens and the PPC on the island of Kythnos, near Athens, has proved successful. Five 35 kW wind generators and a large photovoltaic unit peak output of 100 kW both feed into the local grid, backing up a diesel-powered system serving 2,000 residents.

The most cost-effective use for photovoltaics in Greece may be for the more than 1,000 lighthouses and beacons scattered around the mainland coast and the islands. A demonstration project by Siemens at the Sapientza light-house in south-western Greece, on the main sea lane from the Aegean to the western Mediterranean, mixes photovoltaics and a small wind generator to operate a rotating flashing light.

A new rotary beacon, powered by 10 solar modules with peak output of 1.3 kW, replaced an old oil-fired beacon and a rotation mechanism that had to be rewound manually every two hours by the lighthouse keepers. The storage batteries can keep the lighthouse operating for 12 sunless days. It is now unmanned: a digisponder monitors the system and automatically telephones the local coastguard if something goes wrong.

(Source: *Bangkok Post*, 28 August, 1990.)

250 MW Wind Programme in Holland



Previous stage: Utility testing of wind energy included this project of 15 machines which compared five different designs.

The first week of September 1990 marks the beginning of a new era for wind power in Holland. If no unexpected delays occur, the directors of the semi-public electricity distribution companies are endorsing a joint agreement for the installation of 250 MW of wind power capacity by 1995. The utility initiative is in addition to the government sponsored research and market stimulation programmes in Holland and will more than double the growth rate of wind power development in a country which already ranks third in Europe. Only in Denmark and Germany are turbines going up faster.

For the Dutch wind industry the utilities' 250 MW programme also marks a shift of emphasis away from government control of the wind market and towards a situation where the electric utility companies have chosen to reassume responsibility for the development of generating capacity, including wind power plant. Until now, the electricity sector in Europe has been slow in accepting wind energy as a viable means of power generation and it has been left to government to force development.

The 250 MW goal for wind power is just one part of the Dutch utility sector's far-sighted National Environmental Policy Plan (NMP) which pivots on an intricate system of favoring electricity generation technologies in proportion to the amount of pollution they prevent. The announcement of the scheme in February has had both the wind power industry and energy policy makers busy all summer long. In the package about to be ratified is a call for tenders which will not only open up prospects of a stable market over the coming years for Dutch wind turbine manufacturers, but also provides for a fair chance for foreign suppliers to contribute to Holland's wind power development. In addition, the government ministry responsible for both physical planning and environment matters has made provision for the setting up of wind turbine zones, where building code red tape will be kept to a minimum.

Both power producers and power distributors had launched impressive emission reduction programmes even before the advent of the environmental plan and its ambitious targets: ten and 20 percent reductions in energy consumption, compared with what otherwise would have been used, by 1995 and 2000 respectively.

The plan, to be financed eventually by consumers and taxpayers, requires government spending on management of the environment to be increased from NLG 7.7 billion to NLG 18 billion (US$9 billion) in 1994. It is estimated that NLG 600 billion will be budgeted for energy conservation, double the present amount. The country's goal is to stem the growth of CO_2 emission so that the 1994 level will be the same as what it was in 1989, 182 million tonnes. By the end of this century the aim is to reduce this figure to around 175 million tonnes a year.

The various pollution saving measures proposed so far have each been ranked according to the amount of CO_2 emission saved per guilder invested. At NLG 126 per tonne, wind energy works out as being more expensive than all but one of the eleven alternatives. Small and medium scale co-generation, for example, ranges from NLG 32-51 per tonne. However, because of wind power's total absence of acidifying emissions (SO_2 and NO_x) it receives preferential treatment. The A-MAP target is for the installation of 250 MW using wind turbines of proven technology (250-500 kW) before 1995. Then, the target is 1000 MW before the end of the century using larger machines. Up to 1995 total investment is estimated at NLG 600 million, but it is as yet unclear which share the utilities are willing to assume of the "uneconomical costs" once they have accounted for the savings made in avoided power purchases.

It remains important to remember that the utility sector's NMP programme is in addition to the government's market stimulation programme for wind power. Over the past five years this has cost each person in Holland about three dollars. This level of funding will continue during the next five years, with NLG 12.5 million set aside for research, NLG 2 million for public promotion of wind power and NLG 30 million for market stimulation.

(Source: Pens Poised for a New Era of Environmental Caretaking, by Jos van Beek, *Windpower Monthly*, September 1990, pp.16-17.)

US Utility Interest in Wind Grows

Florida Power & Light (FP&L), Pacific Gas & Electric (PG&E) and Green Mountain Power are investing and researching in wind technology.

PG&E, the Electric Power Research Institute and U.S. Windpower began a US$20 million joint venture last year to build a new wind turbine specifically for the utility market. As significant as PG&E's commitment may be to wind industry morale, utilities invested more in wind hardware than in research during 1989. More of the same is expected for this year.

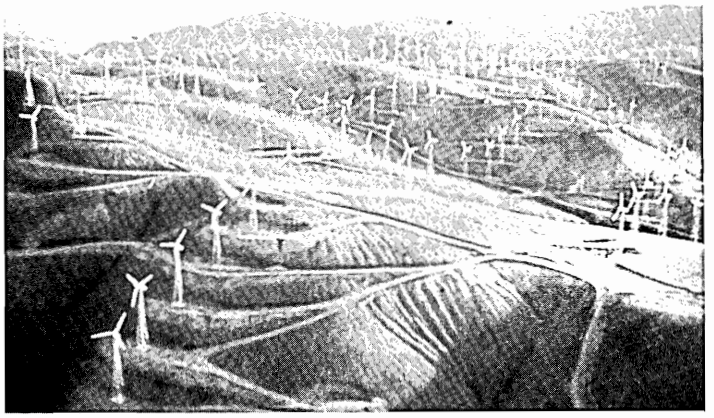
Through its unregulated subsidiary, ESI Energy, FP&L Group has taken an equity position in all but two of the wind projects installed last year – nearly 180 MW of California wind generation, some in PG&E's backyard. The FP&L affiliate was not the first utility affiliate to invest in windpower. Energy National (now a division of Pacific Generation Co., a subsidiary of PacifiCorp) blazed the trail when it participated in a US$60 million U.S. Windpower project in 1987. Also, HydraCo, a subsidiary of Niagara Mohawk, participated in another U.S. Windpower project worth US$36 million during 1988. Nor was ESI Energy alone. Both Green Mountain Power and Iowa Illinois Gas & Electric Co. entered the field last year.

Within one year ESI Energy became one of the wind industry's major players, taking an equity position in a 72 MW transaction with U.S. Windpower in Northern California and an 85 MW project with SeaWest in southern California.

As an affiliate of one of the United States' top five investor-owned utilities, ESI Energy is a force to be reckoned with. By the beginning of 1990, ESI Energy had participated in small power and cogeneration projects having a combined capacity of 1,000 MW, according to Larry Carpenter, ESI Energy vice president. This puts ESI Energy in the same category as Mission Energy, an affiliate of Southern California Edison.

Like Mission, ESI Energy has invested in several technologies: solar, geothermal and waste-to-energy plants. But, unlike Mission, ESI Energy has invested in windpower. ESI Energy believes it can better position itself in the market because of its ability to separate the true risk of a wind project from the perception that wind projects are riskier than most. Wind now accounts for 10 percent of ESI Energy's investments.

Wind technology has become more reliable with experience. According to Kirk Casselman, an investment adviser to Iowa-Illinois Gas & Electric Co., wind is certainly a safer investment today than it was just three years ago. Through its subsidiary, Iowa-Illinois Investment Co., the utility is also seeking to develop projects that produce better-than-average yields.



Zond Systems' Victory Garden, Tehachapi Mountains, California, USA.

Mountain Energy, a subsidiary of Vermont's Green Mountain Power, dipped its feet in the unregulated field late last year when the utility bought a small equity interest in U.S. Windpower's 72 MW project in northern California. Like the other utility subsidiaries, Mountain Energy will not limit itself to wind, but they are going to stick with energy because they are familiar with the risks and opportunities, according to Jonathan Winer, Mountain Energy vice president.

Biggest Project Since 1985

The ability to evaluate risk led ESI Energy not just to the U.S. Windpower projects in the Altamont Pass and Solano County, but also to Tehachapi, California. The company invested in Zond Systems' 22 MW, US$29 million project and the massive US$153 million SeaWest project – the largest single wind project, and one of the more costly, since the energy tax credits expired in 1985.

Financing for the project was raised primarily on the warranty package provided by the large Japanese manufacturer, Mitsubishi, and also on investment tax credits remaining after the 1986 Tax Reform Act. But above all, the warranty on the relatively untested new turbine – among the largest in commercial service worldwide – made the project possible.

Mitsubishi has built 57 smaller versions of the 250 kilowatt turbine. Twenty Mitsubishi turbines on the SeaWest site near Tehachapi turned in a respectable performance during 1988, producing 990 kilowatt hours (kWh) per square metre of rotor area. (However, the company's 37 turbines installed on the Big Island of Hawaii have reportedly operated poorly.) With the performance of the Tehachapi turbines as a gauge, the larger, 28-metre, turbines should be able to generate 620,000 kWh per unit or about 200 million kWh per year for the entire project. Mitsubishi warranted the machines for 10 years, and will make up the difference if generation falls below projections due to failure of the turbines.

(Source: Utility Interest in Wind Grows, by Paul Gipe, *Independent Energy*, July/August 1990, pp.68-69.)

Million Dollar Loan from ADB for Mae Moh Power Transmission Project in Thailand

On 5th June 1990 the Asian Development Bank (ADB) approved a loan of the equivalent of US$48.8 million to help the Electricity Generating Authority of Thailand (EGAT). The project will reinforce EGAT's power supplies in the central and northeastern areas of Thailand as well as in and around Bangkok. The borrower of the loan will be EGAT, with the Kingdom of Thailand as the guarantor. The Bank loan will finance a part of the foreign exchange component of the estimated total project cost of US$210 million. The loan is the Bank's 54th for the Kingdom of Thailand and its 19th for the country's power subsector. Seven of the 12 earlier loans to EGAT have also supported Mae Moh development.

The Project, called Transmission System for Mae Moh Power (Units 10 and 11), is designed to erect a 333 km, 500 kV double-circuit line from Mae Moh in the north to Tha Tako in central Thailand to transmit the electric power generated at the two 300 MW lignite-fired units now under construction. It will also involve the expansion of the substations at Mae Moh, Tha Tako and Nong Chok (Bangkok). Mae Moh Units 10 and 11 are part of the Government's strategy to utilize lignite to develop indigenous energy supplies. Nine lignite-fired units are already installed at Mae Moh – some of them have been in operation for years – with a total capacity of 1,425 MW. Units 10 and 11 will add another 600 MW by mid-1992.

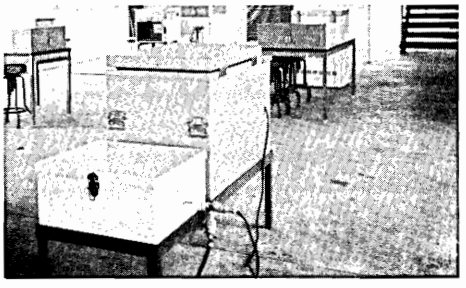
Under EGAT's current power development plan, Thailand's total power generation capacity is to be increased from about 7,760 MW as of May 1990 to about 18,630 MW in FY2001 to meet future demand, which is projected to grow at an average annual rate of about 9 percent in the 1990s. Projects under construction will add about 3,665 MW by mid-1993. The major thrust of development during the decade will be continued exploitation of lignite, gas and hydro resources.

For detailed information about the project, please contact:

Electricity Generating Authority of Thailand (EGAT)
Bang Kruai, Nonthaburi 11130
Thailand

(Source: Extracted from "*ADB News Release*" No. 79/90, 5 June 1990.)

Training Course on Solar Refrigerator Repair & Maintenance
From P. 1



"excellent". The tasks which the participants found to be most useful and interesting were those concerning solar photovoltaic topics which were new to them as well as those regarding the systematic searching for faults based on symptoms found. Tasks like cleanings of PV array and refrigerator were cited to be least interesting; however, they are essential to the system performance and should not be neglected.

Further details about the training course are available in "Report on Training Course on Solar Refrigerator Repair & Maintenance", 9-20 July 1990, Energy Technology Division, Asian Institute of Technology, Bangkok, 1990, 12 p.+App.

ASEAN Gas Pipeline Project

There is sufficient negotiating activity within the ASEAN Groups to indicate that the key players – Thailand, Singapore, Malaysia and Indonesia – are taking seriously the proposed ASEAN gas pipeline project that would provide a gas transmission link between all six Southeast Asian nations.

The Trans-ASEAN Pipeline (TAPL), currently being masterminded by a French-Italian consultancy, would run at least 6,000 km and would establish a gas grid linking Bangkok with Kuala Lumpur via an offshore link between the Thai capital and peninsular Malaysia. The gas pipeline would then run overland, with one branch running offshore across the Straits of Malacca to Sumatra and the other staying on land down to Johor before feeding into Singapore Island, then to Batam Island where it would pick up the Sumatra link. The link would continue down to Jakarta on west Java, run overland to east Java before going offshore to southern Borneo, where it would run overland again north to Brunei and Sabah, before going offshore to Cebu Island and then across the straits to Manila on Luzon Island. The project is expected to cost US$10 billion.

Some recent developments in negotiations include the following:

- The Singapore Public Utilities Board, the state utility, and Petronas, the Malaysian oil and gas company, have agreed to share the US$750 million cost of laying a pipeline link from Johor Baru across the channel dividing southern Malaysia from Singapore. Petronas says it will bear the cost of piping the natural gas from the Kerteh field in northern Malaysia to Johor. The exact details of the cost-sharing have not yet been disclosed.
- The energy ministers of Malaysia and Thailand have ended an 11-year-long dispute over the gas-

Cont. P. 6

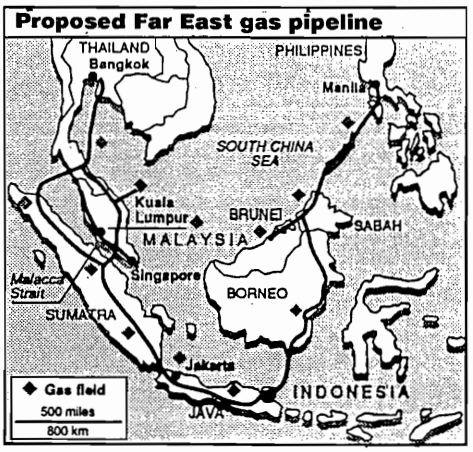
Microbial Desulfurization for Clean Fuels Gets Passing Grades

Drawing on its successes with the removal of sulfur from coal by bacteria, the Institute of Gas Technologies (IGT; Chicago) reports that bioprocesses also hold promise for breaking the carbon-sulfur bonds in char and oil shale. Andrea Maka, an associate microbiologist, described IGT's work at the International Conference on Pollution Prevention (ICPP), held in Washington, D.C., June 1990.

Char, a byproduct of coal gasification, has a relatively high volatile-matter content. However, it cannot be used as a fuel because it contains too much sulfur to meet U.S. clean-air standards. IGT has found that a culture of bacteria developed for coal desulfurization – a mixture of organisms belonging to the genera *bacillus*, *enterobacter* and *rhodococcus* – can remove 60% of the sulfur from char and up to 24% from the oil shale. The process occurs at room temperature and atmospheric pressure under aerobic conditions.
(Source: *Chemical Engineering*, Vol.97, No.7, p.17, July 1990.)

ASEAN Gas Pipeline Project

From P. 5



rich 7,300 square km of offshore reserves off Kelantan, Malaysia by agreeing to set up a joint development authority to exploit the reserves. A formal agreement is expected to be signed soon.

– The energy ministers of Indonesia and Singapore are expected to sign an agreement soon for natural gas to be piped from the Conoco-operated Natunas fields to Singapore before end-1993. Indonesia has said it would finance the US$600-US$700 million, pipeline link which would, in the first instance, be connected to Singapore and nearby Batam and eventually Sumatra. It is hoped that Batam, which Indonesia is developing as an industrial entrepot, will develop sufficient electricity needs to require construction of a 100 MW gas-fired station. In the near term, Batam will get its gas from Singapore.

A cautionary word has come from Petronas President Azizan Zainul Abidin, who said that the TAPL project still has many obstacles. "Gas contracts are not the only issues. Deciding on finance for such a project and the bilateral agreements between ASEAN members for such an undertaking will also take a long time."

Most of the 1,000 km offshore part of the project would run at modest depths of no more than 325 feet, but the Sabah-Cebu-Luzon link would require pipelines being laid to a depth of 1,625 feet. However, it is pointed out that the trans-Mediterranean pipeline between Algeria and Italy, completed in 1982, is laid at a depth of up to 1,976 feet.

The consortium, which comprises Agip, Agip Petroli, Snam, IMI, Total and Gaz de France, is expected to raise much of the financing from the French and Italian governments with further help expected to come from the European Community. The consortium is co-ordinating its planning with the ASEAN Senior Officials on Energy Co-operation (SOMEC).

(Source: ASEAN Gas Pipeline Project Begins to Take Shape, *Power in Asia*, 30 July 1990, pp.14-15.)

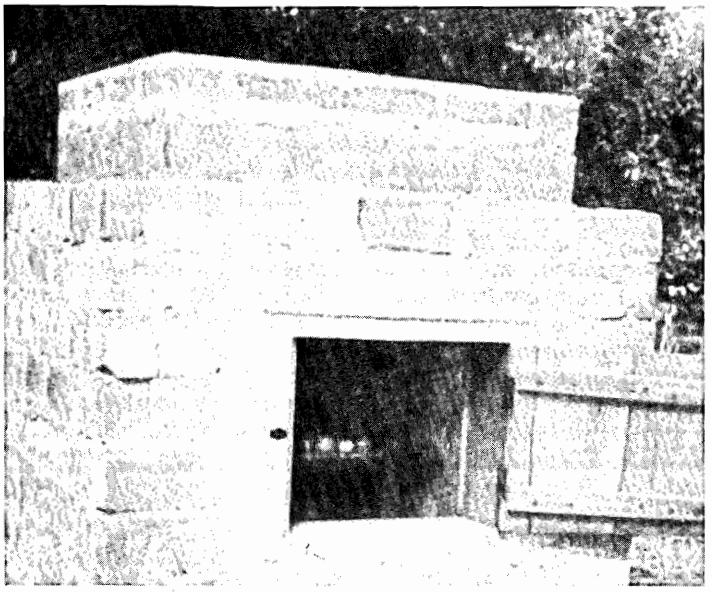
Storing Fruits and Vegetables without Power

It has been always a challenge in the tropics to successfully store fresh fruits and vegetables in containers which are cheap but effective at the same time. Such a container, in the form of a brick cooler which works on the psychrometry of reducing the ambient temperature and raising the humidity (to about 90% RH), was constructed and tested in Kano, Nigeria. It works without a source of generated power.

The brick evaporative cooler is a permanent outdoor structure providing a cold storage chamber with a capacity of about 1.82 m^3. The structure is rectangular, with double-walled brick sides, built on a low plinth. It carries an insulating roof and is provided with an access door on one side wall. The two walls are built of burnt-clay bricks and the interspace is filled with river-bed sand. The inner surfaces of the inner walls and the floor are plastered to a smooth finish. The top of the inner walls carries a 1cm-thick particle board. The edges of the particle board are sealed to the wall top with a layer of mixed cement overlayed with a layer of bricks. The cooling chamber is equipped with three wooden shelves for loading commodities for storage. After loading, the inner opening of the door is tightly covered with the foam board before closing the wooden door.

During use, the river-bed sand is constantly kept wet by adding water two or three times a day, depending on the evaporation rate. For efficient use of the cooling chamber, frequent opening of the door should be avoided in order to minimize heat influx. However, the chamber can occasionally be kept open during nights when the outside air is very cold and of high humidity.

When the ambient temperature is about 30°C the temperature in the cooling chamber reduces to 20°C thereby effecting a 10°C temperature reduction. Also, when the ambient



The brick evaporative cooler.

relative humidity is about 18 percent the relative humidity in the cooling chamber rises to 95 percent. The results of experimental tests with mangoes and oranges, showed that the fruits stayed fresh and unwrinkled for a longer period in the brick cooler than in a conventional refrigerator.

Table 1. Percentage weight loss in stored oranges.

Storage Environment	Storage period (weeks)					
	1	2	3	4	5	6
Ambient Atmosphere	10.77	15.49	31.30	35.05	37.72	43.05
Brick Cooler	1.87	2.70	3.90	6.12	6.15	6.18
Refrigerator	2.80	6.43	8.87	10.51	12.60	15.80

Oranges kept in ambient conditions became shrivelled and wrinkled in appearance with a total loss of appeal. as early as about 14 days and finally became stone hard after the six-week period. Those kept in the refrigerator became hard after 56 days. No shrivelling was observed with oranges stored in the cooler, rather they maintained an unwrinkled appearance. Although fully degreened as early as two weeks, the cooler-stored oranges remained acceptable up to 15 weeks. At this point, however, about 20 percent of the oranges were rotten.

(Source: *Appropriate Technology*, Vol. 16, No. 4, pp.6-7.)

Beneficial Use Found for Piggery Wastes in Barbados

The need to relieve the polluting effects of livestock wastes on the environment arising out of expanded piggery operations in Barbados, and to improve farm sanitation has resulted in some of the country's larger farmers opting to utilize biotechnology. The biotechnology being utilized is the well-known, tried and proven BIOGAS TECHNOLOGY. A biogas plant has been constructed and livestock waste collection and treatment facilities are in place on a number of farms.

One piggery operation which has opted to use biotechnology is Monterey Farms Ltd. at Oldbury Plantation in St. Philip, Barbados. Monterey originally housed about 450 pigs and after the addition of modernized piggery facilities and additional piggery units is now capable of housing 1,400 pigs. The treatment facility biogas plant has a total waste storage capacity of 328 m^3, of which 260 m^3 is the fermentation chamber (digester) and 68 m^3 treated effluent storage (biofertilizer). Biogas is produced at 1.5 m^3/hour; collected and stored in a 100 m^3 plastic storage bag manufactured specifically for this purpose. The biogas and biofertilizer (inorganic) during the anaerobic treatment process are by-products which are beneficially utilized. Biogas is used to fuel an engine driven generator which is rated at 15 kW and the liquid biofertilizer is used to irrigate and fertilize sugar-cane fields. The design of this system took into consideration the shallow top soil and rocky nature of the site and the need to minimize construction above the ground-level.

Piggery wastes which would previously have been stored either in an open lagoon and run off into an open ravine, or pumped down a well, are now collected, treated and beneficially utilized. The process used minimizes or altogether eliminates the unpleasant odors, pollution of the ground water and conditions which encourage the breeding of rodents and flies. The liquid effluent which is a by-product of the treatment process and is used as a biofertilizer does not attract flies and is odorless. A tanker trailer or truck is used to transport and spread the biofertilizer onto the fields.

This bold step taken by Monterey Farms' management must be saluted and the environment in and around Monterey Farms is the eventual beneficiary of this project, which was financed by the owners of the farm and built with design and construction supervision from the Caribbean Development Bank's Biogas Team.

(Source: Extracted from "*TEU NEWSLETTER*", No.27, December 1989/March 1990, pp.1-2.)

Gasohol – Alternative Fuel Gets New Attention

The current uncertainty in the Middle East has brought a renewed interest in using gasohol, a popular topic during energy shortages in the late 1970s, but it remains an expensive alternative to pure gasoline.

Gasohol – a blend of 90% gasoline and 10% ethanol – represents about 8% of the US gasoline market, spurred by federal and state tax incentives amounting to about 8 cents a gallon (2.1 cents a litre).

Tax incentives for the use of gasohol will be up for renewal in 1992 and 1993 and changes in the Clean Air Act could increase the popularity of gasohol, but the leading factor affecting the future of gasohol promises to be the price of crude oil.

Norman Rask, a professor of agricultural economics at Ohio State University, said crude oil would have to be trading in the US$40 to US$45 a barrel range for gasohol made from US corn to be profitable without tax incentives.

With existing tax breaks – 60 cents a gallon (15.87 cents a litre) in a federal tax rebate for pure ethanol and about 20 cents a gallon (5.29 cents a litre) in state tax relief – the price of ethanol typically has remained slightly below the price of pure gasoline, making it profitable for some business to market gasohol.

No modification is needed in cars or trucks for the use of gasohol. In fact, although posted on fuel pumps, most consumers don't even realize they're buying gasohol. But as for straight ethanol, major modifications are needed for car and truck engines to burn the fuel.

James Ross, president of BP America Inc in Cleveland, said gasohol does not make economic sense. "In order to make gasohol competitive with more conventional gasolines you have to have an enormous subsidy," Ross said. "Without a subsidy you're probably paying something like US$2.50 a gallon (US$0.66 a litre) or more. Somebody has to pay for that subsidy. If it's the government paying for that subsidy, the effect of it is the consumer is paying for it."

Rask believes a more accurate figure would have ethanol selling in the US$1.65 range, including the cost of mixing ethanol with gasoline and the typical costs associated with transporting gasoline, operating gas stations and adding taxes.

The wholesale price of gasoline was in the 70 cents a gallon (18.5 cents a litre) range before Iraq invaded Kuwait August 2, but increased to the 90 cents a gallon (23.8 cents a litre) range since the invasion.

"At the present prices of corn we're probably at US$1.25 to US$ 1.30 a gallon (US$0.33 to 0.34 a litre) for (making) ethanol," Rask said. "That will go up and down as the price of corn increases and decreases." The wholesale price of ethanol could go above the cost of making it, depending on demand of ethanol, and the price of corn could go up if the demand for corn increased.

In Brazil, where ethanol is used extensively, it's made for about 90 cents a gallon (23.8 cents a litre). Rask said that by adding about 12 cents a gallon (3.1 cents a litre) for

Professors Win Accolade for Energy Conservation Models in UK

Energy savings estimated at £1 million have been achieved in the past 18 months by architects using a new energy design advisory service that has just won this year's UK Royal Society Esso Energy Award for advances in the use or conservation of energy resources. Key to the success of the service developed at Scotland's Strathclyde University is an advanced computer programme that can model the dynamically complex response of buildings and their engineering services to the highly variable stimulus of weather.

Over half the energy used in Europe is involved in maintaining acceptable environmental conditions inside buildings. The UK Department of Energy estimates that better design of new buildings could lead to a 50 per cent saving in energy use, and that modifications of existing buildings could yield savings of 25 per cent. Taken together, this could reduce the UK energy bill by £2,000 million a year.

Ten years ago, Professors J.A. Clarke and T.W. Maver at Strathclyde University recognized that a major barrier to good design or redesign was the lack of a reliable model that could show designers how a particular building would respond to different weathers. Their research has led to the Environment System Performance (ESP) computer programme that can accurately model the response of buildings to weather and is now being made available to designers through the university's energy design advisory service. ESP is now said to be a strong contender for the lead model throughout Europe and is being used increasingly throughout the world.

Over 150 architectural practices and their clients have used the service in the past 18 months and it is estimated the energy savings that have resulted already greatly exceed the value of the investment made in it. The service is now to be made available nationally and in the meantime Professors Clarke and Maver have just received the Esso Energy Award at a ceremony in London. The Award consists of a gold medal and £2,000 in cash.

For further details please write to:
The Royal Society
6, Carlton House Terrace
London SW1Y 5AG
United Kingdom

(Source: Extracted from *"Energy Management"*, Vol.14, January-March 1990, pp.55-56.)

shipping and allowing for some profit, it could sell in the United States for about US$1.10 a gallon (US$0.29 a litre). However, a 60-cent-a-gallon (15.87-cent-a-litre) tax on such imports has kept foreign-made ethanol out of the US market.

But ethanol does have potential. An environmental consideration is that ethanol creates less carbon monoxide emissions. Tougher clean-air requirements could make it more attractive.

And since ethanol has an octane level of about 117, it can be mixed with gasoline rated at about 84 to make gasohol with the generally accepted octane level of 87.

"We can import this ethanol from Brazil or Central America for a little more than a US$1 a gallon (US$0.26 a litre)," Rask said. "If we could use it as an octane enhancer, then we could do it at US$28 to US$30 a barrel without subsidy. It would be market profitable just to do it."

The push for the use of ethanol began after the Iranian oil crisis in 1979. President Carter signed a law establishing tax incentives to use ethanol made from fermentation of grain as a motor fuel.

The industry grew rapidly from 1980 when hardly any gasohol was on the market, until about 1986, when oil prices declined sharply. Since then growth has been fairly slow.

Ethanol has been used primarily by independent gasoline marketers. These are the people who buy their gasoline from a number of different suppliers. "The major oil companies in general have not used ethanol."

Use of Corn

The new industry drew interest from several sources.

South Point Ethanol, for example, is a joint operation by Ashland Oil Inc of Ashland, Kentucky, the Ohio Farm Bureau Federation, UGI Development Corp of Philadelphia and Publicker Industries Inc of Greenwich, Connecticut.

Ashland Oil's interest is in selling gasohol and the Farm Bureau's interest is in promoting the use of corn. UGI, a utility, is interested in alternative fuels and the use of carbon dioxide, which is a byproduct of the process. And Publicker, a longtime producer of beverage and industrial alcohol, was interested in building an ethanol plant.

The partnership converted an old chemical plant along the Ohio River into an ethanol plant and began operation in 1982. Since then, however, the economics of ethanol have changed.

Lauren Hill, general manager of South Point Ethanol in the southern Ohio town of South Point, argues that the current instability in the Middle East shows the importance of remaining committed to other energy sources such as ethanol.

South Point Ethanol uses what is known as the dry milling process to make ethanol. Corn is ground and mixed with water before cooking. An enzyme is added during the cooking stage to help liquefy the starch. Then it is cooled, and a second enzyme is added that converts the starch to sugar. Yeast is added and the yeast consumes the sugar, producing ethyl alcohol and carbon dioxide.

The carbon dioxide is recovered and sold. The ethanol is recovered as 200 per cent proof alcohol, meaning free of water. And the remainder of the corn protein, fat, fibre, vitamins and minerals are recovered, dried and sold as a high protein animal feed, primarily in daily cattle markets.

Before the ethanol leaves South Point, a small amount of gasoline is added to make it unfit to drink. It's then shipped by truck, train or barge to customers in the petroleum industry. A straight blend of one part ethanol and nine parts gasoline is used to make gasohol.

While gasohol accounts for only 8% of the national market, in some agricultural areas it is higher. Gasohol sales in Ohio, for example, represent about 18% of the market.

(Source: Gasohol, Alternative Fuel Gets New Attention, by Rich Exner, *Bangkok Post*, 28 August 1990.)

Sulfur Dioxide Emission, Acid Rain and Energy Use in China

Environmental pollution is a global phenomenon and is becoming more so as the demand for energy increases following a similar trend in economic growth throughout the world. Such growth is often accompanied by increasing stress on natural systems and significant adverse effects on environmental quality. This is due in part to the view that economic growth and environmental quality are alternatives – deterioration in environmental quality, unfortunately, is viewed as a necessary cost of rapid economic growth. Air pollution, resulting from emissions of oxides of sulfur and nitrogen is one of the major effects of rapid urbanization and industrialization and has significant adverse effects on ecosystems. The high concentration and the high deposition of such pollutants are responsible for causing serious damage to ecosystems. The atmosphere acts as a sink to dump natural or man-made pollutants. However, only a relatively thin layer, a few miles thick, is accessible to us to use in sustaining life and diluting wastes. Atmospheric pollutants return to the earth's surface through wet or dry deposition. The wet deposition of acid pollutants via precipitation may cause acid rain, which is one of the most serious aspects of environmental pollution.

In China, coal combustion is the principal contributor to the acidic atmospheric pollution, especially in big heavy industrial cities or northern big cities. Emissions of sulfur dioxide from coal combustion in 1985 amounted to about 13 million tons. In 1987, about 860 million tons of coal equivalent were consumed for energy production in the country, coal accounted for 76% of the total (Table 1). An estimated 40% of the coal consumed was for industrial, commercial, and domestic use in cities with an area less than 0.5% of the entire coun-

Cont. P. 10

Table. 1. Primary energy consumption structure in China.

Year	Consumption (Mt)	Coal (%)	Petroleum (%)	Gas (%)	Hydropower (%)
1979	586	71.3	21.8	3.3	3.6
1981	594	72.8	20.0	2.7	4.5
1983	660	74.3	18.1	2.4	5.0
1985	764	75.9	17.1	2.2	4.8
1987	859	76.3	17.0	2.1	4.6
2000[1]	1420	64.5	21.0	5.0	9.5

Source: Chinese Statistical Bureau, 1988.
Note: [1] Estimate

try. Thus, air pollution in China occurs most severely in cities. Because the car is still not very popular, NO_x pollution is not as serious in China as it is in western countries. Most of the coal used in cities is burned in medium to small size furnaces with low stacks and without equipment to remove SO_2 from flue gases. Table 2 indicates coal consumption and SO_2 emission in various sectors.

Atmospheric pollution in the form of acid rain in southwestern China has attracted greater attention than the dry deposition of pollution. Environmental monitoring data showed that about 90% of the sampling sites with an annual average pH of rainwater below 5.6 are situated to the south of the Yangtze River. Those with the lowest rain water pH are in the cities of Chongqing, Sichuan province and Guiyang, Guizhou province, and in neighboring areas in the northwest. In Chongqing, almost every episode of rainfall brings acid rain now.

Recently, a study was conducted for an M. Engg. degree by Mr. Tian Xiao Feng of the Energy Technology Division, Asian Institute of Technology (AIT), which dealt with acid rain and the dry deposition of atmospheric pollution around Chongqing, an industrial city located at 20°N latitude and 106°E longitude in the South-east Basin. The study utilized an advanced box model developed by B.E.A. Fisher (also successfully used in Europe). The basic idea for modelling requires four types of data inputs: (1) information on sources including pollutant emission rate, (2) the chemical reaction parameters such as the transformation rate, (3) meteorological data such as wind velocity, direction and turbulence, and (4) deposition parameters. The model then simulates mathematically the transport and dispersion of the pollutant, and its chemical and physical transformation and removal processes. The model output is air pollutant concentration and deposition for a particular time period, at specific receptor locations. The advanced box model which was developed in Europe for solving acid deposition problems, is particularly suitable for the present problem. Furthermore, this model with statistic characteristics can provide a long-term average of the deposition data without considering the individual air masses on a daily basis.

Table. 2. Coal consumption and SO_2 emission in various sectors.

Sector of Coal Consumption	Coal		SO_2	
	Mt	%	Mt	%
Power	170	24.2	3.47	26.4
Boiler	250	35.6	5.10	38.8
Residential	200	28.4	2.88	21.9
Industrial Furnace	60	8.5	1.22	9.3
Locomotive	23	3.3	0.47	3.6
Total	703	100	13.14	100

Source: Wang and Zhao, 1988.

The simulation revealed that in Chongqing city, high SO_2 emission and low wind velocity cause high concentration and deposition of atmospheric pollution around the city. The sulfate concentration is relatively high due to the humid weather. The simulation also detected that the southern city suffers more pollution than other areas. The sensitivity analysis showed that such parameters as wind velocity, wind direction, transformation and deposition velocity are relatively more important. Others such as the eddy diffusivity, mean wet and dry periods, etc., are less important to the accuracy of the model. It also showed that increasing the height of emission sources can still abate the pollution near the city.

In another study for the Master of Science degree, Mr. Lan Zhijian carried out economic analysis and policy planning for abatement of SO_2 emission from coal combustion for the same Chongqing city in China. Here, a linear programming model was used to find out the least cost combinations of presently available SO_2 emission control strategies. With the obtained results, a cost-benefit analysis based on estimates of SO_2 damages showed that the presently recommended National Tertiary Standard for SO_2 concentration might not be optimal for this city for the time being. A more relaxed emission reduction requirement is indicated by the results of this analysis to make it cost-effective.

The linear programming model demonstrates to what extent the presently employable techniques should be used for each source, but appropriate policies have to be formulated to realize the target. Any policy formulation involves consideration of many interrelated and interacting factors of a technological, economic, environmental, social and political nature. Such a complex field calls for innovative techniques of planning which permits explicit consideration of these factors. A newly developed method which provides a framework within which one can consider such a diversity of factors and analyze their com-

International Energy Policy Seminar on Energy Development in South-East Asia and Cooperation with the European Communities

Pattaya, Thailand
27 February - 3 March 1989
B. Lapillonne (Ed.)
Centre International de Formation en Politique Energétique (CIFOPE)
3, Rue Henri Heine, 70516 Paris, France

An International Seminar on Energy Policy was organized by the International Training Center for Energy Policy (CIFOPE) in cooperation with the Energy Technology Division of the Asian Institute of Technology (AIT), from February 27 to March 3, 1989 in Pattaya, Thailand.

The theme was Energy Development in South-East Asia and Cooperation with the European Communities. More than one hundred and fifteen participants attended this meeting. The participants came from European and ASEAN countries, Laos, India, Japan, South Korea, or represented international organizations such as ESCAP, APENPLAN, the World Bank, the European Investment Bank, l'Institut de l'Energie des Pays ayant en commun l'usage du français, the Commission of the European Communities (General Energy Directorate) as well as the French public authorities, Ministère des Affaires Etrangères (Direction de la Coopération Scientifique, Technique et du Développement), Ministère de l'Industrie et de l'Aménagement du Territoire (Direction Générale de l'Energie et des Matières Premières), Ministère de la Recherche et de la Technologie, Agence pour la Coopération Technique, Industrielle et Economique, Agence Française pour la Maîtrise de l'Energie.

Proceedings of the seminar were published for CIFOPE by the Regional Energy Resources Information Center (RERIC) of the Asian Institute of Technology, Bangkok, Thailand. The proceedings contain three papers on energy demand, five papers on oil and gas (production and markets), five papers on electricity, seven papers on energy supply and demand options for the future, eight papers related to transfer of technology and expertise, three papers on financing of energy projects, and nine papers on cooperation between Europe and South–East Asia. Syntheses of the seminar, keynote address, the seminar program and the list of participants are also included.

To obtain the proceedings, readers from developed countries should contact Centre International de Formation en Politique Energétique (CIFOPE), 3, rue Henri Heine, 70516 Paris, France. For developing countries, the proceedings are available from RERIC (Regional Energy Resources Information Center, Asian Institute of Technology, G.P.O. Box 2754, Bangkok 10501, Thailand) at a special price of US$20.00 per copy; the publication is provided with compliments from CIFOPE and the price charged covers only the air-mailing and handling costs.

plex joint interactions and impacts is called the Analytic Hierarchy Process (AHP). Based on the available data, the results from the above analysis and opinions of some of the experts and planners in the city, an AHP model was set up in this study to formulate appropriate policies for abatement of SO_2 emissions from coal combustion. The result suggests that reinforcement of control regulations be given highest priority in the following decade in the studied area.

Further details on the studies are available in (a) "Acid Rain and Dry Deposition Modeling for Chongqing City, PRC", a Research Study by Tian, Xiao Feng, and (b) "Economic Analysis and Policy Planning for Abatement of Sulfur Dioxide Emission from Coal Combustion: A Case Study in China", a Thesis by Lan Zhijian, Division of Energy Technology, Asian Institute of Technology, Bangkok, 1989.

Solar Energy: Small-scale Applications in Developing Countries

P. Vanderhulst, H. Lanser, P. Bergmeyer, F. Foeth and R. Albers
TOOL Foundation
Entrepotdok 68A
1018 AD Amsterdam, the Netherlands
ISBN 90 70857 19 7, 1990, 62 p.

This publication is aimed at people who are interested in finding out whether they can use solar energy for small-scale applications in their daily lives. Thermal applications such as water heating, drying and cooking, as well as electricity generation using small photovoltaic systems are discussed.

Detailed information is provided on the following:

- Solar Driers; principles of drying with the sun's warmth, principle of the flat-plate collector with cover, different designs and constructions of solar driers, and practical tips.
- Warming Water with Solar Energy; technology and applications, collector, storage water distillation, solar boiler, solar disinfector and sterilizer.
- Cooking with the Solar Energy; parabolic solar cooker and the cooking box.
- Electricity from the Sun; solar cells, balance of system, PV-system characteristics, implementation and applications.

Windpumps for Irrigation

H.J. van Dijk and P.D. Goedhart
Consultancy Services Wind Energy Developing Countries
P.O. Box 85, 3800 ab Amersfoort
Holland, 1990, 96 p.

This publication examines the use of wind energy in agriculture and more specifically, the application of wind energy to small-scale irrigation. This book offers a tool to assess the technical, economic and institutional feasibility of windpump irrigation systems; general agricultural topics are treated only in so far as they are pertinent to the use of windpumps. The book particularly emphasizes the use of windpumps in irrigation: hybrid configurations of windpumps with other water-lifting devices such as motor pumps, are not considered.

Chapter 1 introduces the key factors to be studied in connection with the viability of windpumps in different farming systems and illustrates two case studies in regions with traditional windpump irrigation: Crete and Cape Verde. Chapter 2 introduces the technical aspects of windpumps (types, sizes, characteristics and cost prices). Chapter 3 provides information on collecting and analyzing climatic data with special reference to the wind regime. The data required at different stages of project development and the equipment required for measuring are both described. Simple methods to determine water availability are also mentioned briefly. In Chapter 4 and 5, the relationships between the output of a windpump and the use of the water output for irrigation are discussed. Estimating the area that can be cultivated (command area) and the factors influencing this command area are the subjects of Chapter 4. Windpump irrigation has specific problems related to the fact that the windpump output is not constant all the time. The effects of this phenomenon on farm water management are discussed in Chapter 5. Several measures such as storage tanks are suggested to facilitate windpump irrigation and to make more adequate use of the potential windpump output. A method of estimating the required storage tank capacity is included. This method is based on the characteristics of a recently developed windpump, the CWD 5000, but the results can also be applied for other well-adapted windpumps.

In Chapter 6, the economics of windpump irrigation are analyzed, taking into account the national economics and farm economics. A financial analysis is also included since windpumps have to compete with other water lifting devices. Finally, Chapter 7 summarizes the book with an example set-up for a windpump project. Which set-up will best fit the local situation depends largely on the present state of agricultural practices in the area.

Publications Received

BIOMASS ENERGY

* *Chinese Biogas Digester: A Potential Model for Small-Scale, Rural Applications (A manual for construction and operation)*, Charles H. Nakagawa and Q.L. Honquilada, PEACE CORPS, Information Collection and Exchange, Office of Training and Program Support (806 Connecticut Avenue, N.W., Washington, D.C., 20526), July 1985, v+92 p.

* *The Biogas / Biofertilizer Business Book*, Third Edition, Michael Arnott, PEACE CORPS, Information Collection and Exchange, Office of Training and Program Support (806 Connecticut Avenue, N.W., Washington, D.C. 20526), July 1985, xvi+186 p.

* *Trees and Fuelwood from Non-Forest Lands: A Methodology for Assessment – India*, A.N. Chaturvedi, Food and Agriculture Organization of the United Nations, Regional Wood Energy Development Programme in Asia (GCP/RAS/131/NET), Bangkok, June 1990, 45 p.

* *Trees and Fuelwood from Non-Forest Lands – Pakistan*, R.W. Hussain, Food and Agriculture Organization of the United Nations, Regional Wood Energy Development Programme in Asia (GCP/RAS/131/NET), Bangkok, April 1990, 59 p.

* *Population Growth, Wood Fuels, and Resource Problems in Sub-Saharan Africa*, Douglas F. Barnes, Industry and Energy Department Working Paper, Energy Series Paper No. 26, The World Bank, Washington, D.C., March 1990, 16 p.

HYDROPOWER

* *Understanding the Costs and Schedules of World Bank Supported Hydroelectric Projects*, Edward W. Merrow, et al., Industry and Energy Department Working Paper, Energy Series Paper No. 31, The World Bank, Washington, D.C., July 1990, various paging.

ENERGY DEMAND

* *Sectoral Energy Demand in China*, Regional Energy Development Programme (RAS/86/136), Economic and Social Commission for Asia and the Pacific, Bangkok, November 1989, 117 p.

* *Sectoral Energy Demand in Indonesia*, Regional Energy Development Programme (RAS/86/136), Economic and Social Commission for Asia and the Pacific, Bangkok, November 1989, 94 p.+ Annexes.

* *Sectoral Energy Demand in the Republic of Korea*, Regional Energy Development Programme (RAS/86/136), Economic and Social Commission for Asia and the Pacific, Bangkok,

2nd AIT-WHO Training Course on Solar Refrigerators Repair and Maintenance

4-15 February, 1991
Asian Institute of Technology
Bangkok, Thailand

The 2nd AIT-WHO Training Course on Solar Refrigerators Repair and Maintenance will be organized by the Division of Energy Technology, Asian Institute of Technology (AIT), in collaboration with EPI of WHO-SEARO and WHO-HQ.

Aim of the Course and Methodology

The course aims to increase the number of suitably trained repair and maintenance technicians capable of installing and keeping the solar powered refrigerators in good working order. Rapid expansion of the cold chain infrastructure including the use of solar refrigerators necessitates the training of more cold chain technicians. The course follows the EPI scheduled programme of instructions and training materials which is particularly orientated for hands-on experience.

Language

The language of the course is English. The candidates should have ability to understand, speak and write English language.

Application

The number of participants is limited to 20. Applications using preregistration form should reach AIT **not later than 30 November 1990**. Acceptance will be on **first come first served** basis, hence, candidates should send applications as soon as possible.

Date and Venue

The course will be held from 4 to 15 February 1991 at the Division of Energy Technology of AIT.

Candidates/sponsors interested in the course should ask for more details from:

Dr. Supachart C.
Division of Energy Technology
Asian Institute of Technology
G.P.O. Box 2754, Bangkok 10501
Thailand
Fax: (662) 516 2126

November 1989, 11+202 p.

* *Sectoral Energy Demand in Maldives*, Regional Energy Development Programme (RAS/86/136), Economic and Social Commission for Asia and the Pacific, Bangkok, November 1989, 52 p.

* *Sectoral Energy Demand in Nepal*, Regional Energy Development Programme (RAS/86/136), Economic and Social Commission for Asia and the Pacific, Bangkok, November 1989, 183 p.

* *Sectoral Energy Demand in Thailand*, Regional Energy Development Programme (RAS/86/136), Economic and Social Commission for Asia and the Pacific, Bangkok, November 1989, 96 p.

* *Sectoral Energy Demand in Malaysia*, Regional Energy Development Programme (RAS/86/136), Economic and Social Commission for Asia and the Pacific, Bangkok, November 1989, xii+vi+182 p.

3rd International Conference on Energy and Building in Mediterranean Area

Thessaloniki, Greece
8-10 April 1992

The Conference on Energy and Building in Mediterranean Area will be organized by the Laboratory of Building and Construction Physics, Dept. of Civil Engineering, Aristotle University of Thessaloniki, with the support of the Aristotle University of Thessaloniki and under the auspices of the Ministry of Research and Technology. The topics of the Conference are as follows:

- Design and construction solutions for building with a view to energy saving.
- The role of shading devices, thermal mass, natural ventilation and the other design parameters under summer conditions.
- Passive solar systems for heating and cooling.
- Monitoring and evaluation of the performance of passive solar systems.
- Thermal comfort under summer and winter conditions.

Date and Venue

The Conference will be held at the Aristotle University of Thessaloniki, Thessaloniki, Greece, during 8-10 April 1992. The deadline for submitting an abstract is 15 December 1990.

For further information contact:
Laboratory of Building & Construction Physics
Dept. of Civil Engineering
Aristotle University of Thessaloniki
P.O.Box 429
54006 Thessaloniki
Greece
Tel: (031) 992625
Telex: 412181 AUTH GR
Fax: (031) 200392

16th Conference on Science and Technology of Thailand - STT16 "Science and Technology for National Development"

25-27 October, 1990

Bangkok, Thailand

The 16th Conference on Science and Technology of Thailand – STT16 will be organized by the Science Society of Thailand under the Royal Patronage; Faculty of Science, King Mongkut's Institute of Technology Ladkrabang; The National Research Council of Thailand; Office of the Science and Technology Development Board; and Faculty of Science, Mahidol University.

Objectives

The objectives of the conference are to:

- promote activities in science and technology in the country;
- support development in teaching science and technology;
- encourage exchange of views and suggestions for scientific research; and
- act as a forum for activities in science and technology in the country.

Activities

The conference will consist of lectures, state-of-the-art symposia; panel and general discussions; poster sessions; and exhibitions.

Lectures

During the conference, lectures will be given by Dr. Ivar Giaever (Nobel Laureate for physics in 1973); the outstanding Thai scientist for 1990; award winners from the National Research Council of Thailand; various distinguished scientists; researchers awarded grants from the Office of Science and Technology Development Board; and expert scientists in various fields.

State-of-the-Art Symposia

The themes of the state-of-the-art symposia will be information technology and male fertility regulation.

Panel and General Discussions

The topics of the discussions are science and technology of the environment and information technology and national development.

Poster Sessions

The poster sessions will cover 8 major fields namely: physical sciences; biological sciences; science education and educational technology; medical sciences; agricultural sciences; engineering and technology; resources and environmental sciences; and general science.

Exhibitions

The exhibitions displayed during the conference are as follows:

- Information technology;
- Activities of the special programme of research, development, and research training in human reproduction, WHO;
- Scientific equipment;
- Science teaching;
- Publications in science and technology; and
- Activities of the Science Society of Thailand under the Royal Patronage.

Two international exhibitions: Thai Labtech and Thai Instrumex'90 will be shown.

Date and Venue

The conference will be held from 25-27 October 1990 at King Mongkut's Institute of Technology Ladkrabang and at Central Plaza Hotel, Bangkok, Thailand.

For more details contact:
Professor Dr. Vichai Reutrakul
Department of Chemistry
Faculty of Science
Mahidol University
Rama 4 Road
Bangkok, 10400
Thailand

International Conference on Energy and Environment

Bangkok, Thailand

27-30 November 1990

The International Conference on Energy and Environment will be organized by King Mongkut's Institute of Technology Thonburi (KMITT), and Ministry of Science, Technology and Energy, Thailand (MOSTE), and supported by United Nations Environmental Programme (UNEP); United Nations Educational, Scientific and Cultural Organization (UNESCO); and Science and Technology Development Board, Thailand (STDB). The Conference will be held at Tara Hotel, Bangkok, Thailand during 27-30 November 1990.

The Conference aims to show that energy development and the preservation of our environment are not two incompatible goals. They may even complement each other, provided that energy policy and planning include comprehensive environmental analysis. The Conference will focus on energy and environmental science, technology, management, policy and economics.

For further information contact:
Secretary, Int. Conf. on Energy & Environment
c/o School of Energy and Materials
King Mongkut's Institute of Technology Thonburi
Bangmod, Bangkok 10140
Thailand
Tel: 4278094
Telex: 72383 KMITT TH
Fax: 662-4278077, 4279860

Diary of Events

- **September 3-6, 1990, Rotterdam, The Netherlands**

International CIB-Symposium on Energy, Moisture, Climate in Buildings

For more information contact:
Mariëtte Breuls
Bouwcentrum bv
Weena 760, Postbus 299
3000 AG Rotterdam
Netherlands
Tel: 010-43 09911
Telex: 22530 BOUWC NL
Fax: 010-41 21115

- **September 10-13, 1990, New Orleans, LA, USA**

First International Symposium on Oil and Gas Waste Management Practices

For more information contact:
EPA Oil and Gas
c/o GRCDA
P.O. Box 6126
Silver Spring
MD 20906
USA
Tel: 301 585 2898
Fax: 301 589 7068

- **September 10-14, 1990, Madrid, Spain**

Conference Exhibition 1990 on Wind Energy

For more information contact:
H.S. Stephens & Associates
Agriculture House
55 Goldington Road
Bedford MK40 3LS
United Kingdom
Tel: (44) 234 49474

- **September 17, 1990, London, United Kingdom**

Energy Policy Seminar No.3

For more information contact:
9 St. James's Square
London SW1Y 4LE
United Kingdom

- **September 17-19, 1990, Leeds, United Kingdom**

Incineration and Energy from Waste 1990

For more information contact:
Dr. Paul Williams
University of Leeds
LS2 9JT
United Kingdom

- **September 25-28, 1990, Washington, D.C., USA**

Windpower '90

For more information contact:
AWEA
1730 N. Lynn St.
No. 610 Arlington
VA 22209
USA
Tel: (703) 276 8334
Fax: (703) 527 2833

- **October 1-3, 1990, Munich, West Germany**

International Conference on Applications and Efficiency of Heat Pump Systems in Environmentally Sensitive Times

For more information contact:
Conference Organiser
Heat Pumps BHR Group Limited
Cranfield
Bedford MK43 0AJ
United Kingdom

- **October 1-4, 1990, Minas Gerais, Brazil**

First International Conference on Power Distribution

For more information contact:
Carlos Augusto Leite Brandão
ISIDEE Organizing Committee Chairman
Companhia Energética de Minas Gerais – CEMIG

ISES Solar World Congress 1991
"Solar Energy for the 21st Century"

17-24 August, 1991
Denver, Colorado, USA

"Solar Energy for the 21st Century" will be the theme of the 1991 Solar World Congress of the International Solar Energy Society. The Congress, hosted by the American Solar Energy Society, will be held during 17-24 August 1991, in Denver, Colorado, USA.

Sharing the Progress of Solar Technologies

"The 1991 Solar World Congress will provide an opportunity to share the progress of solar technologies and their application to global needs," according to C. Byron Winn, General Chairman of the Congress and Chair of the Mechanical Engineering Department at Colorado State University.

Sessions Planned

Several stimulating plenary sessions have been planned. On Monday there will be a plenary session dealing with the 21st Century; on Wednesday there will be a plenary session dealing with The Environment; on Friday there will be a plenary session dealing with International Aspects of Solar Energy. Speakers such as Phil Abelson (Science magazine), Lester Brown (World Watch), Secretary Watkins (DOE), Senator Wirth, Representative Schneider, and Dr. Enrique Iglesias (Inter-American Development Bank). They also plan to have special sessions on utilities, space power, developing countries, etc.

Topic Categorization

The Congress will cover the following aspects of solar and related renewable energy technologies:

- Solar Electric
- Active Solar
- Education
- Renewable Resource
- Solar Fuels
- New and Innovative Technologies for the 21st Century
- International and National Programs
- Passive Solar
- Solar Heat
- Socio-Economic Aspects.

(Source: Extracted from *"ISES News"*," Newsletter 70, June 1990.)

Divisão de Engenharia de Operacão e Manutenção da Distribuição
Av Barbecena
1200-16° andar-Ala Al
Tel: (031) 349 2623
Telex: 311124-311268-311439-391273 e 391846
Fax: (031) 3494691

- **October 7-8, 1990, Caserta, Italy**

Solar Energy and Hydrogen

For more information contact:
Academician Emilio O. Vicario
Segreteria Organizzativa della Sezione Italiana dell'IAHE
Aven Luigi Settembrini, NR6
81100 Caserta, Italy
Tel: 0823-327222

- **October 9, 1990, London, United Kingdom**

Information Support for the Energy Industries

For more information contact:
Miss Caroline Little
Conference Officer
The Institute of Petroleum
61 New Cavendish Street
London W1M 8AR
United Kingdom

- **October 17-20, 1990, Winnipeg, Manitoba, Canada**

World Environment, Energy and Economic Conference

For more information contact:
Mr. Evhan Uzwyshyn
Conference Executive Officer
Manitoba, Education & Training
Room 409-1181 Portage Avenue
Winnipeg, Manitoba
Canada R3G OT3
Tel: 204 945 7973
Fax: 204 945 8756

- **October 19-21, 1990, Pori, Finland**

Finnwind '90

For more information contact:
City of Pori Tourist Office
Antinkatu 5, 28100 Pori
Finland
Tel: +358 39891 100
Fax: +358 39332 509
or *Finnish Wind Power Association*
c/o VTT/SAH
P.O. Box 34, SF-02150, Espoo
Finland
Tel: +358 0 456 6560
Fax: +358 0 455 0115

- **October 21-23, 1990, Banff, Alberta, Canada**

Canadian Wind Energy Conference & Exhibition

For more information contact:
Nancy Phillips
Conference Coordinator
Passmore Associates International
23 Rockwood Street
Ottawa
Ontario K1N 8L8
Canada
Tel: (613) 234-3602
Fax: (613) 234-0895

- **October 23-25, 1990, Lakewood, CO, USA**

10th SERI Photovoltaic Advanced Research and Project Review Meeting

For more information contact:
SERI Conference Coordination Section
1617 Cole Boulevard
Golden, CO 80401 3393
Tel: 303 231 1000

- **November 6-7, 1990, Middleton, WI, USA**

Energy Expo '90: Key Energy Strategies for the Competitive '90s

Exposition and symposium on energy efficiency.

For more information contact:
JoAnne Jarecki
Enercom
#106, 400 N. Executive Dr.
Brookfield, WI 53005
USA
Tel: (414) 789-2160

- **November 13-15, 1990, London, United Kingdom**

Conference on Power Generation and the Environment

For more information contact:
Julie Brown
IMechE
Conference Department
1 Birdcage Walk
London SW1H 9JJ
United Kingdom
Tel: 071-222 7899
Fax: 071-222 4557

- **November 26-30, 1990, Kyoto, Japan**

5th International Photovoltaic Science and Engineering Conference

For more information contact:
Prof. Junji Saraie
Secretariat of Int '1 PVSEC-5
Nippon Press Centre Bldg.
2-2-1 Uchisaiwai-cho
Chiyoda-ku
Tokyo 100
Japan
Tel: (03) 508 12 13
Fax: (03) 508 08 20

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Library and Regional Documentation Center, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The "RERIC News" is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership along with the other four regular publications namely: RERIC International Energy Journal (formerly: Renewable Energy Review Journal); RERIC Holdings List; Abstracts of AIT Reports and Publications on Energy; and RERIC Membership Directory. For further details contact:

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SOLAR BOX COOKERS

An insulated box with a black bottom, a glass top and a shiny reflector captures enough solar energy to cook food. A simplified design enables most people to make their own solar box cookers out of affordable available materials.

Solar box enthusiasts believe the cookers provide an elegantly simple, practical answer to a number of global problems. The cookers can ease shortages of cooking fuels, reduce the cost in time and money faced by fuelwood users, prevent health problems associated with cooking over smoky fires, provide a cheap means of pasteurizing drinking water, and reduce destruction of the world's forests, thereby easing erosion and flooding problems.

To spread knowledge about building and using solar box cookers, proponents formed a non-profit organization, Solar Box Cookers International (SBCI) in 1987.

One of SBCI's founders was Barbara Kerr. An Arizona nurse and social worker, Kerr invented a solar box cooker in 1976. She had experimented with a variety of designs, seeking always to find one that was practical to use, easy and cheap to make, and adaptable to local conditions.

Photo taken in Zimbabwe in June 1989.

The design she hit upon features a box within a box. The boxes may be made of cardboard, tin, adobe or other inexpensive, available materials. The space between the boxes is insulated with crumpled newspaper, dry plant fibers or other cheap insulator. A glass window on the lid lets sunlight into the box. Aluminum foil or other shiny material lines the inside of the oven and, along with a single reflector on the lid, focuses most of the sunlight on dark cookware and a black, metal drippan. The dark objects convert the sunlight to heat, which remains trapped inside the insulated box.

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PV Development and Applications in Thailand

About 400 kWp of PV modules have been used in Thailand during the past decade. Potential applications of PV can be substantial in the remaining thousands of remote communities which will never be served economically by either diesel driven generators or conventional grid extensions. Three interest groups namely users, local manufacturers/distributors and academic institutions, are involved in PV activity.

A PV working group to promote the realization of PV in this country was established in 1987 under the framework of the Ministry of Science, Technology & Energy (MOSTE). The working group has coordinated technical meetings, information exchanges, etc., among the interest groups. As a result, some recommendations have been presented to the government for its possible support on R&D funding for the academic institutions, tax incen-

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INNERTAP

Incorporates news from the Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

PV Development and Applications in Thailand

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tive scheme for users, block buying of PV modules from local manufacturers for some demonstration projects, etc.

PV Users

A list of users and their related activities are given in Table 1.

Most users are government agencies. Some users with substantial PV installation are: the Provincial Electricity Authority (PEA), the Telephone Organization of Thailand (TOT), the Ministry of Education, and the Electricity Generating Authority of Thailand (EGAT).

The First Grid Connected PV Power Plant

An important landmark was the installation, by EGAT, of a 20 kW PV-power plant at Klong Chong Klum, which is located about 180 km

Table 1. Photovoltaic status in Thailand

Customer	Peak Kilowatt (installed)										
Applications	CU	EGAT	MH	ME	MI	MD	NEA	PEA	TOT	VH	MIS
Remote villages								(60+60+30)*			2
Telecom.		6				10			90-100		30
Water Pumping							10				5*
Primary School				15							2
Health Care			1-2							5-7	3
Navigation Aid		8									5
Miscellaneous											
Lighting/TV etc.	1-2	10		5	5-10		5				10
Hybrid/Grid Interface		27									
TOTAL	1-2	51	1-2	20	5-10	10	15	150	90-100	5-7	57
GRAND TOTAL						405-424					

CU = Chulalongkorn University
EGAT = Electricity Generating Authority of Thailand
NEA = National Energy Administration
PEA = Provincial Electricity Authority
TOT = Telephone Organization of Thailand
MIS = Miscellaneous
ME = Ministry of Education
MI = Ministry of Industry
MD = Ministry of Defense
VH = Volunteer Health Care Mission under the Patronage of the King's Mother
MH = Ministry of Health
* = Donation from Japan

Solar Box Cookers

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Temperatures in a solar box cooker typically reach 200 to 300°F (93 to 149°C). Since germs die at 160°F (71°C), food cooks at 180°F (82°C), and water boils at 212°F (100°C) the solar box oven is completely effective. Cooking times with the solar box may be twice as long as with conventional cooking, but there is no danger of burning food. Cooking with the solar box requires much less of the cook's attention than do most conventional methods.

To protect her right to give her invention to a fuel-short world, Kerr obtained a patent on her design.

Another of SBCI's founders, Dr. Robert Metcalf, is a microbiologist who stresses the usefulness of the cookers for heating water to kill germs. Diseases from contaminated water claim over 10 million lives per year. Metcalf administered a series of tests to prove that the solar cookers leave both foods and water germ free.

"This simple technology can be of tremendous benefit to the hundreds of millions of people in the Third World who face a growing fuelwood shortage," says Beverly Blum, SBCI's executive director. "That's clear when we consider the day to day lives of people who are dependent on fire for cooking. People – often women – must spend hours a day scavenging for wood that is ever harder to find. They spend hours over a smoky fire, suffering damage to both their lungs and their eyes. Twenty percent or more of meager incomes must be spent to purchase firewood, and when the supply is gone there is no way to cook at all."

According to recent studies by the Food and Agriculture Organization (FAO) of the United Nations, 1.5 billion people in the developing countries face fuelwood shortages. That figure is expected to grow to 2.4 billion by the year 2000. In Africa, for example, 84% of the population will face wood shortages by the end of the decade.

SBCI's vision is that within 10 years, these billions of people will learn that solar cooking works and that they can build their own affordable solar box cookers. To that end, SBCI concentrates on developing simple, easy-to-follow educational materials for building and using the cookers. SBCI also tests local adaptations and improvements of the cookers and provides a solar box cooking information bank for the world.

Volunteers from SBCI have travelled from Bolivia to Zimbabwe to lead workshops introducing solar box cooking to community leaders. Metcalf alone has given workshops in ten different countries; the cookers are demonstrated and the participants build their own. Metcalf says the introduction process also includes

east of Bangkok. This power plant, the first grid connected PV-plant in Thailand, is capable of feeding the electrical energy into the local grid network by using the line commutated inverter. The plant was specially designed and installed by utilizing high technology equipment complete with a modern control and data acquisition system (Fig. 1). The construction and installation were completed in May, 1988 and since then the system has been in operation. The plant works in combination with an existing 20 kW hydro power plant as a hybrid system.

Since the solar (hybrid) power plant has been installed and put into operation, the data gathered from the actual operation of this power plant have been evaluated and used for modifying some of the system components to achieve the optimum performance. The outcoming data will also be used to study and evaluate the feasibility of developing larger scale solar power plants in the future. Furthermore, the implementation of this solar demonstration plant will add to the know-how and experience of EGAT's staff and prepare them for future operations.

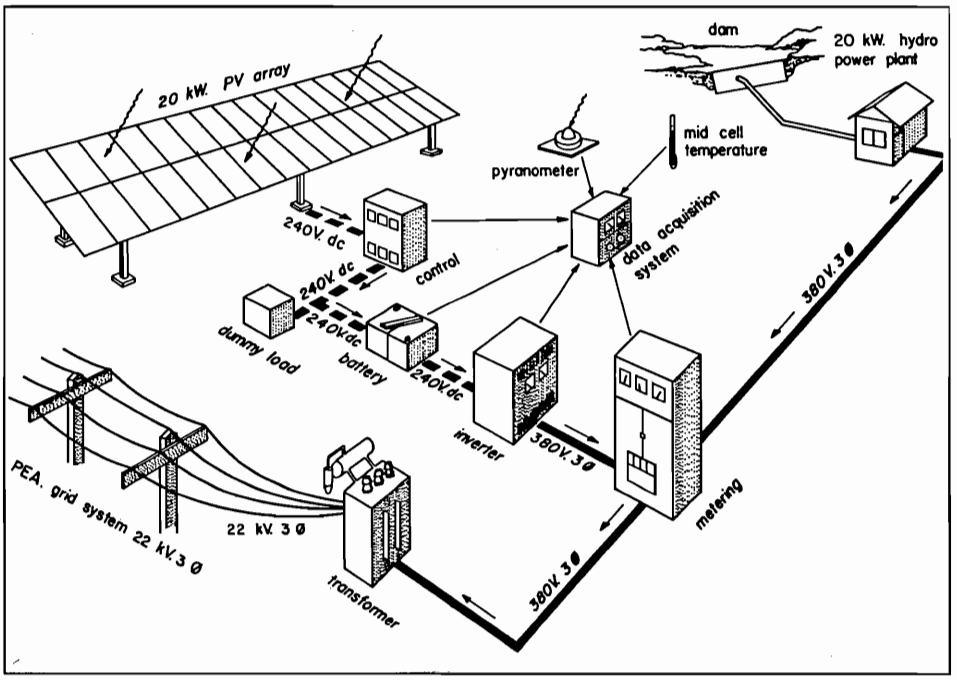

Fig. 1. Pictorial diagram of hybrid power generating system.

EGAT has included PV in its renewable energy program since the late 1970s. This far-sighted policy of EGAT's management was adopted following the oil crisis in the last decade. Table 2 enumerates various PV-activities of EGAT.

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adapting the box to local foods and materials and continuing support by local solar box cooker promoters to respond to the problems, questions and suggestions of local users.

Equipped with an effective cooker, with educational materials translated into ten languages so far, and with a sensitive, thorough approach to introducing the cookers, SBCI is courting organizations to "multiply" knowledge of the cookers. The plan is to pass solar cooking expertise and enthusiasm on to organizations which have existing networks of organizers and promoters in local communities where the solar alternative would be welcome. SBCI has already stimulated active interest among organizations ranging from United Nations affiliates to the International Girl Guides and Girl Scouts.

SBCI is currently developing an inexpensive, collapsible cooker kit that can be shipped easily anywhere in the world for use as a demonstration model.

Despite its long term focus on the developing world, SBCI's most concentrated following so far is in Northern California, where it is headquartered. Hundreds of people in the region have built cookers at SBCI workshops. Thousands more have purchased SBCI's guide for building their own cookers. Income from the sale of the guide helps support SBCI's work of producing educational materials, testing modifications of the cookers, and sponsoring pilot projects in Third World countries.

California users of the solar boxes report that they reduce utility bills, keep the kitchen cooler in the summer time, and produce tasty, succulent foods with less trouble than with conventional methods.

Users in rural India also have a variety of reasons for liking the solar cookers, according to a report by a local promoter of the box ovens. Interviewing 108 solar box users in India's Kangra Valley, the promoter found that reasons for preferring solar cooking included protection of trees and nature; clean, smokeless cooking; savings on commercial fuel costs; and the fact that solar cooked food never gets burnt.

Plans for building a solar box cooker may be obtained in three to six weeks by sending one's name and address and a check for five dollars to: Solar Box Cookers International, 1724 11th Street, Sacramento, CA 95814, USA. For information about SBCI and its new solar box cooker kit, send a stamped, self-addressed envelope to SBCI "Kit" at the same address.

(Source: *Solar Box Cookers International, Press Release*, Autumn 1990.)

PV Development and Applications in Thailand

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Table 2. EGAT's Photovoltaic activities.

Region Activity	Central (kW)	North (kW)	East (kW)	South (kW)	Total
Navigation Aid	0.7	1	3.3	3	8
Telecom.	2	2	2	–	6
Hybrid					
PV+Wind	–	–	–	6	16
PV+Hydro	–	–	21	–	21
Misc.	2	5	2	1	10
Grand Total					61

Proportion of PV Technology installed in EGAT

Single-crystal Silicon	49%
Poly-crystal Silicon	45%
Ribbon Silicon	4%
Amorphous Silicon	2%

Local Manufacturers/Distributors

Three local manufacturers, under some kind of joint venture/technology back-up from foreign companies, have registered with the government and benefited with some investment privileges. Two of the manufacturers fabricate single-crystalline PV modules, one with a US company and the other with a British/Australian company. The third manufacturer has negotiated with a US company to fabricate poly-crystalline PV modules.

Despite the combined annual producing potential of several hundred kilowatts, the current market share of locally fabricated PV modules is considered very small and some are known to have been exported elsewhere. As for local distributors of imported PV modules, there are only a few, usually annexed to small divisions of trading companies. They operate from time to time on some cooperation projects supported by foreign countries.

Academic Institutions

The involvement of academic institutions is almost solely in the field of R&D work. One university and 3 institutes of technology are known to be active in PV. The Semiconductor Development Research Laboratory (SDRL) of Chulalongkorn University (CU) in Bangkok has been experimenting with single crystalline silicon cells and modules from imported silicon wafers for more than 10 years. Facility to process amorphous silicon cells have also been included recently. The other 3 institutes of technology, also in Bangkok, have the capacity to test and evaluate PV modules and PV systems. These academic institutions have also conducted R&D projects on PV system for small scale lighting, refrigeration and water pumping, etc., in remote areas. Also, many vocational schools have begun to include PV education kits in their laboratories.

Price of PV Modules

From EGAT's PV module inventory the FOB price per peak watt of small quantity (up to 2 kWp of 20-40 Wp modules) produced between 1981 to 1988, may be summarized as follows:

Approx.	US$20	in 1981
	US$8-12	in 1984
	US$4-10	in 1985
	US$5-8	in 1988

Since there is no tax incentive scheme for imported PV modules, the real price paid for each procurement has to be multiplied by a factor of 1.6-1.8. For small capacity modules of 5-10 Wp, the prices are double.

Future Outlook

PV is already competitive for some small applications like lighting, television, water pumping, etc., in remote areas. During the next several years PV will be more acceptable in those remote communities which cannot be served by the rural electrification program. If PV prices continue to drop and its efficiency increases, and if energy resources and environmental impacts cause more concern (which is the likely trend), the use of PV for roof-top or even for central station grid connected systems in some areas may become feasible by the turn of this century.

From the status of PV activities in the country, it may be concluded that:

a). Thailand should be in a position to gain significant benefits from solar energy through PV technology.

b). Recommendation should be submitted to the government for its meaningful support. The block buying of PV modules from local manufacturers, tax incentive scheme for users, R&D funding for academic institutions, etc., provided by the government, would assure the long-term interest of these groups.

Further details on PV activities in Thailand are available in: (a) Status of Photovoltaic Development in Thailand by Chaya Jivacate, pp.63-68, and (b) Thailand's First Grid Connected Photovoltaic Power Plant, by Jirakom Padumanon, pp.130-135, in *Decentralized Power Production for the Rural Consumers: Seventh Asian School on Energy,* 17-26 January 1990, Bangkok, Thailand. The proceedings are published by the Energy Technology Division of the Asian Institute of Technology and are available from the Regional Energy Resources Information Center (RERIC, AIT, G.P.O. Box 2754, Bangkok 10501, Thailand) at US$ 20.00/copy.

World's Largest Solar Power Plant Expands in California, USA

The world's largest solar-power facility, located among the scrub brush of the Mojave Desert, has been the site of frenetic activity the last few months as operators worked to fire up their most advanced mirror-troughed energy field.

The operator of the plant, privately held Luz International, was under a severe deadline of September 30 – the date of expiration of the 10% federal and state tax breaks for investors involved in funding the US$278-million project.

That created additional costs, but it is far from the most daunting task Luz faces. Flanagan admits that the company may not be able to expand beyond its current production unless it can surmount several roadblocks.

Still, one very interested observer – Nick Lensson, a researcher at the Worldwatch Institute – thinks solar plants like the one Luz is operating will eventually spread to other sun-drenched areas as well.

All alternative energy tax credits for 1990 would probably cost about US$50 million, Lensson said. By comparison, the recent budget proposal that President George Bush and congressional leaders saw rejected by Congress contained an estimated US$4 billion in tax breaks and incentives for oil companies, he said.

Luz wants to add four more 80 MW plants over the next four years. "The expansion is critical if we're going to come up with new technologies to make solar more affordable," Flanagan said. So plans for a 10th plant, scheduled to be built next year, are on hold. "Without the credits, we can't get the investors," Flanagan said. The new plant was the ninth built by Luz in this desolate area about 225 km northeast of Los Angeles. The plant – called Solar Electric Generating Station Ixe or SEGS Ixe – boosts the capacity of the nine Luz facilities to 340 MW or enough to supply the electrical needs of 500,000 people.

Luz has built the solar fields – consisting of arrays of curved mirrors that individually track the sun – on about 1,000 acres of desert. Each mirror focusses the sun's light onto a steel pipe mounted inside a vacuum-insulated glass tube.

Luz has raised more than US$1 billion from utilities and private investors to build the plants. But it can only sell the power to a utility, and that means Southern California Edison, which is regulated by the California Public Utilities Commission.

Edison's agreement to buy the power is based on contracts that pay Luz partly on how much power it produces and partly on the "avoided cost" of the electricity – in other words, what it would cost Edison to produce the electricity by conventional means. The rates are revised on a quarterly basis. Currently, Edison is paying about three cents per kWh to Luz, based on its cost of burning natural gas. But, as of November 1, 1990, Edison wants to lower the payment to 2.5 cents per kWh, based on the cost of burning crude oil.

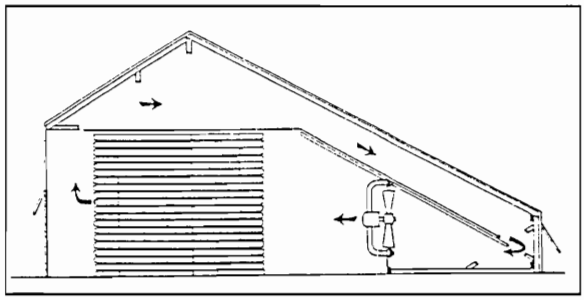
Luz had revenues of US$220 million and a 15% return on equity last year. Investors include Chrysler Capital Corp and Constellation Energy, a unit of Baltimore Gas & Electric.

(Source: *Bangkok Post*, October, 1990, p.25).

The Portable Solar Timber Kiln

In tropical or subtropical countries the air drying of timber is often difficult and results in spoilage. Forced drying is too expensive and may result in cracking or deformation. The portable solar kiln is used in combination with air drying. This innovation caters for furniture makers in developing countries, or others who need a seasoning method that results in wood stability and conservation.

The kiln consists of a frame of aluminum covered with a sheet of "Melinex", which is the ICI trade name for a clear plastic that allows heat radiation to pass through, and is predicted to last in tropical conditions for 4 to 5 years. An inner roof of corrugated metal painted matt black absorbs the heat. Two electrical fans, 1/4 Hp each, circulate the air in the kiln, which has a capacity of 7 cubic metres. The best economy is achieved by starting with the conventional air drying of the freshly cut and stacked timber. Without restacking, it can be finished off in this solar kiln.



Schematic diagram of solar timber kiln.

This innovation offers low capital and operating costs and requires no particular skills from the operators. The waste is considerably reduced compared with conventional methods. In Sri Lanka good quality was obtained after 6 to 10 days of air drying followed by the same time in the kiln.

For further information contact: Mr. R.A. Plumptre, Cambridge Glasshouse Co. Ltd., Comberton, Cambridge CB3 7BY, UK.

(Source: *Appropriate Technology*, Vol.17, No.2, September 1990, p.16).

Solar Lumber Dryer – Philippines

A Philippine research institute has developed an extremely efficient solar-dryer for lumber that could spell considerable energy savings over conventional systems, as well as cutting set-up and operating costs for lumber processors.

The Forest Products Research and Development Institute, under the Department of Science and Technology, reports that the greenhouse-type structure developed, made of locally-available materials and suitable for use even by smaller-scale, rural manufacturers of products such as furniture, can handle up to 500 board feet of lumber per charge.

The new system offers distinct advantages in speed of drying and in final moisture content over the widely-used, air-drying methods. In addition, its cost of 30,000 pesos (US$1,300) is significantly less than 60,000-peso furnace-type and 100,000-peso steam-heat.

The technology is particularly important to the Philippines, where power-generation systems are already stretched to the limits and sunny days are plentiful. In addition, the manufacture and export of wood items, such as furniture, carvings, and novelty items are important components of the economy, especially in more depressed areas.

According to Doroteo Hernandez, the new system can dry one-inch board samples with an initial moisture content of 96% to 11% c.u. in 41 days, compared with the 85 days required to reach 15% in air-drying systems. Standards for wood items to be exported to markets in temperate zones, such as the U.S. and Europe, require a moisture content of no more than 12% to prevent cracking.

(Source: *Power in Asia*, 24 September, 1990, Issue No.60, p.19).

Solar Education for Architects

All buildings are potential solar collectors and architects must be able to design buildings that take advantage of this benefit during cold months while avoiding excessive gains in summer which may cause overheating. Architects must learn to "handle" solar radiation through a knowledge of solar geometry in relation to building form and solar radiation received on walls and roofs and collected by glazed openings. People too are solar collectors when they take advantage of direct sunlight in spaces between buildings, so urban planners must also learn how to ensure adequate winter sunlight in out-door spaces, and achieve shade in hot seasons.

Buildings and urban spaces, unlike other "solar collectors", must fulfill a wide range of functions. Architects cannot concentrate exclusively on solar aspects as they are simultaneously faced with economic, functional, legal, structural, social and aesthetic requirements.

Solar education for architects must cover four sequential steps.

1. Professionals must be convinced of the need for solar design.
2. They must understand the basics of sun-path geometry and solar radiation to gain an intuitive feeling for the variables.
3. They must be able to apply simple techniques for ensuring direct sunlight, incorporating solar protection, checking radiation levels and evaluating conventional energy savings.
4. Finally, they must be able to apply this knowledge during the design process and integrate solar aspects with other design requirements.

These themes form part of the graduate and postgraduate courses established in 1984 in the Faculty of Architecture, Design and Urban Planning at Buenos Aires University.

At the undergraduate level, an annual Course on Bioclimatic Design and Solar Architecture is given to an average of 100 students. They choose a locality, study the climate, propose design guidelines and develop a project, such as a housing group.

As Argentina stretches from the tropics to the south pole, climatic differences, varying sun-paths and contrasting radiation levels must be reflected in the architectural design. Techniques to optimize winter sun, dimension solar protection and compare radiation levels are applied to improve the project. Appropriate passive solar systems for each region are then integrated into the design process. In this course, the emphasis is on application and integration in design using suitable technologies for developing countries.

At the postgraduate level, greater specialization is possible. Three subjects are offered in the Advanced Course of Building Technology and Production: Habitat and Energy, a study of energy use in the built environment; Bioclimatic Design, a deeper study of the themes covered at undergraduate level; and Non-conventional Energy Use in Buildings, quantifying solar-thermal processes in buildings. Thirty to fifty students follow these courses each year.

Since architects are visually minded and think in three dimensions, model studies are extremely useful. The Research Group "Habitat & Energy" has constructed a 5 m diameter heliodon which simulates direct sunlight for each hour of the day in each season of the year for any latitude from the equator to the pole. They have also measured hours of sunlight in existing dwellings to quantify radiation levels and identify design faults. Another research project aims to define appropriate planning requirements for sunlight and solar access in different latitudes.

For further information, write to:
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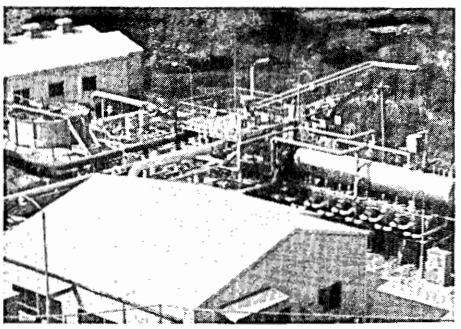
Argentina.

(Source: *IASEE Newsletter*, 3/1990).

The Development of a 10 MW Demonstration Binary Cycle Geothermal Power Plant - Japan

Japan is one of the world's most volcanic countries, and is thought to have abundant useful reserves of geothermal energy. As only a limited amount of other natural energy resources is domestically available, there is considerable interest in developing these geothermal energy resources.

NEDO, the New Energy and Industrial Technology Development Organization, plays a major part in sponsoring the technological development of geothermal energy applications in order to promote the use of this type of energy, particularly in such technical fields as the development of power plants that use hot geothermal water.



10MW Demonstration Plant.

Another method of geothermal energy utilization which NEDO is actively supporting is technology for a hot dry rock power generation system that extracts geothermal energy being held by hot base rock in the earth which contains neither hot water nor steam.

Development of Binary Cycle Power Generation Technology

A conventional geothermal electric power generation plant uses only geothermal steam flowing out to the surface. Hot water that is produced underground together with the steam, although present in great

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Successful Trials for New Solar Paddy Dryer in Indonesia

Field trials of a new NRI (Natural Resources Institute)-designed paddy dryer were completed successfully in Indonesia earlier this year in collaboration with the Sukamandi Research Institute for Food Crops (SURIF). Results look very positive and the final research phase will take place when an NRI team returns to Indonesia early in 1991.

Paddy is usually sun-dried on floors in Indonesia. Instead, NRI's dryer – developed under an ODA Research-funded project – provides a solar collector in the roof of a simple building. This gathers the sun's heat and channels the resulting hot air to a fanhouse where a diesel-driven fan passes it evenly through paddy contained in two drying bins.

Waste heat produced by the engine allows drying to continue at night, and the dryer can also operate during cloudy weather – particularly important in Indonesia as the main rice crop occurs during the wet season.

The prototype dryer was built by local building contractors in Jatasari, about 60 miles to the east of Jakarta, from a set of engineering drawings produced by NRI.

Commissioning trials carried out by NRI engineer David Trim put the dryer through its paces, and showed that it more than lived up to laboratory predictions. It can operate continuously and maintain a throughput of 10 tonnes of wet paddy a day.

Milled rice from the solar dryer was compared with similar sun-dried control samples. "Not only was the yield of milled rice from the solar-dried paddy higher, but its quality was better," said David Trim. A follow-up marketing survey of the paired samples, conducted by NRI economist Ann Gordon and colleagues from SURIF, showed that this improved quality was such that it could command a higher price than its sun-dried equivalent. These financial benefits mean that a miller introducing the dryer could recoup the cost of his investment in three to four years.

Additional comparative trials with a conventional mechanical drying unit have shown that the NRI/SURIF drying system employing solar heat reduces fossil fuel consumption by at least 25 per cent, whilst simultaneously enhancing product quality.

An NRI team will return to Indonesia during the next wet season, primarily to obtain comparative information on the traditional sun-drying of paddy. They will also study the feasibility and cost of converting existing mill buildings to dryers.

In Britain, NRI technologists are looking at the possibility of scaling down the dryer to produce a 6 and a 3 tonne unit. Reducing the size, and therefore the capital cost, of the dryer would make the technology attractive not only to the larger millers but to the great number of smaller ones.

For further information contact:

Natural Resources Institute
Central Avenue
Chatham Maritime
Kent ME4 4TB
UK

(Source: *RESOURCE, NRI Newsletter*, Issue 2, August 1990.)

The Development of a 10 MW Demonstration Binary Cycle Geothermal Power Plant - Japan

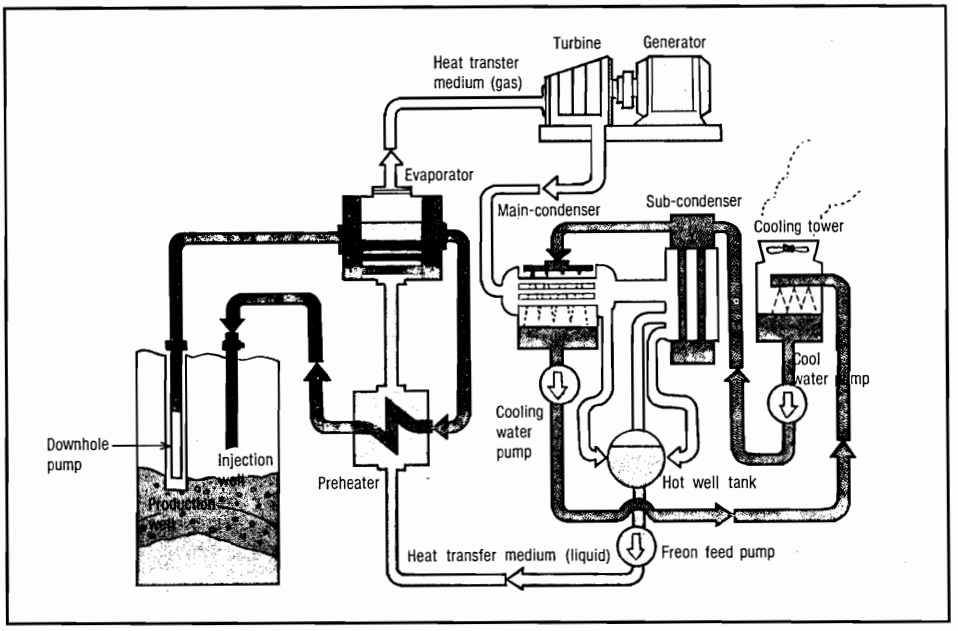
From P. 7

volume, is not used for power generation, and is eventually reinjected into the ground. Another type of unused geothermal water is hot water held in geothermal reservoirs, the temperature of which is not high enough to drive the hot water or steam to the surface. In such a case, pumping it up for utilization has not so far been feasible economically.

NEDO, however, is endeavoring to establish a new technology, binary cycle electric power generation, which permits the use of such hot geothermal water in an economically feasible manner.

In binary cycle power generation, energy being held by such hot water is transferred to a low boiling point heat medium, so as to generate the vapor of the medium, raising its pressure high enough to drive the turbine for power generation. This now makes it possible to use the potential energy in geothermal water. This power generation concept also offers higher economic feasibility than the pumping-out of geothermal water from an underground reservoir which does not have a strong enough driving force, since the water can be used at a binary power plant. In this case, the water will be drawn upward using a downhole pump installed at the bottom of a production well.

By developing this method, a technological base for increasing geothermal power production in Japan will be completely established, since the method can release the power of medium and high temperature liquid-phase geothermal water reserves which are significant potential energy sources.



Flow Diagram of a Binary Cycle Power Plant.

Development of 10 MW Demonstration Binary Cycle Plant

In 1974, when the Sunshine Project was launched after the first oil crisis, research and development of the binary cycle concept was started in order to more fully use geothermal energy. By 1979 NEDO had succeeded in constructing and operating two 1000 kW pilot binary geothermal power plants of different types, one for hot water use, and the other for combined use of hot water and steam. Since then, efforts have been directed towards upgrading the plants to a demonstration level. Such efforts include the development of certain basic techniques that will enhance the performance level of the main plant components, and also includes the optimization of the plant. In 1983, NEDO launched the development of downhole pumps that will be needed for applying the binary cycle power generation concept to medium and high temperature geothermal resources.

Starting in 1985, a preliminary survey was started for a 10 MW binary cycle plant in Hohi Sugawara, Oita Prefecture. Hohi Sugawara is typical of areas having reserves of medium and high temperature geothermal water in Japan. The survey aimed to establish the existence of geothermal reservoirs there. Seven 100m class wells were drilled, and well tests were carried out. The results established the fact that highly prospective medium and high temperature liquid-phase geothermal resources of 190-210°C are present in this area.

The numerical simulation of the reservoir properties, including their temperature, pressure and permeability monitored since FY 1987, proves the prospect for the generation of 10MW electricity in this area.

Development of a Downhole Pump

A downhole pump driven by a submerged motor has been researched and developed since 1983 to produce and effectively use geothermal hot water that has been left unused because the water has insufficient force to flow out.

Target parameters for development of test pumps.

	Pump		
	No.1	No.2	No.3
Discharge, t/h	50	100	200
Lift, m	300	340	340
Water Temperature, °C	170	200	200
Motor Output, kW	100	200	400

The No.1 test pump with a discharge of 50 tons per hour (t/h) successfully ran in a downhole 1000-hour continual operation test carried out in a geothermal well at a site in March 1987 with a bearable water temperature of 170°C and a lift of 300 meters.

With the No.2 test pump, 200°C has been selected as the target stress temperature, a key parameter for a downhole pump that is to operate in geothermal water of high temperature under high pressure.

The No.2 test pump was designed and fabricated to have a discharge of 100 t/h. It successfully ran in a 300-hour continual operation test under 200°C hot water in a shop test in March 1989.

At present, NEDO has studied and developed some elementary techniques. Based on the above results, a No.3 test pump will be designed and fabricated in March 1991 and it is expected that it will be further developed into a practical pump.

For further information contact:
Geothermal Energy Department
New Energy and Industrial Technology Development Organization (NEDO)
29th Floor, Sunshine 60 Building
1-1, Higashi Ikebukuro 3-Chome
Toshima-ku, Tokyo, 170
Japan.

Power Plant Lights up Rural Villages in Chiang Mai, Thailand

For poor rural villagers in Chom Thong District of the northern province of Thailand, the Mae Ya hydropower plant is a dream come true.

Electricity has brightened the hope of many villagers who expect to earn more income from cottage industry and agriculture-based projects, now given a boost by a small dam that generates 4.9 million units of electricity per year.

The 291-million-baht hydropower plant located in Tambon Ban Luang of Chom Thong District was built by the Provincial Electricity Authority (PEA). The government provided 165 million baht for the construction, and 126 million baht in aid was given by the British Government, according to Mr. Boonyiam Rattanakul, Director of the PEA Zone 1, Region 1.

The project is aimed at providing electricity to remote areas far away from the city and power transmission networks. "Because of higher oil prices, the PEA has opted for hydro-power generation," Mr. Boonyiam said, adding that low-cost, small-scale plants are most appropriate.

During the early stages of the project, PEA was assisted by Norwegian and British experts. The engineering consultant company was Balfour Beatty Engineering Limited.

Apart from the Mae Ya plant, which generates 4.9 million units of electricity per year, the PEA is implementing two similar projects in the North, namely the Mae Toey Project (10.1 million units) in Om-koi District of Chiang Mai, and the Mae Pai Project (9.4 million units) in Pai District of Mae Hong Son. The two projects are expected to be completed late next year.

The Mae Ya hydropower plant is located in about 30 rai of land surrounded by mountains in Doi Inthanon National Park, and is close to the Mae Ya Waterfall. A 48-metre-long concrete dam is built across Mae Ya stream, which flows from the mountains.

The power plant generates electricity for more than 280 households in the five villages of Ban Tung Buri, Ban Huay Sapaed, Ban Huay Pu, Ban Huay Muang and Ban Tha Komuang.

The villagers look forward to a better life, with more income from the local cottage industry, fishery and farming. Mr. Boonyiam, however, noted that the most important thing is to increase the villagers' awareness about the importance of forest conservation.

(Source: *Bangkok Post*, 10 October, 1990, p.10)

Gulf Crisis Revives Brazil's Alcohol Energy Programme

Brazil's stalled programme to run cars on pure sugar-cane alcohol instead of gasoline has been revived due to the Gulf crisis. Today, with oil prices rising, critics are taking another look at the programme, known as Pro-Alcohol. The resurrection of Pro-Alcohol is good news for owners of Brazil's 4.5 million alcohol cars – one-third of the nation's vehicles – who believed the clean, sweet-smelling fuel was the energy of the future.

General Motors and Autolatina, which groups Ford and Volkswagen, announced an immediate 11% increase in production of alcohol-burning cars to meet a rise in demand.

"The country was the victim of an optical illusion that oil would be eternally cheap and plentiful," Julio Maria Borges, production director of Copersucar, Brazil's largest alcohol cooperative, said in an interview.

The programme was a response to the 1973 oil shock. Brazil, which imported more than 80% of its petroleum, saw its oil bill soar from US$600 million to US$2 billion in 1974, on one-fourth of total imports. Alcohol seemed then like the solution to dependency on foreign oil. It is made from sugar cane, a renewable source that grows abundantly in Brazil. And it fitted in well with the "national security" concerns of the military governments that ran Brazil from 1964 to 1985.

Few mentioned the risks. Alcohol was untested on a wide scale anywhere in the world. It gave poor mileage and cost more than US$40 a barrel to make. But Brazil, riding the euphoria of its "economic miracle," was undaunted at sinking billions of

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Malaysia Tries Palm Oil as an Alternative Fuel

Awash with surplus palm oil stocks and with an eye on rising oil prices triggered by the Gulf crisis, Malaysia is stepping up efforts to turn palm oil into fuel for trucks and buses.

With an output of six million tons a year, Malaysia is the world's largest producer of palm oil, a major component of the multi-billion dollar edible oils world market.

Overproduction of oilseeds worldwide has dragged down the price of palm oil, which is also used to make soap, and forced Malaysia to look into other possible uses.

Researchers say palm oil diesel is less-polluting, performs better and ensures longer engine life than conventional fuels.

In Malaysia's capital, Kuala Lumpur, 40 city buses began experimenting with palm diesel last September under a programme jointly run by Germany's Daimler-Benz company – makers of Mercedes Benz trucks and cars – and Malaysia's state oil firm Petronas.

The buses, fitted with specially-designed diesel engines, are expected to clock 300,000 km (187,500 miles) during the two-year trial. Earlier trials using army trucks, taxis and jeeps within the city have been encouraging, Choo Yuen May, a young Malaysian scientist, said.

A litre of palm oil diesel would yield 12 km (7.45 miles) of travel compared with 13 km (8.1 miles) for conventional diesel-powered taxis, she said. But for heavy vehicles, it is more economical in terms of fuel consumption to use palm diesel.

Spearheading the research is the Palm Oil Research Institute of Malaysia (PORIM), which started laboratory tests in 1982 at its sprawling premises in Bangi near Kuala Lumpur.

Following the initial success, PORIM and Petronas jointly set up a four million-ringgit (1.5-million-dollar) plant in 1985 to expand the research. The plant is capable of producing 3,000 tons of palm diesel a year, equivalent to 74 barrels per day.

But some economists and energy experts said they doubt the commercial viability of palm diesel due to high production costs and other technical hitches.

However, PORIM officials said the fuel could be commercially viable if crude palm oil prices are much lower than crude oil prices.

"Crude palm oil prices must be below 7000 ringgit (US$259) a ton and crude oil prices above US$30 a barrel for palm diesel to be viable," PORIM Director-General Abdul Halim Hassan said. "At this moment, it is viable."

Palm oil prices are hovering around 670 ringgit (US$248) a ton, down sharply from a high of 2,660 ringgit (US$985) in 1984, largely due to soaring production and the high stock level of over 800,000 tons in Malaysia alone.

In contrast, crude oil prices have shot up to around US$40 a barrel, a 10 year-high, after Iraq's invasion of Kuwait.

Palm diesel, using mainly low quality palm oil, could serve as a fallback measure, Halim said "It can be looked at as a fallback strategy if the price of palm oil drops very drastically."

Halim said tests were being carried out to extract "good" materials out of crude palm oil to ensure the high quality of edible oils exports, and to use the remaining low quality oil for diesel fuel.

Augustine Ong, Scientific and Technical Director of the Malaysian Palm Oil Promotion Council, told a recent seminar that test results showed palm diesel could be used as a substitute for diesel without having to modify car engines.

Augustine also said several research projects were being undertaken to widen the use of palm oil as non-food items. About 90% of palm oil is now used for food items.

(Source: World Business, *Bangkok Post*, 20 October, 1990, p.20.)

Gulf Crisis Revives Brazil's Alcohol Energy Programme
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dollars in mammoth, long-term development projects. The bill would come later.

In 1975, its first year, Pro-Alcohol produced gasohol, which contained 22% alcohol. In 1979, the programme entered its second phase. The first 2,271 alcohol-burning cars were built and sold.

But there were bugs in the early models. They wouldn't start on cold mornings, and the alcohol destroyed metal carburetors and fuel tanks. Auto makers, learning along the way, devised mini-gasoline tanks for cold starts and special anti-corrosion coatings. To compensate for poor mileage, the government made alcohol 35 percent cheaper than gasoline and offered tax breaks on alcohol cars. It promoted the programme with the slogan "Alcohol cars: Someday you'll own one." The response was overwhelming. Sales of the new cars rose to 38% of the market in 1982 and 88% the next year. In 1985, the peak year for alcohol cars, an amazing 96 of every 100 cars sold were alcohol-powered. Pumps bearing the green "A" for alcohol sprouted in service stations across the country.

But things began to go wrong for Pro-Alcohol. Defying predictions, oil prices levelled off and fell. Alcohol, still a hefty 40-dollars-plus a barrel, began to look very expensive. Worse, the government couldn't raise the pump price of alcohol without also raising the price of gasoline. The spiral of fuel prices pushed inflation up to three digits, then four. Farmers, encouraged by subsidies, replaced food crops with sugar cane. The government had to import food, adding to its 117 billion dollar foreign debt.

(Source: *Bangkok Post*, 10 October, 1990.)

Renewable Energy Systems for Nigerian Communities

ACTIVITIES OF THE SOKOTO ENERGY RESEARCH CENTRE, USMANU DANFODIYO UNIVERSITY, SOKOTO

Energy has been the key to the social development of man and an essential component in improving the quality of life beyond the basic activities necessary for survival.

Realising the above fact, the Federal Government of Nigeria established (in 1982) four Energy Research Centres of which Sokoto Energy Research Centre is one. The Sokoto Energy Research Centre aims to cover all forms of renewable energy applications. Research is multidisciplinary and addresses technical, economic, environmental, social and legal issues.

During the seven years of its existence so far, the Centre has studied the energy and related problems of the rural communities in Nigeria, and has made tremendous progress in providing possible solutions to these problems. A number of rural energy systems have been developed and are now ready for commercialization. Some of the solar systems are:

Solar Cooker

Portable box and concentrating types of solar cookers have been designed, constructed and tested at the Centre. These cookers have been used in cooking local dishes at the Centre and can also be used for cooking the majority of local dishes (in a reasonable period of time in average sunshine conditions) in both urban and rural areas. The cooker does not need any auxiliary energy sources and can easily be fabricated by local craftsmen using locally available materials.

Solar Water Heater

The Centre has developed a number of suitable solar flat-plate and concentrating collector hot water systems for specific application using locally available materials. The Centre has constructed a solar water heater that can provide adequate hot water of 70-90°C temperature range in average sunshine conditions.

Solar Still

Numerous solar distillation systems have been designed and developed. These types of solar stills can be used in providing drinking water for the rural communities. A prototype of a "double-slope solar still coupled with a hot water heater" has been constructed and tested. Results showed

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Zambia Charcoal Stove Project

The Zambia Charcoal Stove Project aims at countrywide production and dissemination of improved charcoal stoves. Since mid-February, 1990 the project has embarked on a 10-week pilot project. The Exotic Charcoal Pilot Project aims at assessing consumer reactions and a realistic price relation between charcoal made from exotic trees (eucalyptus) and ordinary charcoal made from indigenous trees.

This pilot project will provide vital information in the future planning of "energy plantations" which will be one of the ways of helping preserve Zambian woodlands. Many eucalyptus species are fast growing and may grow to full size (40 metres) in 8 years; whereas species of Zambian hardwood, which are generally used for charcoal, take at least 80 years to mature. Although the energy content of both traditional and exotic charcoal is the same, the density of eucalyptus charcoal is lower, causing it to burn faster.

This problem can be overcome to a certain extent by using improved charcoal stoves. It has been established that the burning rate of eucalyptus charcoal in an improved stove is similar to that of traditional charcoal in a traditional stove. For this reason, marketing of eucalyptus charcoal is done alongside the sale of improved charcoal stoves. Consumer and market surveys have been carried out.

A report on the pilot project may be obtained from:

The Project Coordinator
Charcoal Stove Project
P.O. Box 37879
Lusaka
Zambia

(Source: Eucalyptus for Charcoal? by Getrude Sakubita, *RWEPA News*, April 1990, No.3, p.1)

Turning Landfill Gas into Clean Diesel Fuel

What is being billed as the world's first plant to convert landfill gas into diesel fuel is being built in Pueblo, Colorado, U.S.A. by Ultrasystems Inc. (Irvine, California) for Fuel Resources Development Co. (Denver) and is scheduled to go on stream around the end of 1990. The process, based on Fischer-Tropsch technology, is suitable for small-scale use at landfills and remote natural-gas sites, says Jackson Yu, vice president of Ultrasystems, because it uses an inexpensive iron catalyst and the equipment costs are relatively low. The product, diesel fuel, has essentially no aromatics and no sulfur, so the overall emissions are about two-thirds less than conventional diesel fuel, says Dennis Yakobson, president of Rentech, which developed the technology.

Gas will be collected through multiple wells at the Pueblo landfill, contaminants such as sulfur and halogenated compounds will be removed, then the gas will be catalytically reformed to produce a synthesis gas. Excess CO_2 is removed and recycled (leaving an H_2:CO ratio of less than 2:1). The gas is then passed over an iron catalyst, and about half of the gas is converted to diesel fuel and the rest to naphtha and wax. Capacity of the plant is about 235 bbl/d all products.

(Source: *Chemical Engineering*, Vol. 97, No.7, July 1990, p.19)

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that this system has a higher yield than the conventional still.

Solar Dryer

Solar dryers can effectively be used for fast and hygienic drying of some agricultural produce. Various types and sizes of solar dryers have been designed, fabricated and tested at the Centre.

Solar-powered Vaccine and Medicine Storage Refrigerator

A conventional refrigerator has been powered with solar energy at the Centre. This is more important in rural areas with no electricity supplies for effective execution of immunization, epidemic control and health care delivery programmes.

Solar-powered Water Pumping System

Various photovoltaic water pumping systems have been tested and characterized in the Centre's pump testing facility in order to evaluate the techno-economic reliability of these systems in the local environment. Plans are underway to install and monitor one or two of these systems in rural communities as pilot demonstration projects in the near future.

Solar-powered Air Cooler

A low-power, solar-powered air cooler has been developed at the Centre as a substitute for conventional air-conditioning systems for rural areas having no electricity supplies. The system, in addition to the reduction in the temperature of the living space, increases the relative humidity which is desirable due to highly dry atmospheric conditions in some regions of the country. The system is cheaper than conventional air-conditioning systems under present economic conditions.

Solar Cooker with Oil-Storage Unit (Indoor Solar Cooker)

This solar cooker is meant to enable cooking, using solar energy, to be done indoors as well as during no-sunshine periods and it is basically a modification of the solar water heater with the exception that the working fluid is engine oil and the construction is made such that high temperatures (90-110°C) are obtained in the cooking chamber. The system constructed is being studied so as to determine its exact performance.

Photovoltaic-powered Laboratory Block

Three Laboratories are powered with photovoltaic panels in the centre's complex. The system is capable of producing more than 4 kW peak power. Among the appliances powered inside the laboratories are fluorescent lamps, ceiling fans and sockets for small refrigerators and other low consuming appliances. A 900 Ahr storage capacity using lead-acid batteries is incorporated into the unit. The system is being monitored with a view to analysing its performance so as to enhance local fabrication of solar cells.

For further details, please contact:
The Director
Sokoto Energy Research Centre
Usmanu Danfodiyo University
P.M.B. 2346, Sokoto
Nigeria.

THERMIE - Grants for Energy Projects

THERMIE is an EEC programme to encourage the adoption of new and better energy technologies. THERMIE replaces the earlier EEC Energy Demonstration and Hydrocarbons programmes.

THERMIE offers financial support for three types of projects:

INNOVATORY (DEMONSTRATION) PROJECTS

These are projects in which a new and advantageous energy technology is applied for the first time on a scale sufficient to prove its technical and economic advantages. Support of up to 40% of eligible costs (including monitoring) may be given for projects in

- Rational Use of Energy (Energy Efficiency)
- Renewable Energy Sources
- Solid Fuel Technologies

DISSEMINATION PROJECTS

Support of up to 35% may be given when the technology has been demonstrated once before but has not yet entered the market. Dissemination projects must, however, differ in some aspect from the earlier demonstration – in technology or in climatic circumstances for example – and must still have some element of risk. They may be in any of the three sectors mentioned above for demonstration projects.

HYDROCARBONS PROJECTS

These, similar to projects supported under the earlier TDHS programme, are development or advanced development projects which may verge on pilot plant or demonstration.

The 1991 Call For Proposals

The THERMIE Regulation has now been agreed with a budget of 350 MECUs (£245 million) over the first three years of the programme. It is likely that at least 125 MECUs will be available in 1991.

It has therefore been agreed that all areas included in the Regulation should be open for proposals in 1991. There will be no excluded areas.

According to the THERMIE Regulation 15% of the budget will be spent on 'supporting measures' – mainly promotion and dissemination together with studies, etc. – and the other 85% will be distributed equally among the four main technological areas: Rational Use of Energy, Renewable Energy, Solid Fuels and Hydrocarbons.

For further information contact:
THERMIE Programme
International Liaison Officer
Energy Technology Support Unit
Building 156
Harwell Laboratory
Didcot, Oxfordshire OX11 ORA
United Kingdom.

ADB Approves US$ 200 Million Loan to Philippines' National Power Corporation for the Sixteen Power Project

The Asian Development Bank approved a loan of US$200 million to the National Power Corporation (NPC) of the Philippines for the Sixteen Power (Masinloc Thermal Power) Project.

The loan will come from the Bank's ordinary capital resources and will be repayable over 25 years, including a five-year grace period. The interest rate will be determined according to the Bank's pool-based variable lending rate system.

The NPC is undertaking a 600 MW coal-based thermal power generation scheme, consisting of two 300 MW units, in Masinloc, Zambales Province, 250 km northwest of Manila. The Bank-financed project will cover the first stage of installing one 300 MW unit, together with the common facilities for both units. The facilities comprise coal and ash handling systems, including harbor facilities for unloading sea-borne coal, cooling water systems, a power house and a stack.

The total cost of the project is estimated at US$441 million and the Bank loan will meet 57 per cent of the foreign currency cost. Joint financing of US$150 million by the Export-Import Bank of Japan has been proposed to meet the balance of the foreign exchange cost and a portion of the local current cost.

Luzon is critically short of generating capacity as a result of a rapid increase in demand since 1986, increased forced outages for ageing oil-fired thermal power plants and the Government's mothballing of the nuclear power plant at Bataan.

NPC's generation expansion program to meet the projected capacity shortages includes using gas turbines in the near-term and geothermal and coal-based projects in the mid-1990s. The Masinloc project, an integral part of this program, is due for completion by end-1994.

This is the Bank's sixteenth loan to the Philippines power sector and, in augmenting Luzon's generating capacity, will help the island sustain its projected economic growth. Luzon accounts for about 70 per cent of the country's GDP. The project will also reduce the Philippines' oil dependency and assist its energy diversification program.

In line with the Bank's increasing concern with environmental protection, the project includes pollution control measures such as water treatment plants, electrostatic precipitators and a high enough stack to ensure that the environmental standards are met. The Bank is also providing a technical assistance grant of US$636,000 for a study of Environmental Management of Coal-based Power Generation for NPC to monitor the levels of emission and make sure they fall within environmental standards. The assistance will also be used to help NPC assess the impact of heated effluent discharge from the plant on coral reefs and fisheries in nearby Oyon Bay, evaluate the viability of converting an oil-fired power generation plant to coal utilizing the clean coal technology of fluidized-bed combustion and study the possibilities of commercial applications of fly ash produced in the coal-fired power stations.

(Source: *Asian Development Bank News Release*, No.184/90, 30 October 1990.)

ESMAP Ongoing Energy Projects in ASEAN

The Energy Sector Management Assistance Program (ESMAP) was launched jointly by the World Bank and the United Nations Development Programme in 1983 to complement the Energy Assessment Program which had been established three years earlier. The assessment program was designed to identify the most serious energy problems facing some 70 developing countries and to propose remedial action. ESMAP was conceived, in part, as a preinvestment facility to help implement recommendations made during the course of assessments.

Today, ESMAP is carrying out energy related preinvestment and prefeasibility activities in about 60 countries and is providing a wide range of institutional and policy advice. The program plays a significant role in the overall international effort to provide technical assistance to the energy sectors of developing countries. It attempts to strengthen the impact of bilateral and multilateral resources and private sector investment. The findings and recommendations emerging from ESMAP country activities provide governments, donors, and potential investors with the information needed to identify economically and environmentally sound energy projects and to accelerate their preparation and implementation. ESMAP's policy and research work analyzing cross-country trends and issues in specific energy sub-sectors makes an important contribution in highlighting critical problems and suggesting solutions for dealing with them.

The program's operational activities are managed by three units within the Energy Strategy, Management and Assessment Division of the Industry and Energy Department at the World Bank. These are the Energy Efficiency and Strategy Unit, the Household and Renewable Energy Unit, and the Natural Gas Development Unit.

The Energy Efficiency and Strat-

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ESMAP Ongoing Energy Projects in ASEAN
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egy Unit is engaged in energy assessments, energy sector strategy development, strengthening sector management, efficiency improvements in energy supply, and energy use, training, and research.

The Household and Renewable Energy Unit carries out strategy studies, prefeasibility studies, pilot activities, technology assessments, seminars and workshops, and policy and research work in the areas of household and rural energy, traditional fuel supplies, and alternative energy.

The Natural Gas Development Unit is charged with the promotion of natural gas development and utilization in developing countries through preinvestment work, formulating natural gas development and related environmental strategies, and research.

The ESMAP program represents a cooperative international effort of energy and environmental assistance in the energy sectors of developing countries. It has been supported by the World Bank, the UNDP and other United Nations agencies, the European Community, OAS, OLADE, and a number of countries including Australia, Belgium, Canada, Denmark, the Federal Republic of Germany, Finland, France, Iceland, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Sweden, Switzerland, the United Kingdom, and the United States.

Some of the ESMAP's ongoing energy projects in the ASEAN region are as follows:

ASEAN REGION

Financing Energy Services for Small-Scale Energy Consumers (Finesse)

ESMAP, in coordination with the U.S. Department of Energy and Environmental Protection Agency and the Netherlands Government, is conducting a joint project to identify and review innovative options for financing energy conservation and alternative energy systems for small-scale energy consumers (households, informal sector, and commercial enterprises). While the opportunities, in the aggregate, for these small-scale energy consumers are quite large, identification, appraisal, financing, and management of these opportunities have been relatively meager due to a lack of established institutional frameworks. Thus, ESMAP's objective is, first, to find out whether the current institutional framework could absorb further aid in this subsector and, second, to package a project of sufficient scope so as to attract financing from the multilateral development banks. The results of this joint effort will be a workshop in early 1991 targeted for the ASEAN (Association of Southeast Asian Nations) region to help identify and promote viable projects in the sector. It is also envisioned that a project identification and evaluation handbook will be developed as an input for the workshop.

INDONESIA

Biomass Gasifier Preinvestment Study

The objectives of this activity are to assess the potential technical and economic role of biomass gasifiers in Indonesia, define the scope of their possible contribution to the needs in the energy sector, and, if significant, outline the investment requirements necessary to support their efficient utilization. The project has resulted in a report to the Government of Indonesia outlining a strategy for the development of the technology which is consistent with national priorities. A seminar to discuss the recommendations of the report was held in Jakarta in July 1990. The Government of the Netherlands is providing US$138,000 for this activity.

Improved Biomass Utilization Study Phase I

The overall objectives of this activity are to (a) develop a consistent and comprehensive database of biomass resources in Indonesia, (b) locate sites where utilization of these resources could supply economic power for existing energy demand, and (c) prepare projects to demonstrate biomass energy conversion technologies in these high potential applications. Phase I will consist of a review of all recent studies on this subject and an identification of the subsectors likely to make the greatest contribution to meeting Indonesia's energy needs. The Government of the Netherlands has agreed to finance the US$133,000 cost of phase I.

Technology Transfer and Demonstration of Charcoal Ferrocement Gasifiers

The primary objective of this project is to introduce and transfer the Asian Institute of Technology (AIT) ferrocement gasifier technology to Indonesia where the potential for its further development and eventual economic application are very promising. The Institute of Technology Bandung (ITB), given its long-term experience with wood and rice husk gasification, is the appropriate recipient point for the technology transfer to Indonesia. Transfer of the AIT ferrocement gasifier technology to ITB will also allow ITB to redirect its current research efforts in gasification technology in the direction of low-cost ferrocement gasification systems and to investigate the possibility of using lower cost fuels such as waste wood and rice husks with the ferrocement technology. The potential result would be the development of a significantly more economic gasification system for use in Indonesia and elsewhere.

PHILIPPINES

Assistance for Updating the Nonconventional Energy Program

Since the first oil shock in the early 1970s, the Philippines have undergone an energy substitution process involving the development of indigenous energy sources for self-reliance. Oil imports were reduced to about 49 percent in 1985, substantially through exploitation of abun-

dant geothermal resources. However, except for the use of traditional agri-residues such as bagasse and rice hulls, there have been few opportunities for economic applications of renewable energy resources. A responsive activity considered of high priority by both the World Bank 1988 Energy Sector Review and the government's Office of Energy Affairs was to update the non-conventional energy (NCE) program and integrate it into the national energy plan. The proposed ESMAP activity aims to provide expert assistance to the government in evaluating its NCE projects and programs, including expansion of the existing database and matching supply incidence with potentially commercial utilizations. The activity will attempt to realistically determine the most likely contribution of NCE in the national energy plan. The joint ESMAP/OEA effort is costed at US$275,000 for local and outside experts and supporting microcomputer equipment. An initiation mission was launched in June 1990 where agreement was made with the government on the detailed scope of the study. The study will be financed by the Government of the Netherlands.

Household Energy Strategy Study

A comprehensive planning study to assist the government in formulating urban and rural household energy policy is being conducted under the auspices of the Office of Energy Affairs. Under the study, a nation-wide household energy survey has been completed by the National Statistics Office. A woodfuels marketing study for major urban areas is underway. The main mission was in August 1990. This activity will cost US$377,000 and is being financed by the Government of the Netherlands.
(Source: *ESMAP Information and Status Report - September 1990,* World Bank/UNDP/Bilateral Aid Energy Sector Management Assistance Program, Energy Strategy, Management and Assessment Division, Industry and Energy Department, The World Bank (1818H Street, N.W., Washington, D.C. 20433, U.S.A.), 1990, pp.120-123.)

Super Conducting Magnets Make Coal Cleaning More Efficient

A system employing low-temperature super conducting magnets requires less energy than traditional coal-cleaning processes, according to Richard Doctor, chemical engineer and project manager at Argonne National Laboratory (Argonne, Illinois). Argonne's route yields a dry product, eliminating the costly handling and dewatering required for coal slurries produced during conventional wet-cleaning methods, he says. Reporting at ICPP, Doctor described Argonne's tests of an open-gradient magnetic separation system.

Pulverized coal is fed through a screw feeder into a high-magnetic-field zone. There, a super conducting quadrupole magnet, wound from a niobium alloy, operates at 4K with liquid-helium cooling and generates a gradient of 53.3 Tesla/m. After a brief residence time (1-2s) in the separator, the coal's sulfur and ash content are both reduced by about 24%. A set of three nested pipes at the bottom of the magnetic chamber collects the coal fractions. Clean coal drops out through the center pipe, the high-sulfur stream exists through the outer pipe and (being nonhazardous) is returned to the mine, and an intermediate fraction is collected in the middle annuals and recycled.

Preliminary estimates indicate costs of roughly US$8 per ton. This is in the same range as froth flotation, but would be less costly because the dry product does not need dewatering, Doctor notes.
(Source: *Chemical Engineering*, Vol.97, No.7, July 1990, p.17).

Electric Utilities Data Book for the Asian and Pacific Region

Industry and Development Bank Department
Asian Development Bank, Manila
1985, xiv+461 p.

The Asian Development Bank has accumulated extensive data pertaining to electric power utilities in its developing member countries (DMCs). The range of data covers such aspects of power systems as generation plant mix, transmission and distribution facilities, system operations and maintenance, financial performance, tariff policies and information on the organization and staffing of power utilities.

The book covers data on 22 countries from FY 1983 to FY 1988 and is divided into three parts. Part I consists of a regional profile of the power sector in the DMCs. It contains a comparative analysis of the experiences of different countries with regard to electricity use and economic growth, power system management, tariffs and system performance. This analysis serves to identify the factors which influence development of the DMC's power systems. Part II presents a profile of the power sector in each country, including data on the power market and on power system operations, financial aspects of the power sector and its management and staff. It also includes a power system map for each country. Part III provides utility profiles and consists of data sheets for each utility in the Region. The data contained in these sheets are the basis of the country analyses in Part II and the regional analysis in Part I.

This edition, with revised and updated information, was prepared by the Tata Energy Research Institute (TERI), New Delhi with the active involvement of the staff of the Bank's power divisions.

Contributions of Developed and Developing Countries to Greenhouse Gas Emissions

The OECD countries, the Soviet Union and Eastern Europe currently produce over 50 percent of the greenhouse gas emissions, or five times as much per capita as the rest of the world. (These estimates are based on the concept of "global warming potential," which is used to compare the potential warming effects of different greenhouse gases.) Carbon dioxide accounts for about half of the "global warming potential" of all greenhouse gases, and the energy sector produces about half of total emissions. Carbon dioxide emissions from fossil fuel combustion and chlorofluorocarbon (CFC) emissions are known fairly accurately, while carbon dioxide emissions from deforestation and total methane emissions from the different sources are not yet well quantified. The relative contributions of present greenhouse gas emissions to climate change, by gas, by sector and by region, are illustrated in Fig. 1.

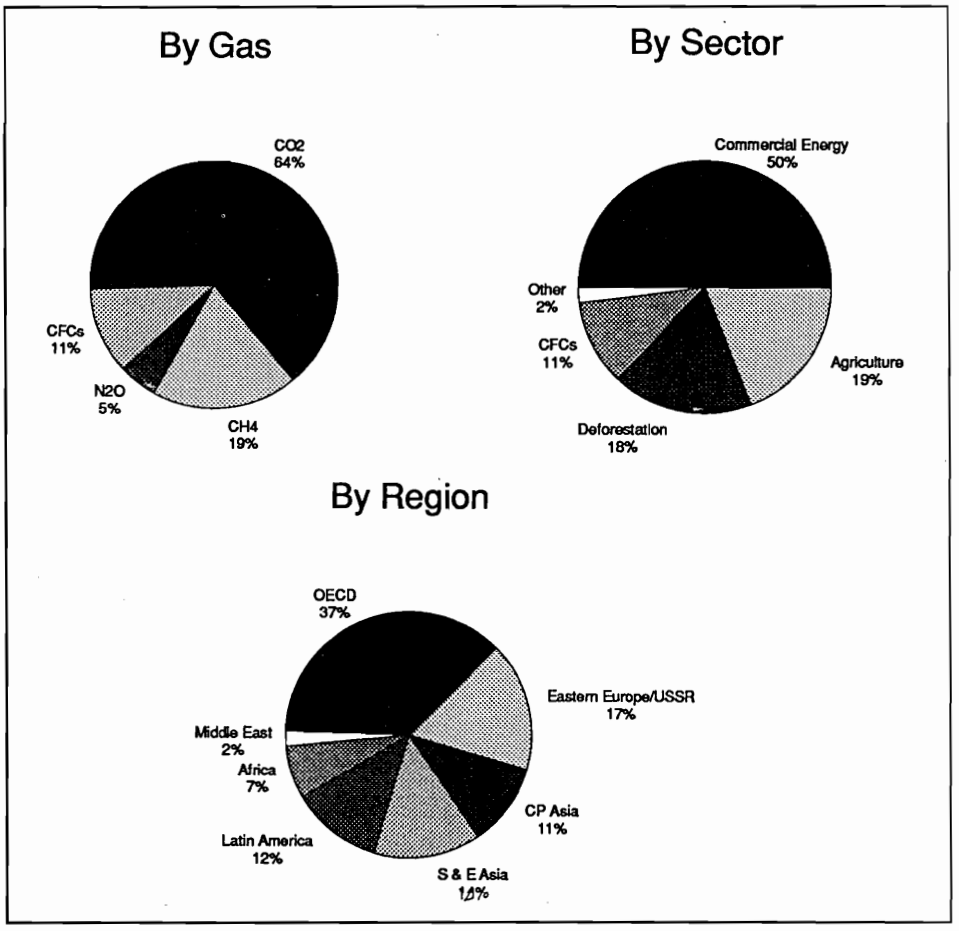

Fig. 1. Relative contribution of 1985 emissions to radiative forcing.

The industrialized countries are likely to account for a declining share of future emissions, while the rapidly industrializing developing regions will contribute a substantially greater share over the next three to five decades, because they must increase their per capita energy use to further their economic growth.

In developing countries the burning of biomass associated with deforestation contributes substantially to greenhouse gas emissions, but increases in commercial energy use will be the largest future source of such emissions. In principle, forests can be transformed from carbon sources to carbon sinks, if they don't disappear before forest stabilization programs are instituted. The agricultural sector is an important source of methane and nitrous oxide, principally resulting from rice production, domestic animals, fertilizer use and biomass burning, but taken individually, these contributions appear to be small in comparison with natural emissions; collectively, they represent about 60-70% of total CH_4 emissions.

Even though the concentration of greenhouse gases in the atmosphere is likely to grow over the next few decades, the rate of growth depends on the extent to which successful policies to control emissions can be implemented. Stabilization of greenhouse gas concentrations over the next century can be brought about through rapid implementation of energy efficiency measures, major increases in non-fossil energy supplies, reduced growth in fossil fuel emissions, and significant forest management and conservation efforts. Successful introduction and diffusion of these measures will require significant innovation on all fronts – technological, policy, financing, and institutional. No single innovative approach or technology can adequately control greenhouse gas emissions, but by implementing a balanced and comprehensive strategy over the next few decades, significant reduction in emissions can accompany accelerated economic growth in the developing nations.

Yet, even with the most aggressive energy efficiency strategies in developing countries, total energy use in these countries will continue to grow for many decades. However, even in the highest growth scenario developed by the IPCC, the per capita contributions of developing countries to greenhouse gas emissions in the year 2025 are at most 10-20% of those of the OECD countries.

Further details about the main sources of greenhouse gas emissions (energy production, deforestation, and agriculture) and the countries and geographic regions from which these emissions emanate are available in the report entitled "Greenhouse Gas Emissions and the Developing Countries: Strategic Options

and the USAID Response", a report to Congress, U.S. Agency for International Development, Washington, D.C., July 1990.

The report also discusses strategies which could and should be pursued to reduce greenhouse gas emissions, and it attempts to estimate the effect such strategies might have on reducing atmospheric concentrations of those gases. Ongoing and planned A.I.D. activities concerned with climate change are described and possible new initiatives which will be further explored to determine their feasibility and efficacy are suggested.

Workshop on Building Energy Management

Energy Auditing and Conservation Methodologies

Asian Institute of Technology
Bangkok, Thailand
22-26 April 1991

The Workshop on Building Energy Management will be organized by the Regional Centre for Energy, Heat and Mass Transfer for Asia and the Pacific (RCEHMT) and the Energy Technology Division of the Asian Institute of Technology (AIT), from 22-26 April, 1991 at AIT, Bangkok, Thailand. The workshop will be sponsored by UN Centre for Human Settlements (HABITAT) and French Agency for Energy Management (AFME).

For application and further information, please contact:

Organizing Secretary
Workshop on Building Energy Management
Division of Energy Technology
Asian Institute of Technology
P.O. Box 2754
Bangkok 10501, Thailand
or
Scientific Secretary
Regional Centre for Energy, Heat & Mass Transfer for Asia & the Pacific
Indian Institute of Technology Campus
Mardras-600036, India.

International Symposium on Renewable Energy for Education and Nordic Solar Energy R & D Meeting

19-20 June, 1991, Borlänge, Sweden

The International Symposium on Renewable Energy Education is organized by the International Association for Solar Energy Education (IASEE), Energy Educators Association (EEA), and University College of Fälun/ Borlänge.

The Nordic Solar Energy R & D Meeting is organized by Solar Energy Association of Sweden (SEAS) and University College of Fälun/ Borlänge and is sponsored by ISES-Scandinavian Section.

Both conferences will be held in Borlänge, Sweden during June 19 - 20, 1991. There will be joint plenary sessions as well as separate paper sessions, a solar energy exhibition and time set aside for informal discussions. The symposium topics include renewable energy education at all school levels, in universities and for the general public. The meeting topic is solar energy utilization in the Nordic countries, i.e. Denmark, Finland, Iceland, Norway and Sweden. One-page abstracts are invited not later than April 30, 1991. Registration fee is SEK 900 (approx. US$ 165; after April 30 add SEK 300). A pre-conference tour to renewable energy installations is arranged on June 18 and costs SEK 400.

Send registration to or request information and registration form from:

Conference Secretariat
c/o SERC
P.O. Box 10044
S-781 10 Borlänge, Sweden
Fax: 176 - 243 73750

Regional Training Course on Biomass Energy Development

2 to 28 June, 1991, Nairobi, Kenya

The 4th Regional Training Course on Biomass Energy Development will be hosted by the Kenya Energy and Environment Organization (KENGO) under the auspices of the Regional Wood Energy Programme for Africa (RWEPA).

The last 3 courses have so far attracted participants from Angola, Ethiopia, India, Kenya, Madagascar, Rwanda, Sudan, Tanzania, Uganda and Zambia. Additionally, specialized courses have been organized for Madagascar, Rwanda, Sudan, Uganda and Zambia.

The theme of this 4-week course will be "Management of Community Biomass Energy Programmes". Target participants are middle and senior level project personnel involved in project planning and implementation in either Government Department, NGOs, Donor Organizations or Private Entrepreneurs.

Amongst other topics, the thrust of the course will be energy policy and planning, project formulation, management, monitoring and evaluation, overview of mature renewable energy technologies (RETs), training, dissemination and commercialization of RETs. As per tradition the course will also include practical "hands-on" sessions on some RETs and a 1-week training attachment with an established enterprise involved in the participants "special" field of interest.

The cost of the 4-week course is approximately US$2,500 and interested participants/organizations are advised to approach funding agencies for financing support.

For more details and application forms, please contact:

Course Coordinator
KENGO/RWEPA
P.O. Box 48197, Nairobi, Kenya
Tel: 254-2-749747/748281
Telex: 25222 KENGO KE/25360 KOPACAT KE (ATT KENGO)
Fax: 254-2-749382/740524 ATT. KENGO

AIT Faculty Member Received the Energy Journal's Best Paper Award for 1989

The International Association for Energy Economics has selected Dr. Harry R. Clarke* and Dr. Ram M. Shrestha** to receive the *Energy Journal's* Best Paper Award for 1989. This award is made for their two related articles "Traditional Energy Programs and the Theory of Open Access Forest Resources," July 1989, and "Traditional Energy Programs with an Open Access Forest Resource: Policy Implications," October 1989. The research was selected by the award committee as being an outstanding contribution to international energy economics that represents an innovative application of solid economic analysis to an important policy issue. The two papers provide a particularly valuable framework for evaluating market and non-market options for managing forest resources and should help stimulate other researchers to address related issues with the same care and clarity.

The paper "Traditional Energy Programs and the Theory of Open Access Forest Resources" analyzes implications of open access forestry for traditional energy programs in LDCs. The roles of improved woodstoves, charcoal kilns, forest access and biogas programs are examined. A key finding is that, with sufficient elasticity in fuelwood demands, traditional energy programs may reduce long-run fuelwood supply stocks.

The second paper discusses policies for managing a forest subject to open access exploitation from the viewpoint of encouraging greater efficiency in the use of woodfuels. The usefulness of market and non-market policy options for managing forest resources is shown to depend on whether fuelwood collection is the major cause of deforestration or not and, if so, whether fuelwood collection procedures have a market valuation.

* Senior Lecturer in Economics, Department of Economics, La Trobe University, Bundoora, Victoria, Australia 3083.

** Assistant Professor of Energy Planning and Economics, Division of Energy Technology, Asian Institute of Technology, G.P.O. Box 2754, Bangkok 10501, Thailand.

Course on New Information Technologies and Computerized Library Services

Many organizations in developing countries need a modern, automated library that can efficiently and economically supply current, useful information to clients competing in a swiftly changing world with even more rapidly evolving technology.

The heart and soul of a modern, automated library are staff knowledgeable about state-of-the-art information technologies and computer applications.

The Library and Regional Documentation Center (LRDC) of the Asian Institute of Technology (AIT) provides an annual summer course on new information technologies and computerized library services.

The course gives librarians, information officers, computer technologist and subject specialists the principles, knowledge and technologies needed to improve and update their information management skills and services.

Lectures and seminars train participants to exploit fully the power of the latest software for library applications.

This knowledge is then proven by using the software on personal computers to do practical, hands-on, supervised projects.

The 12-week course is conducted at AIT during May-July.

COURSE CONTENT

The course focuses on six major areas:

1) Effective Communications Skills (30 hours)
2) Specialized Information Services (60 hours)
3) Computer Application (180 hours)
4) Management and Marketing of Information (30 hours)
5) Production and Publishing (30 hours)
6) Audio-visual Communication (30 hours)

For further information, contact:

The Director
Library and Regional Documentation Center
Asian Institute of Technology
GPO Box 2754
Bangkok, Thailand 10501

Publications Received

BIOMASS ENERGY

* *Techno-Economic Assessment of Selected Biomass Liquefaction Processes*, David Beckman, et al., Technical Research Centre of Finland, Research Reports 697, Technical Research Centre of Finland (VTT), Laboratory of Fuel and Process Technology, Espoo, Finland, 1990, 161 p.+app.

* *Household Stoves in Zimbabwe*, Stephen Karekezi and Dominic Walubengo, Foundation for Woodstove Dissemination (FWD) and African Centre for Technology Studies (ACTS), Nairobi, Kenya, 1990, xii+50 p.

* *Proceedings of the International Biomass Course, Held at Sagret Hotel, Nairobi, Kenya, June, 1989*, edited by Dominic Walubengo, KENGO Regional Wood Energy Programme for Africa (RWEPA), Nairobi, Kenya, 1990, 59 p.

ENERGY

* *Greenhouse Gas Emissions and the Developing Countries: Strategic Options and the U.S.A.I.D. Response: a Report to Congress*, U.S. Agency for International Development, Washington, D.C., July 1990, various paging.

* *Rural Energy Appraisal: Workshop on Rural Energy Appraisal; held at Silliman University, Dumaguete City, Philippines, 24-30 October, 1989*, Food and Agriculture Organization of the United Nations, Regional Wood Energy Development Programme in Asia (GCP/RAS/131/NET), Bangkok, July 1990, 63 p.

* *Industrial Power Production as a Supplement or an Alternative to the Utility, Seventh Asian School on Energy, 17-26 January 1990, Bangkok, Thailand*, edited by B. Mohanty, Asian Institute of Technology, Bangkok, 1990, 202 p.

* *Decentralized Power Production for the Rural Consumers, Seventh Asian School on Energy, 17-26 January 1990, Bangkok, Thailand*, edited by B. Mohanty, Asian Institute of Technology, Bangkok, 1990, 188 p.

* *Interfuel Substitution and Changes in the Way Households Use Energy: the Case of Cooking and Lighting Behavior in Urban Java*, Kevin B. Fitzgerald, Douglas Barnes, and Gordon McGranahan, Industry and Energy Department Working Paper, Energy Series Paper No. 29, The World Bank, Washington, D.C., October 1990, 34 p.

* *Regulation, Deregulation, or Reregulation -- What is Needed in the LDCs Power Sector?*, W. Teplitz-Sembitzky, Industry and Energy Department Working Paper, Energy Series Paper No. 30, The World Bank, Washington, D.C., July 1990, 97 p.

* *A Framework for Evaluating the Economic Benefits of Power Projects*, Ifzal Ali, Asian Development Bank Economic Staff Paper No. 43, Asian Development Bank, Manila, August 1989, 57 p.

* *Electric Utilities Data Book for the Asian and Pacific Region*, prepared by the Tata Energy Research Institute (TERI), New Delhi, for the Asian Development Bank, Manila, 1989, 461 p.

* *ESMAP: Information and Status Report: March 1990*, Industry and Energy Department, Energy Strategy, Management and Assessment Division, The World Bank, Washington, D.C., March 1990, 147 p.+app.

* *ESMAP: Information and Status Report: September 1990*, Industry and Energy Department, Energy Strategy, Management and Assessment Division, The World Bank, Washington, D.C., September 1990, 145 p.+app.

* *A Linear Programming Energy and Environment Model for Space Heating*, Juha Forsstrom and Eero Tamminen, Technical Research Centre of Finland, Research Reports 698, Technical Research Centre of Finland (VTT), Espoo, Finland, August 1990, 54 p.

Diary of Events

- **November 25-30, 1990, Dallas, TX, USA**

Solar Energy in the 90's

The general theme of the conference is Solar Energy in the 1990s.

For more information contact:
General Program Chairman
Tom Mancini
Sandia National Laboratories
Division 6227
P.O. Box 5800
Albuquerque, NM 87185
USA
Tel: (505) 844 8643

or

Technical Program Chairman
William M. Worek
Department of Mechanical Engineering (m/c 251)
University of Illinois at Chicago
P.O. Box 4348
Chicago, IL 60680
USA
Tel: (312) 996 5610 or (312) 996 5317

- **December 19-20, 1990, Brussels, Belgium**

European Energy Conference

For more information contact:
Amanda Jenkins
Conference Organiser
DRI Europe Ltd
30 Old Queen Street
London SW1H 9HP
United Kingdom
Tel: 01 222 9571
Fax: 01 222 6918

- **April 3-5, 1991, London, United Kingdom**

International Conference on Coal in the Environment

For more information contact:
World Coal Institute
Conference & Exhibition Secretariat
8 Cotswold Mews
Battersea High Street
London SW11 3JE
United Kingdom
Tel: 071 228 8034
Fax: 071 924 1790
Telex: 917712 POLYBS G

Diary of Events

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- **May 12-16, 1991, São Paulo, Brazil**

Sixth International Symposium on Anaerobic Digestion

The main objectives of the symposium are to promote and enhance the exchange and dissemination of information and experience on research and development related to the following topics:

- anaerobic digestion processes for protection of the environment; and
- anaerobic digestion technology for recovery of renewable resources.

For more information contact:
Secretariat
Sixth International Symposium on Anaerobic Digestion
ABES/IAWPRC – Brazil
c/o Maria Isabel Pulcherio
Associação Brasileira de Engenharia Sanitaria e Ambiental – ABES
Av. Beira Mar, 216 - 13º andar
20021 Rio de Janeiro - RJ
Brazil
Tel: +55 21 210 3221
Fax: +55 21 262 6838

- **May 21-28, 1991, Amman, Jordan**

The International Seminar on the Commercialization of Solar and Wind Energy Technologies

This seminar is being organized by The Royal Scientific Society and sponsored by the German Ministry for Economic Cooperation (BMZ) through the German Agency for Technical Cooperation (GTZ).

For more information contact:
Dr. Rizeq Ta'ani
Royal Scientific Society
Renewable Energy Research Centre
P.O.Box 925819
Amman - Jordan
Tel: 844701/9
Cable: ERRAMAH - AMMAN
Telex: 21276 RAMAH JO
Fax: (9626) 844806

- **July 8-12, 1991, Sydney, Australia**

International Mechanical Engineering Congress and Exhibition

The Congress has been organized as separate streams including one on "Energy: Resources, Usage, Conservation and Environment".

For more information contact:
The Conference Manager
The Institution of Engineers
11 National Circuit
Barton ACT 2600
Australia
Tel: (06) 270-6549
Telex: AA62758
Fax: (06) 270-6530

- **August 25-28, 1991, Espoo, Finland**

Energy & Environment:1991 International Symposium

The symposium is sponsored by Helsinki University of Technology.

For more information contact:
Center of Energy Technology
Helsinki University of Technology
Otakaari 4
02150 Espoo
Finland
Tel: 358-0-4513580
Telex: 125161 htkk sf
Fax: 358-0-4513419

- **October 14-18, 1991, Amsterdam, The Netherlands**

Amsterdam EWEC'91

Conference and Exhibition of the European Wind Energy Association – Amsterdam EWEC '91. The conference, which is held bi-annually in Europe, and the Exhibition are being organized by the Netherlands Wind Energy Association.

For more information contact:
Van Namen & Westerlaken Congress Organization Services
P.O Box 1558
6501 BN Nijmegen
The Netherlands
Tel: +(31) (0) 80-234471
Fax: +(31) (0) 80-601159

- **27 May – 7 June, 1991, Asian Institute of Technology, Bangkok, Thailand**

2nd AIT-WHO Training Course on Solar Refrigerators Repair and Maintenance

The 2nd AIT-WHO Training Course on Solar Refrigerators Repair and Maintenance which was originally planned to be held from 4-15 February, 1991 has been rescheduled to 27 May – 7 June,1991 at the Energy Technology Division of the Asian Institute of Technology (AIT), Bangkok.

For further details please contact:
Dr. Supachart C.
Energy Technology Division
G.P.O. Box 2754, Bangkok 10501
Thailand
Fax: (662) 516 2126

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Library and Regional documentation Center, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The "RERIC News" is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership along with the other four regular publications namely: RERIC International Energy Journal (formerly: Renewable Energy Review Journal); RERIC Holdings List; Abstracts of AIT Reports and Publications on Energy; and RERIC Membership Directory. For further details contact:

Regional Energy Resources Information Center
Asian Institute of Technology
G.P.O. Box 2754
Bangkok 10501, Thailand
Telex: 84276 TH
Tel: 5160110-29; 5160130-44 Ext. 5866
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Industrial-Scale Solar Fruit Dryer: Thailand

An industrial-scale solar fruit dryer has been developed and tested by a research team comprised of researchers from five educational institutions in Thailand, namely: Naresuan University (NU), King Mongkut's Institute of Technology Thonburi (KMITT), Asian Institute of Technology (AIT), Pibulsongkram Teachers College (PTC), and Uttaradit Teachers College (UTC). The principal researcher is Assoc. Prof. Wattanapong Rakwichian of the Naresuan University. The solar dryer is a hybrid type with an electric fan for evacuating the hot air from a collector plate of 36 m^2 area. The schematic diagram of the dryer is shown in Fig. 1. The dryer consists of four parts:

1. A solar air collector plate (6m x 6m).
2. A burner stone which can burn agricultural residues as well.
3. A heat exchanger (30m x 30m x 3m) with a chimney 3 m high.
4. Two dryer cabinets, each 2m x 6m.

The dryer, with a capacity of 1,500 kg, can be used for drying mangoes, tamarinds, or bananas. The temperatures inside the dryer are 32-67°C and

Cont. P. 3

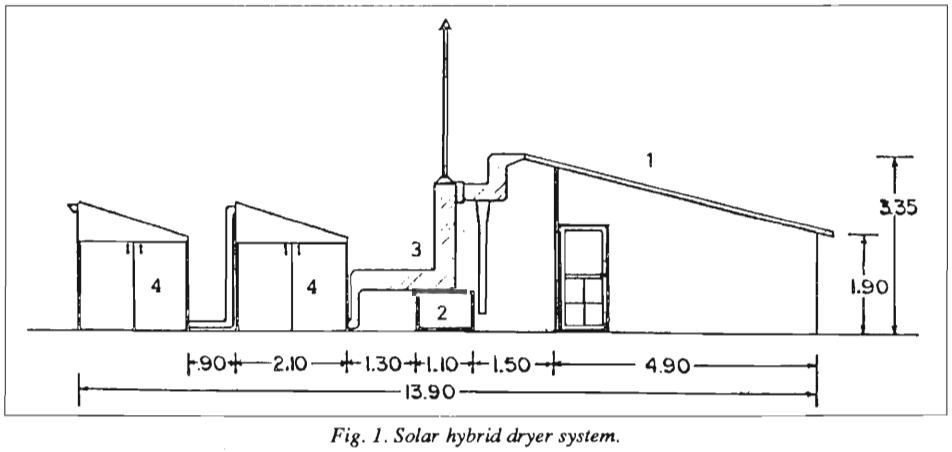

Fig. 1. Solar hybrid dryer system.

Solar Drying of Tropical Fruits

Since February 1986, GTZ/GATE, in cooperation with its partner organization NUTEC (Nucleo de Technologia Industrial) has been implementing a pilot project aimed at providing advice on technological innovation. As a part of this project, small holders and cooperatives in the Brazilian federal state of Ceará are being given support and advice on the introduction of new fruit drying technologies. The technical and economic feasibility of solar drying under local conditions has been investigated, new fruit drying methods have been developed and old ones have been improved.

Three solar dryers have been built on NUTEC's premises in Fortaleza.

A diagram of the chimney-type dryer built first (Dryer I) is shown in Fig. 1. It is 1.5 m wide, and 6.1 m long overall. The collector is 2.5 m long, while the drying area and after-warming zone are each 1.5 m long. The height of the chimney is 4 m, and that of the air regulation box is 0.5 m. The frame height is 10 cm. The drying capacity of the chimney-type dryer is 45 kg of fruit. In this dryer the air current is generated by the chimney

Cont. P. 2

INNERTAP
Incorporates news from the Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

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Solar Drying of Tropical Fruits

From P. 1

updraught, which is caused by a density gradient due to different temperatures inside the chimney. A further increase in air flow through the dryer is achieved by positioning the collector inlet facing the main wind direction.

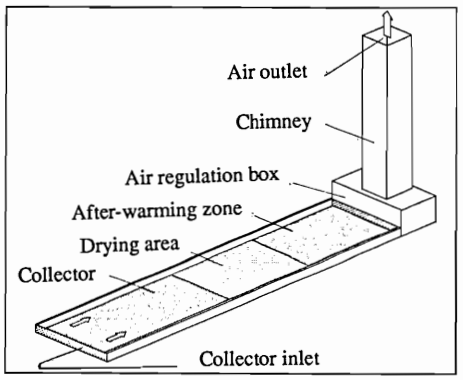


Fig. 1. Sketch showing design of Solar Dryer (chimney-type dryer).

Dryer II (Fig. 2) is 20 m long. The width of the collector is 1 m, that of the drying area 2 m, and the frame is 6 cm high. The drying capacity of Dryer II is approximately 800 kg of fruit, and thus is suitable for larger producers. In contrast to the chimney-type dryer, the collector is situated alongside the drying area, to limit the overall length of the dryer. This makes it necessary to deflect the air between the collector and the drying area with baffles. The air current is generated by a radial-flow fan placed at the collector opening.

Dryer III (Fig. 3) is 1.6 m wide and 20 m long. The first 10 m serve as the collector, the residual 10 m as the drying area. The frame is 6 cm high. This dryer is capable of drying 320 kg of fruit at a time. The air current is generated by a radial-flow fan built directly into the collector tunnel at the beginning of the collector. The tunnel sucks in air from below. This is possible because Dryer III was erected 80 cm above ground level, supported on old oil drums. Since the drying area is directly behind the collector it is not necessary to deflect the air.

The technical suitability of the three types of solar dryers has been compared. In favorable weather conditions (sunny, no dust) all three solar dryers proved capable of producing high-quality dried fruit within practically the same time. The maximum temperatures attained at the beginning of the drying area (at midday) were just under 70°C. The collector efficiencies (energy gain of drying air/irradiated energy) of Dryers II and III may be regarded as good, at 44% and 42% respectively. In heavy downpours it proved impossible to prevent water entering between the collector and drying area of Dryer II. Similarly, penetration of dust and sand were unavoidable during the long time it took to load and empty the dryer. In its present form, therefore, this dryer is not suitable for the local climate. The cover sheet of Dryer I was supported, which made the dryer waterproof, and with the small amounts of fruit dried each time it was possible, by loading and emptying the dryer carefully, to prevent dust from entering it. Dryer III was optimally protected against penetration by water and dust. The specifications of all the three types of solar dryers are presented in Table 1.

The economic suitability of the dryers for the target groups was investigated by an investment analysis using banana drying as an example.

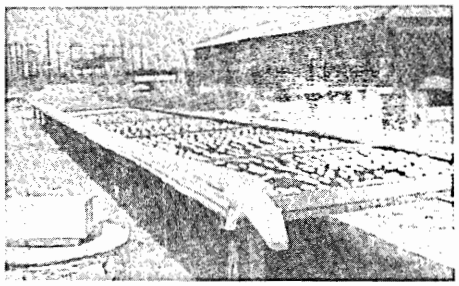


Fig. 3. Dryer III being used for drying bananas.

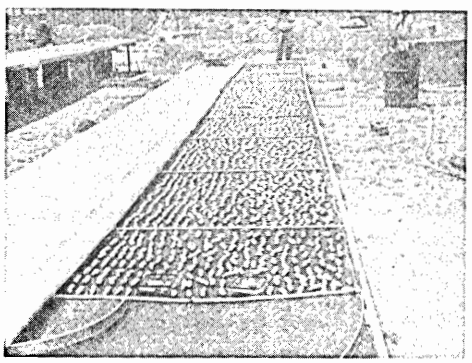


Fig. 2. Dryer II, loaded with bananas.

Table 1. Specifications of the three solar dryers.

	Dryer I	Dryer II	Dryer III
Air Flow (m^3/h)	130-560	1100	790
Air Velocity (m/s)	0.3-1.3	2.6 (collector) 1.3 (dryer)	1.0
Max. Temperature at Beginning of Dryer (°C)	68	67	60
Mean Daytime Temp. at Beginning of Dryer (°C)	45	50	43
Collector Efficiency	–	43	42
Overall Efficiency (%) (with 25% charge)	5	5	5

Table 2. Profitability criteria of solar dryers and oven drying.

Dryer type	NIR	Av. Profit per Annum (US$/year)	Amortization (months)	Initial Investment (US$)	Qty. of Bananas (kg/yr.)	Area under Cultivation (ha)	Profit per Man Hour (US$/h)	Wage Increase (%)
Dryer I	4.01	76	15	151	750	0.28	0.15	13
Oven Dryer	5.17	669	16	963	36,000	2.70	0.15	13
Dryer III	6.84	1,002	8	1,029	26,667	2.00	0.31	27

NIR = ratio between net profits and investment costs.

Various criteria of profitability (Table 2) were calculated for Solar Dryers I and III and traditional oven drying. Solar Dryer II was excluded from the analysis because of its technical shortcomings.

But whatever the cost, prior to actual drying, suitable methods of pretreatment of the fruit have to be found so as to make it suitable for storage and consumption.

(Source: "Solar Drying of Tropical Fruits, Appropriate Drying Technology for Small-Holders and Cooperatives in North-East Brazil" by Herbert Schwarz and Adelinde Mayer, *Gate: Questions, Answers, Information*, No.3, November 1990, pp.21-25.)

Industrial-Scale Solar Fruit Dryer: Thailand

From P. 1

the outside temperatures are 26-37°C. In case of rainy or low temperature days, an auxiliary heating system using alternative energy sources such as LPG or agricultural residues can be used. A number of experiments were carried out to study the performance of the solar dryer, the efficiency of the auxiliary heating system, the quality of the dried products and the economical feasibility of the solar fruit dryer.

The experimental results showed that the quality of dried bananas depends on the drying temperature, humidity and the intensity of light. Qualitative investigation of sugar and protein content, revealed that the solar dried bananas had a sugar and protein content higher than natural dried ones.

Further details of the performance testing are available in "Development of a Fruit Solar Dryer for the Industrial Scale" by Wattanapong Rakwichian and Banchob Sudaprasert, in *Proceedings of the International Conference on Energy and Environment*, 27-30 November 1990, Bangkok, Thailand, organized by King Mongkut's Institute of Technology Thonburi and Ministry of Science, Technology and Energy, Bangkok, Thailand.

Indonesia to Install 2,000 Solar Energy Systems

Indonesia, the world's fifth most populous nation, has scheduled the installation of 2,000 solar energy systems as an integral part of efforts to provide electricity to its vast archipelago of 13,000 islands and over 66,000 villages.

To improve the living standards of the rural populace, the first such installation, a photovoltaic solar panel system, was made in Sukatani, a remote village 113 km south of Jakarta, the Indonesian capital, and 457 metres above sea level on the slopes of Mt. Salak.

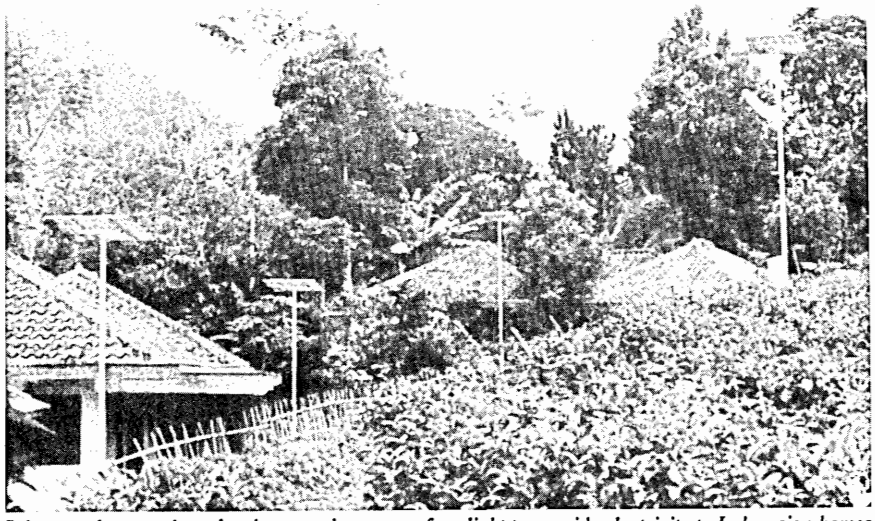
The solar power programme in Sukatani cost US$1 million, half of which was financed by the Dutch government while the Indonesian government and R & S Renewable Energy provided the other 50 percent. The Indonesian Agency for Technology Assessment and Application (BPPT) and R & S Renewable chose Sukatani as the site for the first installation because the company wanted to test the solar panels in a remote area with above average rainfall, less than ideal road conditions, and an average rate of daylight of only three days per week. According to BPPT's chief researcher, Pramuseto, "If the project is workable at Sukatani, it should be workable in other parts of Indonesia." During the trial operations, the monitoring data showed that all the solar panels worked.

Cooperation between BPPT and R & S Renewable also extends to the study of the social and economic effects of the project after installation. They found that solar power costs each family US$1.95 per month, less than kerosene lighting and battery purchases. The report concluded that the electrification of Sukatani has expanded business opportunities for small traders, shop owners, and other small enterprises by increasing their productivity through better lighting, more electrical power, and longer working hours.

Creative forms of financial assistance are being developed to enable villages to be electrified by solar energy. The main obstacle to installation of the system was the village's inability to raise the funds necessary to purchase the solar panels. The commercial price of one unit with a capacity of 120 Watt hours per day is US$470.

Bank Rakyat Indonesia, a government-owned bank operating in rural areas, has committed itself to providing credit through a rural bank credit system. Based on this plan, monthly installments would be in the range of US$11-13, depending on the required down payment and current interest rates. The savings from the use of solar power, in addition to the increased productivity in business enterprises, would allow villages to pay off the loan in five years.

(Source: *Sun World*, Vol.14, No.3, 1990, pp.94-95.)



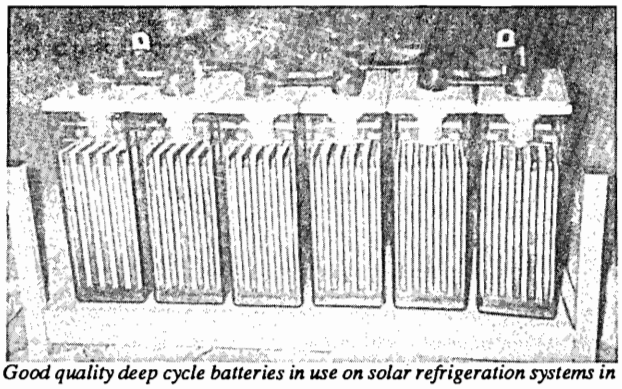
Solar panels, atop the poles, harness the power of sunlight to provide electricity to Indonesian homes.

WHO/EPI Consultation on Batteries for Solar Refrigeration Systems

A significant percentage of breakdowns in solar systems are caused by failures in the battery/charge regulator pair and some of the causes for these failure include:

- The use of poor quality batteries which are not really designed for a refrigerator load, such as the use of standby batteries rather than deep cycle/ heavy duty batteries;
- Inadequate matching of the regulator to the charging specifications of the battery bank;
- Inadequate sizing of the solar generator (array and batteries) for the installation site.

This results in a loss of confidence in solar refrigeration technology by users and donors. In order to improve the reliability of the systems, it has been agreed that, in addition to the existing joint WHO/UNICEF Standard Performance Specifications and Test Procedures, stricter criteria should apply to the selection of the battery/regulator pair. With this, the initial capital costs will be slightly higher but at least five years of reliable operation can be assured.



Good quality deep cycle batteries in use on solar refrigeration systems in Tanzania.

In May 1990, WHO/EPI convened an informal consultative meeting of battery experts, battery manufacturers, solar refrigeration system suppliers, regulator specialists and consultants.

The recommendations of this group, which were adopted by unanimous consensus, aim to ensure that:

- The systems are properly sized for the installation site.
- Good quality batteries, suitable for solar refrigeration systems, are selected. The use of deep cycle batteries which conform to the International Standards for lead-acid traction batteries is recommended. Sealed batteries or so-called "maintenance-free" batteries are excluded, unless satisfactory cycling to a 50% depth of discharge is achievable.
- System suppliers take the necessary steps to adjust charge regulators to the characteristics of the batteries.

(Source: *Cold Chain Newsletter*, August 1990, No. 90.2, pp.4-5.)

Manufacture of Solar Refrigeration Systems in Zimbabwe

A recent request from a solar refrigeration company in Zimbabwe, Solarcomm, to be included in the Product Information Sheets (PIS) as a system supplier was received with enthusiasm by WHO/EPI, Geneva.

Solarcomm is a subsidiary company of Apex, a major corporation in Zimbabwe which owns 38 companies and specializes in the manufacture, design and supply of solar systems, particularly for lighting, telecommunications, pumping water and vaccine refrigerators.

In August 1987, with the support of the Government of Zimbabwe, a plant was set up to assemble photovoltaic (PV) modules, with a total production capacity of 10 kW. The present cost of the modules is estimated to be around Z$25/Wp (US$ 10/Wp), significantly higher than the price on the international market (which is approximately US$6/Wp). The 45 Wp module costs approximately Z$1,000 (US$100).

The design of the solar refrigerator and the results of the preliminary tests conducted by Solarcomm were found to be satisfactory. It was therefore agreed that, when the final modifications are introduced and when Solarcomm is satisfied with its own test results, a preseries model (with panels and regulator) will be independently tested by WHO/EPI.

The possibility of conducting a field trial in parallel with the laboratory tests was also discussed with Solarcomm and ZEPI.

It is hoped that, in spite of the hard currency difficulties facing industry in Africa, Solarcomm will soon be able to qualify as a system supplier. Solarcomm's knowledge of the African environment, as well as their proximity to the users, are positive factors in their favour.

The addresses of the 2 Solarcomm factories are:

Solarcomm
12 Lobengula Close
P.O.Box ST319
Southerton, Harare
Zimbabwe
Tel: 64341/2
Telex: 26482 ZW

and

Solarcomm
Corner Birmingham / Chartham Roads
P.O.Box FM 47
Famona, Bulawayo
Zimbabwe
Tel: 77916/7

(Source: *Cold Chain Newsletter*, August 1990, No. 90.2, p.5.)

Improved Solar Cells may make Sun-power Cheaper than Coal

Researchers at the University of New South Wales (UNSW) in Sydney, Australia are improving the efficiency of solar cells, aiming to reduce power production costs to about half the level of coal-fired plants. Professor Martin Green, group leader of UNSW's Centre for Photovoltaic Devices and Systems believes that this target could be achieved in the next 10 years with the efficiency of the cells being boosted to 26% or nearer to what is considered the theoretical limit of 30%. This would definitely reduce the costs to around five US cents per kilowatt hour; the present cost is in the range of 20 to 40 US cents per kilowatt hour.

Unlike coal-fired power, solar energy does not cause any air pollution or contribute to global warming. The solar collectors have no moving parts and produce power continuously for 30 years before needing maintenance. Excess solar energy can be stored in batteries for use at night or on cloudy days.

UNSW scientists are boosting the efficiency of the cells by using lasers to remove defects that impede the flow of sunlight into the electric contacts. The cells are composed of tiny crystalline pyramids that capture and direct light energy into contact leads. This concept was invented at UNSW and is presently used worldwide.

The researchers are working both on the reduction of the cost of the silicon wafer on which the cell is mounted and on the efficiency of production engineering for mass production at affordable prices. An early generation of cells made with laser grooves were a boon for solar power since they were compatible with existing solar arrays which invariably produced more power. These cells were also used to power the Swiss solar-powered car which won the solar race from Darwin to Adelaide, Australia. Besides this, UNSW is also working with the New South Wales Department of Minerals and Energy to develop a "solar farm" that would feed sun-power into a city's electricity grid in peak periods.

(Source: *Bangkok Post*, April 2, 1991.)

Hokkaido goes ahead with 80 MW FBC Unit – Japan

Hokkaido Electric Power Co., has decided to firm up plans for a pressurised fluidised-bed combustion unit. Japanese utilities are anxious to push ahead with this technology, since it could enable them to expand coal use while cutting pollution levels.

Hokkaido Electric is looking at an 80 MW unit which will form the third unit at its Tomato-Azumi plant. Test burning is provisionally scheduled for 1996. The aim is to establish a fully commercial complex with a final capacity of as much as 600 MW.

The lure of pressurised fluidised-bed combustion technology is clear enough: firstly it holds the promise of permitting fuel efficiencies to be raised to the 46% level compared with present levels of around 43% for a conventional unit. At the same time, it should permit sharp reductions in emissions of carbon dioxide and nitrogen oxide.

Because the utility commissioned its most recent unit, the nuclear-fired Tomari #2 unit in mid-1990, it now has time to experiment with the prospective technology of pressurised FBC technology without having to worry about its supply capabilities. Nonetheless, the utility is anxious to capitalise on this technology in order both to cut its overall fuel bill and to provide alternative base-load capacity to its existing nuclear units.

(Source : *Power in Asia*, No. 68, 28 January 1991, p.18.)

EGAT speeds Domestic Fuel Power Schemes – Thailand

The Electricity Generating Authority of Thailand has decided to accelerate plans to construct power stations using domestic feedstock. Thailand's crude imports tripled between 1988 and 1990 to 478,990 b/d, with 80% imported from the Middle East. Though supply disruptions due to the Gulf War seem unlikely, future catastrophes in the region would pose problems.

With the Gulf crisis, says EGAT Secretary-General Poapat Chavanalikhorn, "We have been given a healthy dose of reality. Consequently, EGAT intends to speed up new power plants using other domestic types of fuel". The speed-up is directed at four stations under construction:

- A three-unit, 900MW gas-fired plant being built by Alsthom and Marubeni in the eastern coastal city of Rayong. Officials from the Petroleum Authority of Thailand, or PTT, have requested that Unocal boost output from its five interconnected producing fields in the Gulf by 23% to 675 mmcfd to help meet Rayong's demands. Though Rayong isn't due for total completion until March 1994, EGAT officials hope two units will be available by the end of this year, with the remaining unit onstream by late 1993.
- The 300 MW Namphong gas-fired station near the central city of Khon Kaen. EGAT has purchased two 100 MW generators. Though 60 mmcfd from Esso's Namphong field came onstream in early January, Esso says output is expected to reach the 250 mmcfd mark by mid-1994. The first gas-fired unit comes onstream this summer and will utilise 40 mmcfd, or two-thirds of Esso's current output. While work is to be

Cont. P. 6

Biomass Densification

The Technology and Development group, University of Twente, in close cooperation with DENSI-TECH Ltd and the Biomass Technology Group, have recently completed a survey into the state-of-the-art of biomass densification (briquetting) in South and South-East Asia. The objectives of the research were to identify potential markets for densified fuels and the establishment of briquette requirements in accordance with specific market sectors and their socio-cultural-economic acceptance. Their findings have now been published as a report.

The report reviews recent experiences of densification and briquetting in Thailand, India, Nepal, Sri Lanka, Malaysia and The Philippines. This is based on a number of studies from specialised institutes in these countries, which makes it a novel feature of this type of study.

As well as the technical problems this technology is known to suffer from, the study also investigated the potential for increased and improved briquetting technology. The viability of briquetting in South and South-East Asia was assessed by addressing four key factors: the market for briquettes, the acceptance of briquettes by potential users, the availability of biomass residues as a resource, and the modes of production.

The report concluded that, despite the investment of over US$15 million of private funds over the last 10 years, there has been only limited success mainly due to technological problems and an unsuitability of the briquettes for the intended market. Although a considerable wealth of experience exists in the region, a focal point for the accumulation and exchange of these experiences is lacking.

Despite the technical problems, which are not insurmountable, there would appear to be a market for briquettes in the monetised fuel economy. Briquettes can certainly help fuel those rural industries, which are important providers of employment, and which are facing severe shortages of wood, e.g. brickmaking. There would appear to be sufficient under-utilised residues in the region to act as a feedstock. The production of briquettes can also provide employment opportunities in rural areas.

The report concludes with recommendations for further work on technological improvements, the need to design a methodology for the economic evaluation of briquetting, and a mechanism by which transfer of knowledge in existing and new briquetting technologies can be promoted throughout the region.

The entire project was financed by the Government of the Netherlands, Directorate General of International Co-operation.

Copies of the Executive Summary can be obtained from:

Prof. W Hulscher
VOK
University of Twente
Postbox 217
7500 AE Enschede
The Netherlands.

EGAT speeds Domestic Fuel Power Schemes – Thailand

From P. 5

brought forward on the second and third units by one year, or mid-1993, Esso officials see scant hope for reaching the production deadline.

- Two more 600 MW gas-fired units at Bang Pakong station near Bangkok. Due for completion by mid-1992 and mid-1993, the schedule is being upgraded to early-1992 and early-1993. These are expected to utilise feedstock from both Esso's Namphong field and increased Unocal output.

(Source : *Power in Asia*, No.69, 11 February 1991, p.3.)

Rice Hull-Fueled Dryer prolongs Life of Onions

A rice hull-fueled onion dryer that can cure onions artificially in a very short time and prolong their shelf life for up to four to six months was devised by the Forest Products Research and Development Institute (FPRDI), Philippines.

FPRDI's Furniture Wares and Packaging Division, under the direction of its chief scientific research specialist, Engr. Troadio Cuaresma, began developing this technology in 1987.

The experimental dryer was installed on a farm in San Jose City, Nueva Ecija. Its main features are a drying chamber that can accommodate 126 boxes (approximately 3.3 tons) of onions in a single load; a Dutch oven-type furnace connected to a hopper through which fuel is fed; a heat exchanger; a chimney; a flue pipe which runs across and transmits heat

Co-Combustion of Natural Gas and Biogas in a Medium Size Steam Plant

In the interests of energy conservation, The Energy Management Centre of the Gas and Fuel Corporation (GAFCOR) of Victoria, Australia undertook a project to make use of biogas, produced in the anaerobic digesters at the McCain Australia Pty. Ltd. Food Processing Plant in Ballarat. The large quantity of potatoes consumed in the plant produces vast amounts of potato peelings which are removed as a sludge fluid effluent. The sludge is treated in the anaerobic digesters to render it acceptable for normal sewerage disposal and biogas is a by-product.

The aim of the project was to use the biogas in the factory's existing

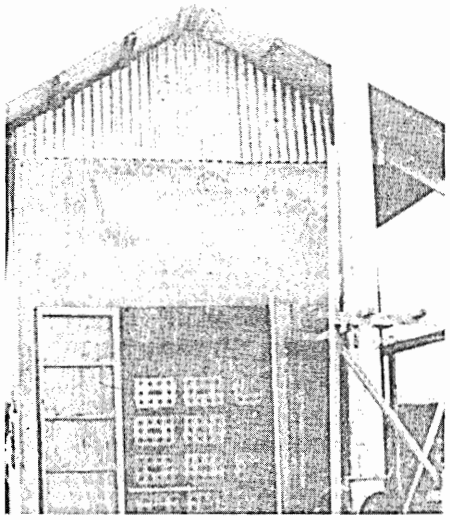


Fig. 1. Crates of onions stacked inside dryer.

to the drying chamber; fans to provide air circulation; a humidification and ventilation system consisting of water sprays and air vents; and a manual control system to regulate the temperature and relative humidity of the kiln (Fig. 1).

A series of tests on the dryer's performance showed that it can cure a load of onions to the desired dryness in a matter of 48 to 60 hours. The exact length of time required varies, depending on the onion variety, the size of the bulbs and their moisture content.

The tests also indicated that rice hull serves the dryer's heating requirements quite efficiently. With its low calorific value, rice hull is very suitable for onion-drying which requires only a low temperature. Too much heat would scorch the delicate skin of the onions.

The use of rice hull as fuel is also very economical and convenient. Using rice hull as fuel therefore saves the farmers not only the cost of fuel for the onion dryer, but also the problem of rice hull disposal. The dryer uses up approximately 12 to 15 sacks of rice hull in 48 hours.

FPRDI started installing the dryers in 1988. To date, a total of 28 have been installed – 27 in Nueva Ecija, one in Nueva Vizcaya. Twenty more units are expected to be put up this year in different parts of the country.

(Source: *Energy Alternatives*, Vol. VI, Nos. 1-2, p.4, 1990.)

steam-raising boiler plant which consists of three 3.9 MW natural gas-fired boilers. Before commencement of the project, the biogas was usually disposed of by flaring to the atmosphere.

It was found that in this particular case, there was insufficient biogas produced to completely satisfy the thermal input requirements of one boiler and furthermore, the gas flow rate from the digesters was subject to variation. To overcome these difficulties, a unique method was proposed to blend digester gas with natural gas and to use the resultant mixture to fuel the baseload boiler.

The biogas utilisation installation was designed, supervised and successfully commissioned by the Energy Development Division of the GAFCOR Energy Management Centre. The novel system of firing biogas from the plant digesters, in conjunction with the natural gas, in such a way as to ensure that the fuel mixture supplied to the baseload boiler had similar burning properties to natural gas, operated satisfactorily. This system, together with all installed safety interlocks guaranteed safe boiler operation.

At present, the plant is consuming approximately 50 GJ/day of biogas which on today's natural gas pricing represents a pay-back period of less than two years on equipment and installation costs (neglecting demonstration and experimental aspects). The system is designed to handle 4,000 m^3/day of biogas and is presently handling 2,800 m^3/day. This allows a large scope for future expansion of the plant and the firing of additional boilers on biogas/natural gas fuel.

Further details about this project are available in "Co-Combustion of Natural Gas and Biogas from Potato Wastes in a Medium Size Steam Plant" by Victor Waveluk, in *Proceedings of the International Conference on Energy and Environment*, 27-30 November 1990, Bangkok, Thailand, organized by King Mongkut's Institute of Technology Thonburi and Ministry of Science, Technology and Energy, Bangkok, Thailand.

Denmark's Offshore Wind Farms

The world's first offshore wind farm will consist of eleven 450 kW machines sited in two rows off Vindeby, Lolland Island, in Denmark. It is being built by ELKRAFT, one of the main co-operative power companies in Denmark.

The reinforced concrete foundations for the wind turbines are being built in a dry dock dug out of clay near to the site and are being floated out to the station and manoeuvred into position using a catamaran. On completion, the farm will consist of eleven wind turbines arranged in two rows, 300 m apart, situated some 1500 to 3000 m offshore in 2.5 m to 5 m of water. Some modifications have been made to the Bonus machines in view of the more hostile offshore environment; they have three 16 m blades made from glass fibre reinforced polyester mounted on a 35 m tubular steel tower, with a rated capacity of 450 kW.

When the wind farm comes into operation next June, it is expected to generate 12 million kWh/a. According to Kurt Mortensen at ELKRAFT, the electricity will cost around US$0.11/kWh, including US$0.014/kWh for operation and maintenance, and assuming a 5 per cent real interest rate and a 20 year life.

Work on a second offshore project in Aarhus Bay on Jutland has been delayed due to the need to resolve differences among a number of Ministries that have an interest in the project. This could be overcome with the establishment of the new "Windmill

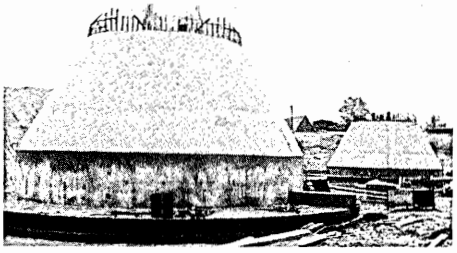


Fig. 1. Caisson foundations for the Vindeby turbines.

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Denmark's Offshore Wind Farms

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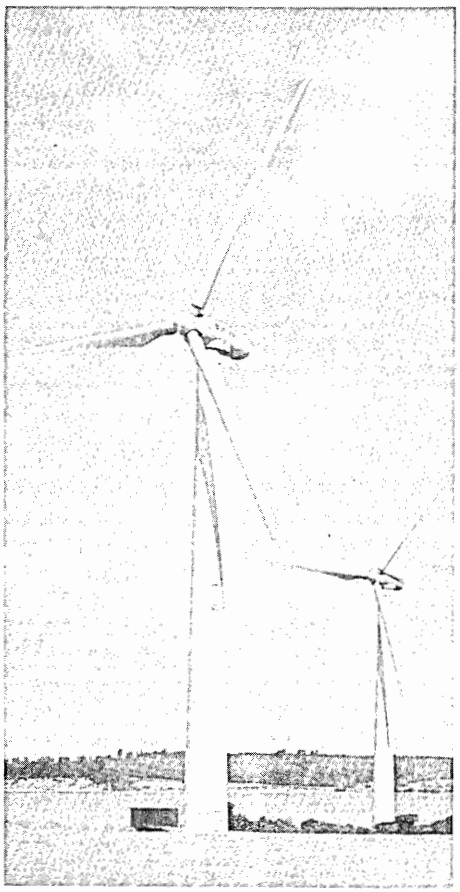

Fig. 2. 450 kW Bonus wind turbines.

Law". Thus the overall responsibility for offshore wind will be given to the Ministry of Energy; it will also set strict specifications for all new wind turbines, on- and off-shore.

Danish companies have been involved in other offshore wind programmes: Wind World won the contract to build Sweden's first offshore machine, which was put in place last month. The 220 kW, 28 m diameter wind turbine, which is now undergoing trials, is mounted on a tripod in five metres of water 250 m off the coast of Western Blekinge, north-east of Malmö.

The UK plans to build a 750 kW machine 5 km off the north Norfolk coast collapsed last year when James Howden, one of the main partners in the project, pulled out of wind energy. The UK Department of Energy is now planning to carry out yet another feasibility study.

(Source: *Modern Power Systems*, Vol. 10, Issue 12, December 1990.)

Pumped Storage in East China

The East China region produces more than a quarter of the national industrial and agricultural output providing about one third of state revenues. But, this area has been plagued by power shortages which result in annual industrial losses of more than US$11 billion. In order to meet peak electricity demands and offset these losses, plans are underway to built a pumped storage station at Tianhuangping, 175 km southwest of Shanghai.

Construction of the project is scheduled to begin in 1992 and finish in 1998 according to the preliminary plans worked out by the East China Power Administration (ECPA). By then, Tianhuangping is expected to have six turbo-generators in operation with a total installed capacity of 1800 MW. The station will generate some 3.16 TWh each year which will be sent through 500 kV transmission lines to the East China power grid.

According to the design, two reservoirs will be built on a tributary of the Xitiaoxi river, which empties into Lake Taihu. The upper reservoir will be able to store 8.85 million cubic metres of water, while the lower reservoir located 1400 m downstream will store 8.77 million cubic metres. The annual precipitation of 1821 mm is expected to be sufficient for normal operation of the station.

An underground powerhouse of 21 m width, 46 m height and 198 m length on the left bank of the lower reservoir will accommodate six pump turbines which are reversible, vertical shaft, single stage Francis type machines, with a generating capacity of 306 MW each. They need a head of between 512 m – 607 m for power generation and have a lift of between 523 m to 614 m to operate as pumps. Their speed will be 500 rev/min. Also six generator motors each with a capacity of 335 MVA will be installed in the powerhouse. These will be synchronous, reversible single shaft machines.

The total investment for the project is estimated at US$380 million. Of this total, US$200 million will be raised from foreign capital – including US$5 million for construction equipment, US$4.5 million for technical consultancy services and about US$190 million for station equipment.

Already three pumped storage stations are operating in China and two others are currently under construction. With the completion of Tianhuangping in 1998 these type of stations will play a significant role in meeting the future energy needs of growing industrial areas in China.

(Source: *Modern Power Systems*, Vol. 11, Issue 2, February 1991.)

The Special Energy Programme Tanzania

The Special Energy Programme (SEP) Tanzania has been jointly initiated by the United Republic of Tanzania and The Federal Republic of Germany. The main objectives of the SEP Tanzania are to develop, adapt, manufacture and disseminate technologies which utilize renewable energy sources efficiently in an ecologically sound manner.

The organizations jointly implementing the SEP are the Centre for Agricultural Mechanization and Rural Technologies (CAMARTEC) operating under the Ministry of Industries and Trade and on the German side, the German Agency for Technical Co-operation (GTZ), charged by the Ministry of Economic Co-operation (BMZ).

The technologies and products disseminated in the present phase of the SEP Tanzania are biogas units for small scale farmers, biogas units for institutions, biogas units for water pumping in rural areas and bio-latrines in institutions mainly for sanitation. Improved charcoal stoves for urban households and community charcoal stoves for hotels and restaurants are manufactured and sold commercially. Large chimney-at-

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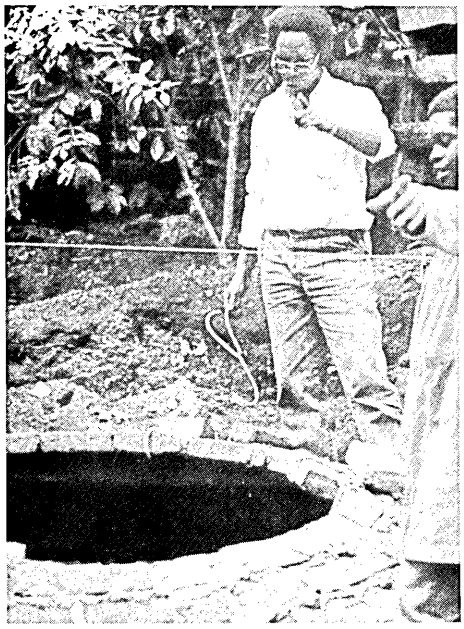

Family size CAMARTEC fixed-dome biogas plant.

Wood stoves in the institutional kitchen.

tached community wood stoves with stainless steel pots have been designed for cooking with firewood in public institutions. A nationwide advisory service and stove installation service for community wood stoves is offered to assure correct stove selection, stove installation and an efficient stove operation.

Technology Development

Biogas Plant

A viable and sustainable biogas plant – the CAMARTEC Fixed-Dome Biogas Plant – has been developed by the CAMARTEC engineers after four years of research and development work.

To date more than 270 plants of this type have been constructed in Tanzania and many more are being built. The family size (16 cubic metres) plant shown here is one example of the CAMARTEC FIXED DOME installations.

For biogas utilization, kerosene pressure lamps, kerosene refrigerators, gas cookers, gas incubators for chicken and many other appliances have been modified and tested.

Wood Stoves

A period of three years has been required to design, test and standardize the SEP/CAMARTEC community wood stove technology and the stainless steel pots. In January 1988, the first 50 litre capacity wood stove went into trial operation. In January 1991, community wood stoves and stainless steel pots in sizes of 25, 50, 100, 200 and 300 litre capacities were field proven and offered to wood-using public institutions. Furthermore, the stove technology has been adapted to be utilised for baking or fish drying by using special chambers. Exchangeable combustion inserts allow the use of different fuels like biogas, charcoal or mineral coal.

The dissemination of community wood stoves is carried out in three steps. The most suitable and efficient stove arrangement for each single institution is selected and recommended to the management during the "Advisory Service". Once an order has been placed, stoves and pots are manufactured and their quality is controlled. Lastly, all stoves are installed by qualified technicians in the institutional kitchens, before the cooks are instructed in wood chopping and the most efficient method of stove operation. Extensive field experience has shown that correct stove installation and introduction will reduce wood consumption by 70-80% compared to the previously used open fire places.

Special stoves for processing agricultural products have been developed to reduce wood consumption and support local processing and product preservation in agriculture. Large destilles with stainless steel tanks of 1500 litres capacity are in operation near Babati to extract Geranium oil for exportation. Improved salt drying stoves are under test to reduce wood consumption and allow use of alternative fuels in this very energy intensive drying process applied in coastal areas.

Besides these products and services, the feasibility of establishing a briquetting plan for sawdust is being investigated. Plans to support public institutions in planting and management of woodlots for firewood generation are under preparation.

For further information please contact:

SEP Tanzania
c/o CAMARTEC
P.O. Box 764
Arusha
Tel: 057-3594 or 3966

or

SEP Tanzania
c/o GTZ-PAS
P.O. Box 1519
Dar es Salaam
Tel: 051-31481/2 or 33546

African Energy Policy Research Network (AFREPREN)

The key objective of AFREPREN is to strengthen local research capacity and to harness it in the service of energy policy making and planning.

Coordinated by the National Institute of Development Research and Documentation (NIR) of the University of Botswana, the AFREPREN initiative brings together over 25 researchers and policy makers from Eastern and Southern African region who have a long term interest in energy research and the attendant policy making process. AFREPREN members come from 16 countries of the region, namely: Angola, Botswana, Burundi, Ethiopia, Kenya, Lesotho, Mauritius, Mozambique, Rwanda, Seychelles, Somalia, Sudan, Tanzania, Uganda, Zambia and Zimbabwe.

With support provided by the Swedish Agency for Research Cooperation with Developing Countries (SAREC), AFREPREN has initiated a two-year program that will focus on the following six major energy policy research themes: Institutions & Planning; Electricity; Oil & Gas; Coal & Gasification; Renewable Energy Technologies (RETs); and, Biomass Energy.

More information on AFREPREN can be obtained from:

Prof. Ansu Datta
AFREPREN Coordinator
National Institute of Development Research and Documentation (NIR)
University of Botswana
Private Bag 0022, Gaborone
Botswana
Tel: 356364/5
Telex: 2429 BD
Fax: 357573

(Sources: 1) *AFREPREN Newsletter,* No.3, March 1990. 2) *African Energy Policies: Issues in Planning and Practice,* African Energy Policy Research Network (AFREPREN). London: Zed Books Ltd., 1990.)

AFREPREN's six research programmes for 1989-91, with participating countries.

	Title	Country
1.	Key factors for the dissemination of rural energy technologies and bio-energy interventions	Uganda Sudan Kenya Burundi Zambia Angola Lesotho
2.	Use of biomass energy balance to determine the woodfuel problem	Rwanda Botswana
3.	Rural electrification: main issues in decentralisation and pricing of electricity generation and supply	Somalia Ethiopia Lesotho Tanzania Zambia Burundi Botswana
4.	Substitution of coal for other fuels in household and institutional applications: a critical analysis of the technological and socio-economic prerequisites, and environmental impacts	Botswana Zimbabwe Zambia
5.	Efficient use of petroleum products: opportunities and constraints in the household, transport and electricity generation sectors	Mauritius Ethiopia Tanzania
6.	Institutions and planning appropriate to energy demand management	Lesotho Seychelles Botswana Kenya

Micro CDS/ISIS Society – Nepal Formed

On 14 June 1991, CDS/ISIS Society – Nepal (CISN) was established. The major objectives of the Society are to train librarians and information scientists in the use of Micro CDS/ISIS and to promote the use of new information technologies in specific areas. An immediate challenge to this Society is to develop links between CISN and CDS/ISIS user groups in the country and region.

Mr. Pramod Pradhan (ICIMOD), Mr. Bhanu Pathak (Swiss Development Corporation, Nepal), Mr. Mohan Pradhan (Institute of Medicine and Mr. T.M. Dahal (RONAST), the coordinator, have been nominated as executive members of the Society.

Participants at the Seminar on Environmental Sanitation Information Exchange Through Focal Nodes financed by the ENSIC/ADB Project held from 11-12 June 1991 had stressed the need for such a Society, and acted as a catalyst in Kathmandu in the creation of CISN, to encourage supportive activities among the CDS/ISIS users in Nepal and to develop international links between CISN and other CDS/ISIS user groups in the region.

UN Information Service assists in Locating Partners in Developing Countries

For companies seeking partners in developing countries, TIPS is the vehicle to assist them. An information service of the United Nations Development Programme designed to expand the technology and trade transactions of developing countries, TIPS offers daily bulletins in different sectors, and a query service to match supply and demand.

The sectors covered are agro-industries, biotechnology, building materials, business opportunities, chemicals, electronics, energy, fisheries, and food processing, machinery, mining, packaging, pharmaceuticals and textiles.

TIPS maintains a database containing more than 35,000 records of developing country offers and requests. Its national offices, which are in daily contact with companies, are based in countries that represent more than two-thirds of the population of developing countries. Thus, TIPS opens a window to a very large market.

Firms wishing to have their requirements registered in its database and featured in the bulletins can get in touch with the nearest TIPS office or

TIPS
Via Panisperna 203
Rome 00184
Italy
Tel: 482-6967
Fax: 482-8838

TERI Information Digest on Energy – TIDE

This new quarterly journal, to be published at the beginning of 1991 by Tata Energy Research Institute (TERI), will feature an exhaustive range of energy-related literature. The journal will embody, in a substantially refined and consolidated form, TERI's existing publications, namely, Indian Energy Abstracts and Energy Digest.

The journal will highlight various topics, including:

- Abstracts of papers from primary journals, conferences, etc.
- Newsbriefs about current research and its applications.
- Concise digests on subjects of topical interest.
- Announcements of conferences, workshops, symposia, etc.
- Comprehensive and latest statistical profiles.
- Reviews of recent books.
- Short, up-to-date bibliographies.
- Details of new books, reports, etc. received in the TERI Library.
- Analyses of trends.

All those who have subscribed for either the Indian Energy Abstracts or Energy Digest for 1991 will automatically receive this new journal.

For subscriptions and more information please write to:

Tata Energy Research Institute
Documentation and Information Center
102, Jor Bagh
New Delhi – 110 003
India

Private Sector Participation in Power through BOOT Schemes

Industry and Energy Department Working Paper Energy Series Paper No. 33
The World Bank Industry and Energy Department
The World Bank
1818 H Street, N.W.
Washington, D.C. 20433, U.S.A.
December 1990, various pagings

This report reviews the issues and options for private sector participation in power supply by means of Build-Own-Operate-Transfer (BOOT) schemes, particularly in developing countries. This report is an edited transcript of presentations given by senior executives of major private sector organisations at the seminar organised by the World Bank in Washington, D.C. on April 23 and 24, 1990. The presenters drew on their experiences in implementing BOOT schemes around the world during the 1980s. Since the seminar was only intended to review issues, this report does not present a formal statement of the World Bank's policy on this subject.

The report focuses on the practical issues for implementing successfully the BOOT approach for power development from the different perspectives of host governments, power utilities and financiers as well as investors, suppliers and contractors from the private sector. The following key aspects are covered:

- objectives of the approach for all parties;
- security package and risk allocation;
- bidding and negotiation processes;
- responsibilities of host governments; and
- options for the role of the World Bank.

A recurring theme in the report is the trade-off between the potential advantages (risk sharing, additional investment resources, improved efficiency) and drawbacks (lengthy and

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1991 European Directory of Renewable Energy Supplies and Services

Editor: Bruce Cross
James & James Science Publishers Ltd.
75 Carleton Road
London N7 OET
United Kingdom
ISBN 0-907383-55-6
1991, 198 p.

This directory contains a number of different types of information. The core of the directory is the A-Z and classified listing of the companies around Europe that are active in the renewable energy field. This information has been gathered mainly by means of a questionnaire, but also by consulting many other miscellaneous sources of information about renewable energies.

General information both about the field as a whole and about the different sub-areas are also included. There are listings of trade and non-trade organizations, of books, journals and sources of statistical information, of conferences and courses, glossaries of key terms and a list of conversion factors.

This is complemented by a number of articles which outline the potential and possible future development of each type of renewable energy, or some specific application.

Private Sector Participation in Power through BOOT Schemes

From P. 11

costly negotiations, inflexibility in plant usage, higher price from greater returns sought by private investors) of BOOT power projects for developing countries. On balance, it appears that experience to date does not provide a reliable basis for evaluating this trade-off, but it appears to show that the approach could offer a decisive net advantage once the process for developing these projects is improved.

Review of Electricity Tariffs in Developing Countries during the 1980s

Industry and Energy Department Working Paper
Energy Series Paper No. 32
The World Bank Industry and Energy Department
The World Bank
1818 H Street, N.W.
Washington, D.C. 20433, U.S.A.
November 1990, 39 p.

According to World Bank policy – as stated in OMS 2.25 of March 1977 – the determination of electricity tariffs should be based on two major principles. The first is that tariffs should reflect economic efficiency prices, in terms of the structure and levels of costs for supplying electric power. In practice, this principle has been taken to mean that consumers should pay the long run marginal costs of meeting their demand. The second major consideration is that tariffs should be set so as to make power utilities financially viable with an acceptable financial rate of return. There has been concern within the Bank about the effectiveness of these two principles, especially when the results of an earlier study on Bank lending in the power sector indicated that the economic and financial performance of utilities borrowing from the Bank was declining.

As a results of this concern, the Industry and Energy Department (IEN) of the World Bank has carried out an extensive survey of tariffs during the 1980s to determine the extent to which they reflected economic efficiency prices. This report summarizes the results of this survey, in terms of: (a) whether tariffs in developing countries have been based on long run marginal costs and, if not, what the prospects are for these countries adopting economic pricing; (b) how tariff levels in developing countries have changed in constant price terms during the 1980s; and (c) how these tariff levels compare to levels in OECD countries and the average incremental economic cost of power system expansion during the 1990s in developing countries.

The results of the research show that tariff levels in constant US$ terms in developing countries, as a group, remained relatively stable between 1979 and 1983, but deteriorated markedly thereafter. Between 1983 and

3rd AIT-WHO Training Course on Solar Refrigerators Repair and Maintenance

3-14 February, 1992
Asian Institute of Technology
Bangkok, Thailand

The 3rd AIT-WHO Training Course on Solar Refrigerators Repair and Maintenance will be organized by the Division of Energy Technology, Asian Institute of Technology (AIT), in collaboration with EPI of WHO-SEARO and WHO-HQ.

Aim of the Course and Methodology

The course aims to increase the number of suitably trained repair and maintenance technicians capable of installing and keeping the solar powered refrigerators in good working order. Rapid expansion of the cold chain infrastructure including the use

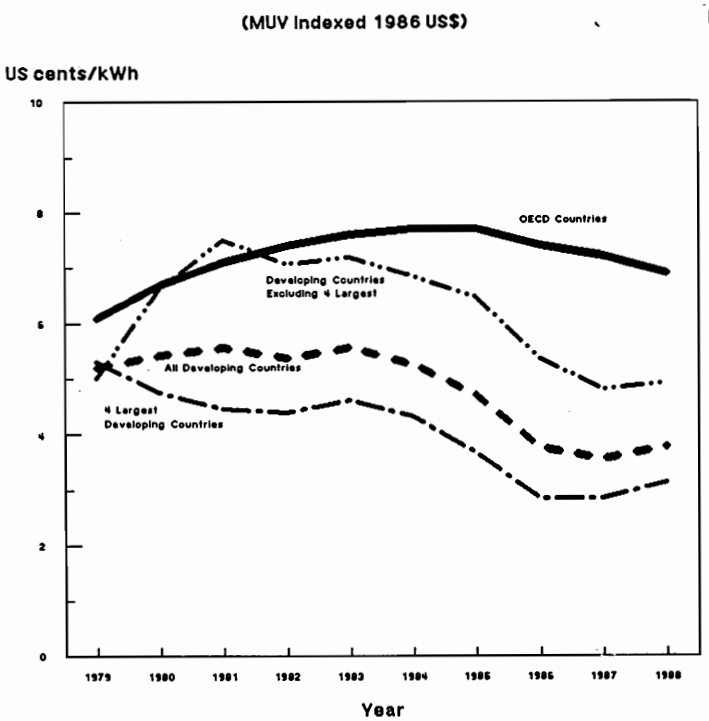

Fig. 1. Trends in electricity tariffs of OECD and developing countries for 1979-1988 in constant US$ terms.

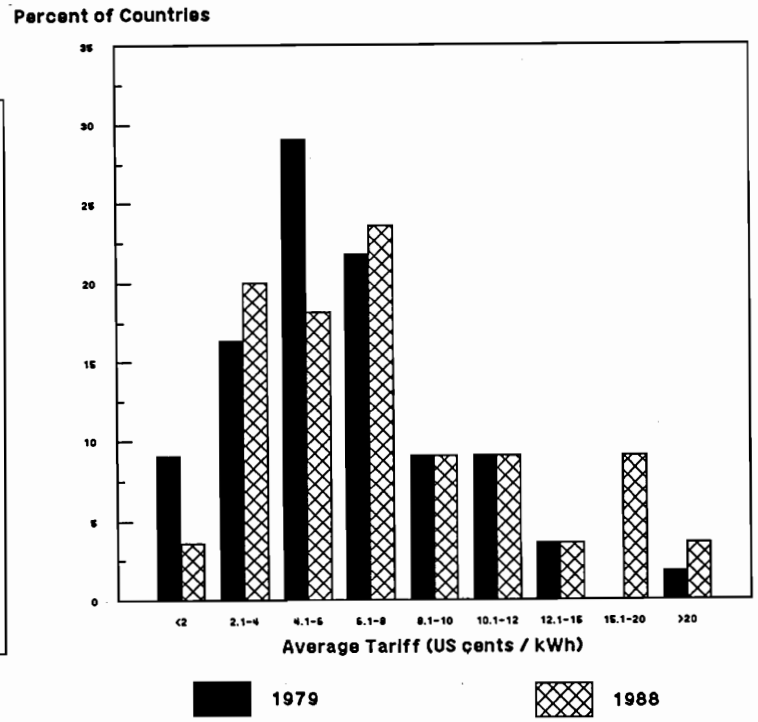

Fig. 2. Distributions of average tariffs in developing countries for 1979 and 1988 in constant US$ terms.

1987, tariffs fell by around 35%. The average level of tariffs in the late 1980s was only about half the average incremental economic cost of power system expansion during the 1990s. The average level in developing countries was also just over half the average level in OECD countries in the late 1980s. Thus, electricity consumers in developing countries generally faced tariff levels that were too low to encourage efficient use of electricity, while power utilities were unable to raise sufficient funds from revenues to finance their expansion needs. The relative movements in tariffs, expressed in constant local price terms, show that electricity consumers in developing countries faced greater fluctuations in tariffs than their counterparts in OECD countries. The results of the survey indicate that most governments and power utilities had not adopted efficiency pricing for their electricity tariffs in the late 1980s, even though the marginal costs of supplying electricity had been studied in most countries. The study also reports the results of research into empirical correlations between trends in average tariffs and factors reflecting macroeconomic and power system characteristics.

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of solar refrigerators necessitates the training of more cold chain technicians. The course follows the EPI scheduled programme of instructions and training materials which is particularly orientated for hands-on experience.

Course Programme

The course programme consists of: Principles of operation of solar refrigerators; System familiarization; Installation of solar refrigerators; Safety considerations; Basics in electricity and electrical measurements; Solar panel and array (characteristics, installation and performance); Installation of a complete solar refrigerator system; Maintenance procedures and record keeping; and Fault finding and repairs.

Four different solar refrigerators systems are available for hands-on experience

Pre-Requisites

Candidates should have undergone a training course for compression refrigerators repair technician **or** have equivalent certificate trade course from a reputed national institute and some experience on repair of refrigerators.

Language

The language of the course is English. The candidates should have ability to understand, speak and write English language.

Application

The number of participants is limited to 20. Applications using pre-registration form should reach AIT **not later than 30 November 1991,** Acceptance will be on **first come first served** basis, hence, candidates should send applications as soon as possible.

Date and Venue

The course will be held from 3 to

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3rd AIT-WHO Training Course on Solar Refrigerators Repair and Maintenance

3-14 February, 1992
Asian Institute of Technology, Bangkok, Thailand

PRE-REGISTRATION FORM

Name: _____ Sex: _____
(Surname/Family Name) (Other Names)

Employer's Name: _____
& Address (if any)

Telex _____ Fax _____ Telephone _____

Candidate's Position: _____

Sponsoring Agency: _____
(if applicable)

Place & Date of Birth: _____

Nationality: _____ Passport No.: _____ Date of Issue: _____

Place of Issue: _____ Expiry Date: _____

Education: _____

Compression Refrigeration Training Course Attended (Date, Place): _____

Experience of repairing refrigerators (in Years): _____

NOTE: Accommodation and full boarding (breakfast, lunch and dinner) cost at AIT is US$45 per day which is optional. This amount is payable directly to AIT hotel by the participant.

Date: _____ Place: _____ Signature: _____

NOTE : Application to reach Dr. Supachart C., AIT before 30 November 1991.

Post-Graduate Diploma Course in Forestry for Rural Development

A rapidly increasing number of integrated rural forestry activities demonstrate the importance of forestry within the international community. To execute and manage these new forestry activities additional training is required for staff presently working in the organizations responsible for the execution of rural forestry programmes.

The International Institute for Aerospace Survey and Earth Sciences (ITC), in collaboration with Forestry Manpower Development Consultants (FMD) has organized this post-graduate diploma course.

The main aim of the course is to encourage the development of skills and socio-economics insights, which enables participants to achieve a greater understanding of the role of woody biomass in rural development. The second aim is to facilitate more productive use of wood components for local community needs in a framework of sustainable rural development.

The 8-month course will start on the second Tuesday of October of each year. Fellowships are available. For further information, contact:

ITC Student Registration Office
P.O. Box 6
7500 AA Enschede
The Netherlands

Micro Hydro Power Training Course

3-22 September 1991
Intermediate Technology Development Group (ITDG)
Nuwara Eliya, Sri Lanka

The Intermediate Technology Development Group (ITDG), together with local engineers, has acquired a great deal of direct experience in installing and rehabilitating micro-hydro schemes in Sri Lanka. Developments in turbine design and electronic load control pioneered by ITDG, have led to an increasing interest throughout the world in micro-hydro schemes as an economic power source.

ITDG is keen to pass on its acquired skills and knowledge to increase the capability of engineers in other parts of the world as well as in Sri Lanka, in all practical aspects of micro-hydro work.

Thus, this course is basically intended for engineers and technicians with experience or qualifications in mechanical, electrical or civil engineering and also could be useful to suitably qualified staff of rural development, banking and credit organizations.

The course will include:

- lectures and discussions, complemented with slides, model exhibits, computer programmes and detailed course notes;
- continuous practical design exercises;
- field visits to a number of micro-hydro installations nearby;
- visits to university laboratories for practical exercises and demonstrations;
- exchange of experience of participants from different countries; and
- the opportunity to select a site and undertake a full design study.

The course will be led by Sri Lankan engineers with considerable experience and expertise in micro-hydro technology, supported by experts in this field from ITDG (United Kingdom) and other international organizations.

The course is residential and the fee amounts to Sterling Pounds 900 (exclusive of airfares). Depending on the availability of funds, the organizers will grant financial assistance to subsidize the course fee. For applications and further details, please contact:

Course Co-ordinator
Micro-Hydro International Course
Intermediate Technology Development Group
33, 1/1 Queen's Road
Colombo 3, Sri Lanka
Tel: 941-586504/941-503786
Fax: 941-502850
Telex: Attention: ITDG 421579 BIMBO CE

or

Adam Harvey
Intermediate Technology Development Group
Myson House
Railway Terrace
Rugby CV21 3HT
United Kingdom
Tel: 0788-560631

3rd AIT-WHO Training Course on Solar Refrigerators Repair and Maintenance

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14 February 1992 at the Division of Energy Technology of AIT.

Candidates/sponsors interested in the course should ask for more details from:

Dr. Supachart C.
Division of Energy Technology
Asian Institute of Technology
G.P.O. Box 2754, Bangkok 10501
Thailand
Fax: (662) 516 2126
Telex: 84276 AIT TH
Cable: AIT Bangkok
Tel: (662) 516 0110–29 Ext. 5408 or 5440

MSc Programme in Survey Integration for Resources Development

International Institute for Aerospace Survey and Earth Sciences (ITC), Enschede, The Netherlands

This new international MSc programme will be organized by the Social Sciences Division of the Development of Land Resource Surveys and Rural Development, International Institute for Aerospace Survey and Earth Sciences (ITC). The starting date is in the second week of September each year. The next course will start on 7 September 1991.

Objectives

The course is designed to develop the participants' (especially from the developing countries) critical understanding and competence in the management of information and its subsequent use for resource management and rural development.

Structure

The total duration of the MSc programme is 18 months which consists of a core programme, (a postgraduate course of six months' duration) followed by a specialization programme of 12 months (a MSc course). Three fields of specialization are offered.

- Land Use Planning and Resource Management
- Project Planning and Implementation
- Rural Energy and Development

On successful completion of the core programme, a Postgraduate Di-

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International Course on the Introduction of Wind Turbines

May 1992

Energy Research Foundation (ECN), Petten, The Netherlands

Wind energy is one of the most environmentally pollution-free methods of producing electricity and countries considering adopting this technology will definitely benefit from this course.

The course is organized by the Energy Research Foundation (ECN) and Renewable Energy Development, the Netherlands. Decision makers, project managers and industrialists who are engaged in implementing projects will particularly benefit from this course. It also provides a rare opportunity for people working in this specialized field to exchange their experience and ideas.

The four weeks course includes lectures, practical work and excursions. The medium of instruction will be English. The course programme will focus on

Planning stage
- energy planning;
- planning of wind energy systems;
- finance; and
- legislation.

Pre-investment stage
- pre-investment studies.

Implementation stage
- technology assessment;
- procurement of wind turbines;
- production, installation, monitoring;
- infrastructure; and
- management.

Operational stage
- personnel;
- control; and
- training.

The course fee will be approximately US$4,000 which is inclusive of the course-work and three excursions. Travel fare and accommodation are excluded.

Interested candidates please contact:

Netherlands Energy Research Foundation (ECN)
P.O. Box 1, 1755 ZG Petten
The Netherlands
Tel: (+31)2246-4949
Telex: 57211 REACP NL
Fax: (+31)2246-4480

MSc Programme in Survey Integration for Resources Development

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ploma will be awarded. Students may continue in one of the three MSc specialization programmes which include four months of course-work followed by an eight-month research period wherein they work individually on a selected research theme.

Course Content

The specialization focuses on three major fields:

Land Use Planning and Resource Management

This specialization focuses on the following subjects:
- data requirements for land use planning for sustainable rural development, including the role of land evaluation and farming systems analysis;
- assessment of land use alternatives which are ecologically and economically sound and socially relevant;
- institutional and physical infrastructure components in support of land use planning; and
- geographic information systems for land use planning and resource management.

Project Planning and Implementation

This specialization focuses on:
- the role of projects in guiding rural development processes;
- the process of integration of disciplines in project planning and implementation;
- methods and techniques for projects planning and implementation;
- information management and institutional infrastructure for project planning and implementation; and
- social, agricultural, economic and physical infrastructural components in support of the planning and implementation of rural development projects.

Rural Energy and Development

This specialization focuses on:
- data requirements for needs-oriented energy planning;
- assessment of natural resources for decentralized energy supply;
- evaluation of options for matching rural energy supply and demand;
- social, economical and environmental aspects of sustainable energy development; and
- processes of rural energy planning and management.

Enrollment

Applicants should be graduates with at least a BSc or BA degree. Candidates should preferably have at least two years' working experience. Fluency in English is essential. The total cost of the MSc course is approximately Dfl. 45,000 which includes registration and tuition fees, books and educational materials, health insurance premium, subsistence allowance and the costs of fieldwork. International travel fares are not included. Fellowships are available for selected candidates. Details are given in ITC's General Information Brochure.

For further details contact:

ITC Student Registration Office
P.O. Box 6
7500 AA Enschede
The Netherlands
Tel: 053-874-444
Telex: 44525 itc nl
Fax: 053-874-400

Second International Training Course on Wind Energy for Water Pumping

5 August – 13 September 1991
The University of Reading
United Kingdom

The 2nd International Training Course on Wind Energy for Water Pumping will be organized by the University of Reading, UK; in co-operation with Gamos Ltd., UK; Renewable Energy Development (RED), The Netherlands; and the University of Eindhoven, The Netherlands.

The training course covers all aspects of windpump selection, construction, implementation and testing for reliable water supply in any remote site. The course includes the fields of:

- Resources Analysis
- System Components
- System Interaction
- Project Implementation
- Practical Implementation

The course is mainly intended for persons concerned with wind energy development and/or the setting up of wind pumping projects in rural area. This six weeks course includes lectures, laboratory work and fieldwork .

The course fee will be £2,500 and living expenses including insurance are estimated to be £1450, for accommodation on the campus. Financial support is available for participants from developing countries and details are available in "Study Abroad", an international handbook.

For details of registration and information contact:

Mrs. R. Phillips
Department of Engineering
P.O. Box 225
University of Reading
Reading RG6 2AY
United Kingkom
Tel : (UK) + 44-734-31 8565
Telex: (UK) + 847813 RULIB G
Fax : (UK) + 44-734-313327

International Training Course on Civil Works of Small Hydro Power

14-27 September 1991
The State Science & Technology Commission of China (SSTCC)
Hangzhou, China

This international training course will be hosted by the Department of International Science and Technology Cooperation in collaboration with The State Science & Technology Commission of China (SSTC) and Hangzhou Regional Centre (Asia-Pacific) for Small Hydro Power (HRC).

Objectives

The main objectives of the training course are

- to give practical experience of Small Hydro Power (SHP) development with emphasis on cost reduction and the application of simplified civil works structures in China as well as available information from throughout the world;
- to introduce general idea of electro-mechanical design of SHP stations and specification of Chinese made equipment.

Qualifications

Qualified applicants should

- have completed a Bachelor's Degree in the field of SHP;
- have been working in a relevant field for not less than 3 years;
- have a sufficient command of spoken and written English;
- be between 25-45 years old;
- have good health; and
- be nominated by their government or organization.

Expenses

International travel expenses of participants will be borne by themselves. Boarding, lodging, and local transportation expenses as well as anything needed for the training course during the training period will be covered by the Chinese Government. A small daily allowance will be given to each participant.

Outline of the Programme

The training course on Civil Works of SHP is divided into three parts.

Part one

Theoretical part:

- Design criteria of hydraulic structures of SHP projects in China;
- Intake structure & water channels;
- Power house;
- Site-selection of a SHP project; and
- Electro-mechanical equipment manufacture in China.

Part Two

Observation tour or practice:

- Site-visits to several SHP stations.

Part Three

Presentations and discussion.

Participants who have successfully completed the training course will be awarded a certificate by the International Science & Technology Cooperation Department of SSTCC and HRC.

For application forms and further relevant information please contact:

Ms. Wang Qi
Hangzhou Regional Centre (Asia-Pacific) for SHP (HRC)
P.O. Box 1206
Hangzhou
China
Tel: 886586
Telex: 35034 HRC CN
Fax: 862934

Biocoal: Technology and Economics

S.C. Bhattacharya and Ram M. Shrestha
Division of Energy Technology
Asian Institute of Technology
Bangkok, Thailand
ISBN 974-8201-414, 1990, vii+495 p.

"Biocoal: Technology and Economics" by S.C. Bhattacharya and Ram M. Shrestha is published for the AIT-GTZ Biocoal Project of the Asian Institute of Technology by the Regional Energy Resources Information Center (RERIC).

Industrial biocoal production technology has been known for about four decades, but has not received much attention in terms of research and development effort commensurate with its potential. The literature is sparse and scattered across numerous technical reports and journals. These considerations were central to a biocoal project carried out by AIT under the sponsorship of the German Agency for Technical Co-operation (GTZ). This book reports the outcome of the studies conducted under the project.

While the book does not claim to be an exhaustive source of reference on the subject, it has been a key objective of the authors to make it comprehensive in its coverage. The state-of-the-art report presented in Chapter 1 attempts to lay out systematically the subject matter of biocoal technology and review available papers and reports. It also lists the machinery manufacturers and on-going research projects worldwide. The two technical routes of biocoal production are compared in Chapter 2, while a wide range of experimental results are presented in Chapter 3 and 4. A method of biomass residue estimation, taking the case of Thailand as an example, is illustrated in Chapter 5 and the characteristics of ten selected residues are described in Chapter 6. The remaining part of the book presents case studies on various aspects of biocoal and its market in Thailand. This includes a market survey of briquetted biomass (Chapter 7), the economics of biocoal production in Thailand (Chapter 8) and a ranking of the selected residues in terms of their suitability for biocoal production (Chapter 9).

The case studies aim to provide practical insights on different aspects of biocoal e.g. production set-up, users' reaction to biocoal use, and activities for which biocoal use could be attractive; they are not, however, meant for generalized conclusions for a variety of developing countries. Overall, the book presents an up-to-date account of technology and economics of biocoal production that includes the results of the recent research on the subject undertaken at AIT and elsewhere.

The book is available from the Regional Energy Resources Information Center (RERIC) on payment of mailing and handling costs only since the publication is provided with the compliments by the AIT-GTZ Project.

For further details please contact:
RERIC
LRDC/AIT
G.P.O. Box 2754
Bangkok 10501
Thailand
Tel: 5160110-29 Ext. 5866 or 5245866
Fax: (66-2) 516 2126 or (66-2) 524 5870

Publications Received

ENERGY AND ENVIRONMENT

* *Energy Systems and the Environment: Approaches to Impact Assessment in Asian Developing Countries*, edited by Peter Hills and K.V. Ramani, Asian and Pacific Development Centre, Kuala Lumpar, Malaysia, 1990, xviii+384 p.

* *International Conference on Energy and Environment*, 27-30 November 1990, Bangkok, Thailand, King Mongkut's Institute of Technology Thonburi, Bangkok, 1990, xvi+404 p.

ENERGY

* *Conference Proceedings on Inaugural Meeting of Non-government Organizations Involved in Energy*, 20-21 March 1989, edited by the Technology Information Service (TIS) of the Botswana Technology Centre (BTC), Botswana Technology Centre, Botswana, November 1990, ii+68p.

* *Review of Electricity Tariffs in Developing Countries during the 1980s*, Industry and Energy Department Working Paper, Energy Series Paper No. 32, the World Bank, Washington, D.C., U.S.A., November 1990, 39 p.

* *Private Sector Participation in Power through BOOT Schemes*, Industry and Energy Department Working Paper, Energy Series Paper No. 33, the World Bank, Washington, D.C., U.S.A., December 1990, various pagings.

BIOMASS ENERGY

* *Biomass Densification Research Project, Phase One, Volume A: Conclusions, Recommendations and Executive Summary*, Technology and Development Group, University of Twente, Enschede, The Netherlands, 1990, 60 p.

* *Compendium of Biogas and Cooking Stove Technology Research, Development and Demonstration Projects in the Asia/Pacific Region*, Economic and Social Commission for Asia and the Pacific, United Nations, New York, 1990, i+69 p.

Diary of Events

- **April 21-24, 1991, Montreal, PQ, Canada**

Fluidized Bed Combustion

For details contact:
Raymond Kissel
Dearborn Chemical Company Ltd.
345 Erindale Station Road
P.O. Box 3060 Station A
Mississauga, ON L5A 3T5
Canada

- **April 21-27, 1991, Athens, Greece**

6th European Conference on Biomass for Energy, Industry and Environment

For details contact:
Dr. G. Mondelli
Fertec-via A. Fauser 8
28100 Novara
Italy

- **April 23-24, 1991, Anaheim, CA, USA**

Worldcon'91

For details contact:
WORLDCON
P.O. Box 1026
Lilburn, GA 30226
USA
Tel: (404) 925 9558

SOLAR ENERGY

* *EPI Logistics and the Cold Chain: Improving Quality, 1990*, WHO Logistics for Health Series (WHO/EPI/LHIS/90.5), World Health Organization, Geneva, Switzerland, September 1990, 32 p.

RENEWABLE ENERGY

* *European Directory of Renewable Energy Suppliers and Services 1991*, edited by Bruce Cross, James & James Science Publishers Ltd., London, United Kingdom, 1991, 198 p.

- **April 30 - May 1, 1991, Gloucestershire, United Kingdom**

Fire and Explosion Hazards: Energy Utilisation

For details contact:
The Institute of Energy
Attn: Judith Higgins
18 Devonshire Street
London W1N 2AU
United Kingdom
Tel: 580 0077
Telex: 265871 MONREF G
Fax: 580 4420

- **May 6-10, 1991, Colorado Springs, CO, USA**

Thirteenth Symposium on Biotechnology for Fuels and Chemicals

For details contact:
Charles E. Wyman
Thirteenth Symposium on Biotechnology for Fuels and Chemicals
Solar Energy Research Institute
1617 Cole Blvd,
Golden, CO
USA

- **May 13-14, 1991, Singapore**

Oil & Money: Asia & The Pacific Conference

For details contact:
Brenda S Hagerty
International Herald Tribune
63 Long Acre
London WC2E 9JH
United Kingdom
Tel: (4471) 836 4802
Fax: (4471) 836 0717

- **May 13-17, 1991, Helsinki, Finland**

Senior Expert Symposium on Electricity and the Environment

For details contact:
Joint Secretariat
c/o IAEA
Wagramerstrasse 5
P.O. Box 100
A-1400 Vienna
Austria
Tel: 431 2360

- **May 17-19, 1991, Bournemouth, United Kingdom**

Institute of Energy Annual Conference

For details contact:
Judith Higgins

or

Jill Leigh
The Institute of Energy
18 Devonshire Street
London W1N 2AU
United Kingdom
Tel: (071) 580 0008
Fax: (071) 580 4420

- **June 2-5, 1991, Sydney, Australia**

World Energy Council Pacific Asia Regional Energy Forum, Regional Energy Strategies for the Future

The event will be hosted by the Australian National Committee of the World Energy Council. The objectives of the forum are to provide a unique opportunity to discuss regional energy issues at the highest managerial levels and to develop appropriate energy strategies accordingly.

For details contact:
The Secretariat
WEC Pacific Asia Forum
G.P.O. Box 2609
Sydney 2001, Australia
Tel: (612) 241 1478
Telex: AA 120454
Fax: (612) 251 3552

- **June 11-14, 1991, Kuala Lumpur, Malaysia**

4th Malaysian Oil & Petrochemical Engineering Exhibition

For details contact:
Malaysian Exhibition Services Sdn Bhd
2nd Floor, Wisma Socfin
Jalan Semantan
Damansara Heights
50490 Kuala Lumpur
Malaysia
Tel: (03) 255 1700
Fax: (03) 255 9659

- **June 18-21, 1991, Birmingham, United Kingdom**

Power Supply Europe

For details contact:
Swan House Special Events Ltd.
Attn: Chris Timmins
Holly Road, Hampton Hill
Middlesex TW12 1PZ
United Kingdom
Tel: 783 0055

Diary of Events
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- **June 24-26, 1991, Canada**

17th Annual Conference of the Solar Energy Society of Canada, The Conference on Energy and Environment – The Next Generation

For details contact:
Conference on Energy & Environment
c/o Solar Energy Society of Canada
15 York Street, Suite 3
Ottawa, Ontario KIN 5S7
Canada
Fax: (613) 236 5053

- **June 24-29, 1991, Cusco, Peru**

IV Latin American Meeting on the Utilization of MHP

For details contact:
PROMIHDEC
Casilla Postal No. 846
Av. Pardo 1041, Cusco
Peru
Tel. and Fax: (0051) 84 224 103

- **July 8-10, 1991, Honolulu, Hawaii, USA**

14th International Conference of the International Association for Energy Economics

For details contact:
Dr. James Dorian
Chairman of the Organizing Committee
East-West Center
1777 East-West Road
Honolulu, Hawaii 96848
USA
Tel: (808) 944 7526
Telex: 989171 EWCUD
Fax: (808) 949 7298

- **July 8-10, 1991 Honolulu, Hawaii USA**

Energy Developments in the Pacific Rim

For details contact:
Rebecca Anthony
or
Stephanie Fox
East-West Centre
1777 East-West Road
Honolulu, Hawaii 96848
USA
Tel: (808) 944 7555
Telex: 989171
Fax: (808) 944 7970

- **July 8-12, 1991, Ontario, Canada**

8th International Conference on Wind Engineering

For details contact:
International Association for Wind Engineering
University of Western Ontario
London, Ontario N6A 5B9
Canada
Tel: (519) 661 3338
Telex: 064 7134 Ldn
Fax: (519) 661 3339

- **August 19-21, 1991, Colombo, Sri Lanka**

International Conference on Alternative Sources of Energy

The conference is organized by the Ministry of Power and Energy (MPE), Sri Lanka; the Institute of Fundamental Studies (IFS), Sri Lanka; and the Asian Energy Institute (AEI), India.

An exhibition of Alternative Sources of Energy will be held in parallel with the conference from 19 to 23 August 1991.

For details contact:
Prof. Cyril Ponnamperuma
Director
Institute of Fundamental Studies
Kandy, Sri Lanka
Tel: 094 8 32001
Telex: 21700 IFS CE
Cable: Fundamental
Fax: 094 8 32131
or
Mr. G.B.A. Fernando
Director
Ministry of Power and Energy
P.O. Box 576, Colombo
Sri Lanka
Tel: 094 1 437932
Telex: 21368 KILOWAT CE
Fax: 094 1 449572

- **October 25-29, 1991, Shanghai, China**

Shanghai Electric Power and Infrastructure Expo'91

For details contact:
China Council for Promotion of Intl. Trade (CCPIT) and China Electricity Council, China Promotion Ltd.
Room 2801
Tung Wai Commercial Bldg.
109 Gloucester Road
Wanchai, Hong Kong
Tel: (852) 838 7427
Telex: 76270 CHOCH HX
Fax: (852) 838 9692

- **August 19-23, 1991, Denver, Colorado, USA**

1991 World Congress of the International Solar Energy Society

For details contact:
ASES
2400 Central Avenue, B-1
Boulder, CO 80301
USA
Tel: (303) 443 3130

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Library and Regional Documentation Center, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

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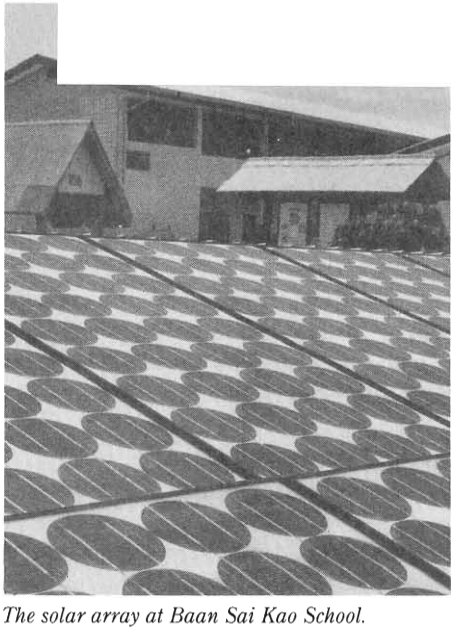
Solar-powered School, Southern Thailand

Baan Sai Kao School, in the Tha Sae district of Chumphon Province, has become well-known for its solar power unit.

The school is located in a remote setting only 12 kilometres from the border with Burma. It provides six years of primary education for a total of 350 children. When Typhoon Gay struck Chumphon two years ago, Baan Sai Kao was badly damaged.

After the storm, the school received help from the Government to construct a new, more permanent building. Along with it came a gift from Argonshu, a Japanese monastery, of a solar power generator which supplies electricity for all lighting and audio-visual equipment.

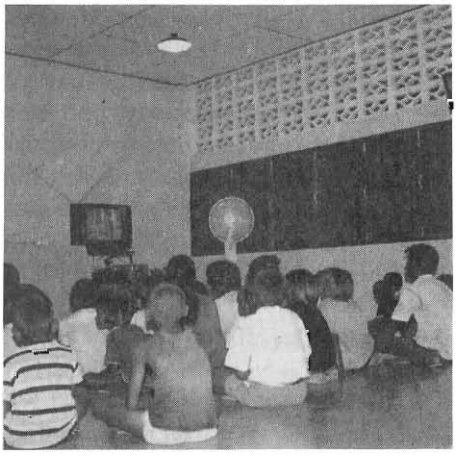
The solar system was designed and manufactured by BP Thai Solar. The system comprises of solar panels, batteries, an electronic control unit, and a panel-holding structure.



The solar array at Baan Sai Kao School.

The solar array at Baan Sai Kao consists of 68 modules, each measuring roughly a metre by half a metre, weighing about 7.5 kilogrammes, and delivering 58 watts of power. This system is capable of generating an average of 20 kilowatts of power a day. It has 36 batteries with a total storage capacity of roughly 60KW.

The cost-effectiveness of solar-generated electricity depends on functions and places of use. A study comparing a diesel generator to solar power conducted by the Electricity Generating Authority of Thailand concluded that in places where demand for electricity is not high, the cost of that produced by solar power is less than that produced by diesel generator.



Pupils at Baan Sai Kao and villagers nearby all benefit from solar power. They can now watch television in a lighted school building.

According to Mr. Apichai Thamrongsak, business development manager of BP Thai Solar, if environmental costs such as loss of forests and wildlife in our present-day production of electricity is considered solar energy is cheaper.

Another advantage of solar power is its flexibility for future expansion. At Baan Sai Kao School, there are already

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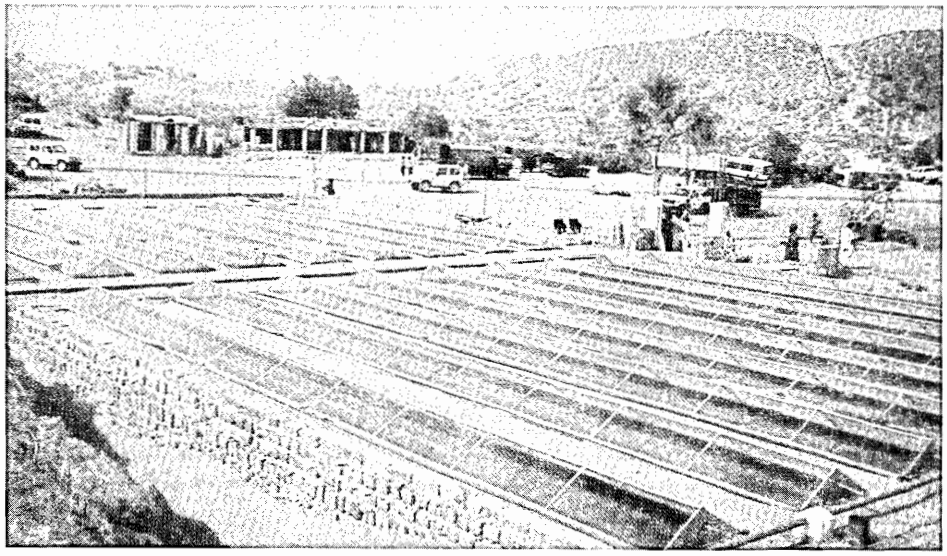
Solar Water Desalination Plants, Pakistan



A solar water desalination plant installed at Vajuto by the PCSIR.

The Pakistan Council of Scientific and Industrial Research (PCSIR) conducts various research and development projects in the fields of: applied chemistry; plastic and polymer; pharmaceutical and fine chemicals; food science; biosciences; minerals and metallurgy; glass and ceramics; pilot plant and engineering; standard calibration and instrumentation; solar energy; leather technology; fuel science and technology; precision engineering; rural technology; and environmental studies. In its thirty seventh Annual Report for 1989-90, PCSIR summarized its activities related to solar water desalination as follows:

i) Vajuto Desalination Plant

A solar water desalination plant (capacity 250 gpd) was fabricated and installed at Village Vajuto (Taluka Mithi, Distt. Tharparkar). The pumping of brackish water is being performed at present by an electric pump using an electric generator; this will be replaced by a photovoltaic-powered submersible pump.

Another plant of the same capacity will be installed soon in Mithi Taluka at a place indicated by the SAZDA (Sind Arid Zone Development Authority).

ii) Pakistan Navy Water Desalination Plant, Gwadar

A 6000 gpd solar water desalination plant based on sea-water is being fabricated for the Pakistan Navy at its establishment at Gwadar; the work is being undertaken under a contract agreement to supply the plant on turn-key basis at a cost of Rs.7.661 million.

iii) Manbai-Jo-Tar Desalination Plant

The 250 gpd solar still installed in Taluka Chachro in 1988-1989 under the instruction of the Prime Minister is being maintained and operated by the SERC. The desalination complex is based on 250 feet deep-well brackish water pumped by an electric submersible pump and by another pump run on power from a wind-mill.

iv) Islamkot Desalination Plant

The WAPDA (Hyderabad Division) has given its letter of intent for getting a 250 gpd plant installed at Islamkot Grid Station. Final details are being worked-out.

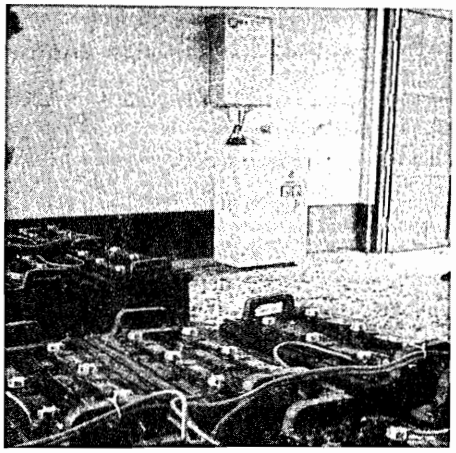
For Further details contact:
Scientific Information Centre
Pakistan Council of Scientific and Industrial Research
39-Garden Road, Saddar
Karachi - 74400
Pakistan

(Source: *PCSIR Annual Report 1989-90*, Pakistan Council of Scientific and Industrial Research, Karachi, pp.vii-ix, 32-33.)

Solar-powered School, Southern Thailand

From P. 1

plans to extend the system. Another array of 14 panels will be installed to provide villagers with a battery charging facility.



The solar-generated electrical energy is stored in a total of 30 batteries. The electronic control unit, seen near the door, regulates the charge and discharge of the current.

Almost every villager today owns a 15-volt battery to provide electricity for one tiny light-bulb at night. Some have a television set. The school's headmaster Prapat Kanchanapat estimates that about 200 families in the area use batteries and have to recharge them every seven to 10 days.

Each battery charge can cost as much as 100 baht (= US$4.00), says Prapat: 15 baht for the charging itself, 60 baht for transport to town and back, and the rest for lunch in town plus loss of a day's work.

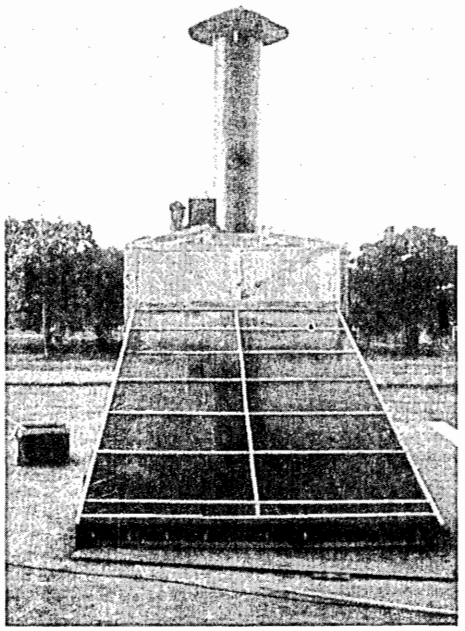
The villagers will save a lot of time and money if they can charge their batteries directly from the expanded solar power unit.

(Source: Extracted from "School that Thrives on Sunshine" by Saowarop Panyacheewin, pictures by Saowasak Putararak, *Bangkok Post Outlook*, Vol.XLVI, No.163, June 12, 1991).

Solar Banana Drier, Belize

In response to a request from the CTCS Network at the Caribbean Development Bank, Oliver Headley and his research team from the University of the West Indies, St. Augustine, Trinidad and Tobago, have recently designed and constructed a solar banana drier at San Ignacio in Belize. This drier has a 102 sq.ft. solar collector covered with 0.5 mm thick clear PVC plastic sheet connected to a drying chamber containing six trays. Air circulation is aided by a chimney rising 8 ft. above the top of the drying chamber which itself stands on 4 ft. legs to give the collector a slope of 16.6 degrees. The total height of the chimney is 15 ft.

This drier is designed to dry ripe bananas at a rate of 200 lbs. per day and the materials and construction methods were specifically chosen to allow it to be built in rural areas with readily available skills such as carpentry and sheet metal working. Five modules of this size have now been built in Belize and more should be built in Jamaica in the near future. The drier is a modified version of the rock bed drier, an 84 sq.ft example of which has been used to dry spices in Grenada since 1983. Since the wooden frame is not strong enough to carry several hundred pounds of rocks, it is proposed to use a wood stove as a back-up heat source for cloudy days, rainy periods or extra production at night. Only clean hot air would be passed into the drier, the flue gases from the burning wood being discarded through a separate chimney.



The Solar Banana Drier at the "Running W" Factory, San Ignacio, Belize, 1991.

(Source: Extracted from "A Solar Banana Drier" by Oliver Headley, *CTCS Network News*, No.20, July 1991, pp.1-2.)

Solar Water Heating, Cyprus

Cyprus has a 30-year history of solar power use and about one million square metres of solar collectors are installed throughout the country. According to Dr. T. Drakos, Director of the Higher Technical Institute in Nicosia, 90 per cent of the island's houses and 50 per cent of its hotels use solar power for water heating. The systems are manufactured locally and are also exported. Solar power currently displaces 175 million kWh of electricity a year – 4.5 per cent of the island's annual primary energy use.

The Higher Technical Institute is currently testing a solar prototype to power hospital x-ray equipment on behalf of the World Health Organization (WHO). WHO is interested in reliable alternative power systems for hospitals in the developing world. The prototype has been used at the Nicosia General Hospital since 1989 without resort to other electrical backup. The institute is also working on a solar-powered water treatment system to recycle domestic "grey" water which is discharged from showers, wash basins and washing machines.

(Source: "Solar Water Heating on Island of Cyprus", *Update*, No.45, Spring 1991, p.8.)

Amorphous Silicon PV with 12.3 Per cent Energy Conversion Efficiency, Japan

An amorphous silicon solar cell with an energy conversion efficiency as high as 12.3 per cent has been developed by a research team at the Tokyo Institute of Technology.

The high energy conversion efficiency was attained by using an optical chemical vapour deposition (CVD) process and using a special doping technique.

The research team hopes to further improve the manufacturing process to reach an energy conversion efficiency of 13-14 per cent. They also intend to combine amorphous silicon solar cells with copper-indium-selenium cells to develop a solar cell module with a predicted energy conversion efficiency of up to 20 per cent.

(Source: *Modern Power Systems*, Vol.11, Issues 8, August 1991, p.12.)

Monitoring and Testing Centre for Firewood/Coal-Saving Stoves, China

Improved wood and/or coal stoves are used by about fourteen million rural households in China. Most of these stoves are sub-standard in quality, and are fuel-inefficient. Under the auspices of the China Ministry of Agriculture and the State Planning Commission, a Monitoring and Testing Centre for these improved wood and coal stoves was set up by the Foundation for Woodstove Dissemination (FWD) Focal Point in China, China Centre for Rural Energy Research and Training (CCRERT).

The centre will provide the requisite monitoring, testing and management support to ensure that the improved wood and coal stoves manufactured for the market are of high quality. The centre will also provide efficiency testing facilities.

For more information, contact:

Wang Mengjie
China Centre for Rural Energy Research and Training
Changping 102200
Beijing 100014
People's Republic of China
Tel: 1-500 2961
Fax: 1-500 2448

(Source: *Stove News*, No.5, May/June 1991, pp.2-3.)

Renewable Energy Activities of the Sokota Energy Research Centre, Usmanu Danfodiyo University, Sokoto, Nigeria

A number of rural energy systems have been developed by the Sokoto Energy Research Centre and are now ready for commercialization. Information about these systems is available in an article entitled "Renewable Energy Systems for Nigerian Communities", published in RERIC News, Vol.13, No,4 December 1990, pp. 11-12.

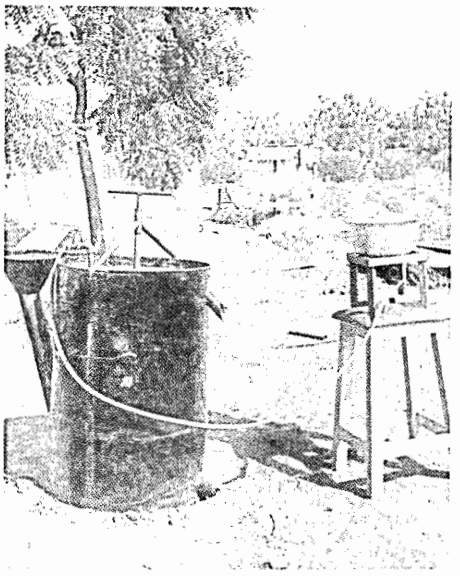
Photographs of some of the rural energy systems were recently provided by Dr.S.A. Sambo of the Sokoto Energy Research Centre. For further details please contact:

Dr. S.A. Sambo
Usmanu Danfodiyo University
Sokoto Energy Research Centre
P.M.B. 2346
Sokoto
Nigeria

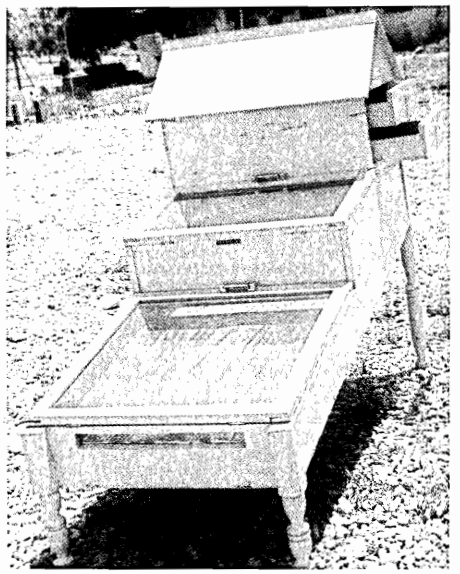
The Nigerian Journal of Renewable Energy (ISSN 1115-0610) is also a good source of information on renewable energy activities in Nigeria. The journal is published by the Sokoto Energy Research Centre, Usmanu Danfodiyo University to serve as a focal point for the dissemination of research and development outputs in renewable energy.

The Volume 1, 1990 maiden issue contains the following articles:

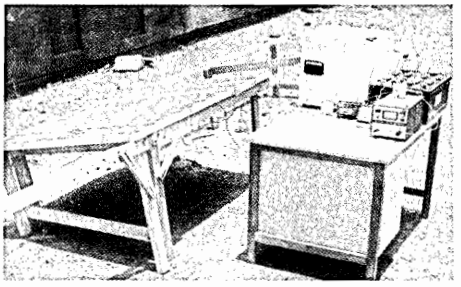
1. Estimation of Total Solar Radiation in Nigeria Using Meteorological Data: R. 'Layi Fagbenle
2. An Experimental Evaluation of Collector Units for Thermo-Syphonic Solar Water Heaters: A.S. Sambo and M.B. Bello
3. Preparation and Characterization of Thermally Oxidised Copper Substrates for Photothermal and Photovoltaic Energy Conversion: G.A. Adegboyega
4. Stabilization of Cadmium Sulphide Photo-Anode by Polypyrrole Against Photo-Decomposition: V.O. Aimiuwu
5. Solar Energy for Power Generation: B.G.Ishaku
6. Renewable Energy Sources for Rural Electrification: A.S. Sambo and P.F.U. Taylor
7. An Experimental Investigation of Combustion of Wood in Fluidized Bed Combustors: F.O. Akinbode
8. Biomass Gasification - A Rediscovered Technology: E.I. Kucha
9. Biogas Generation from Animal Wastes: M.M. Abubaker
10. Prospects for Small Hydropower Development for Rural Applications in Nigeria: U.O. Aliyu and S.B. Elegba
11. Economics of Renewable Energy Systems: The Case of Solar Energy for Nigeria: A.S. Mika'ilu and K.K. Kamaluddeen
12. The R20 Primary Battery Hydrogen Depolarizer : A.I. Onuchuku and B.M. Dukku
13. Conference Report 1st World Renewable Energy Congress - African Contributions and Challenges: R. 'Layi Fagbenle



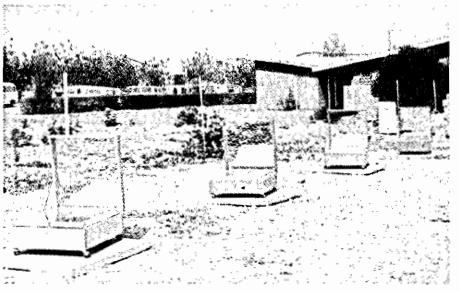
Biogas digester and stove.



Solar dryer.

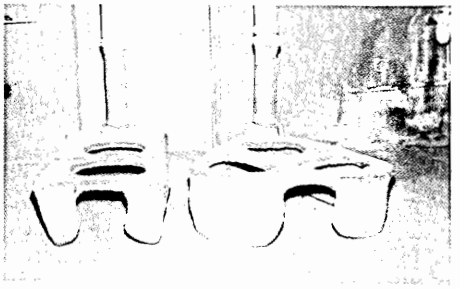


Solar-powered refrigerator.



Solar cookers.

Solar dryers.

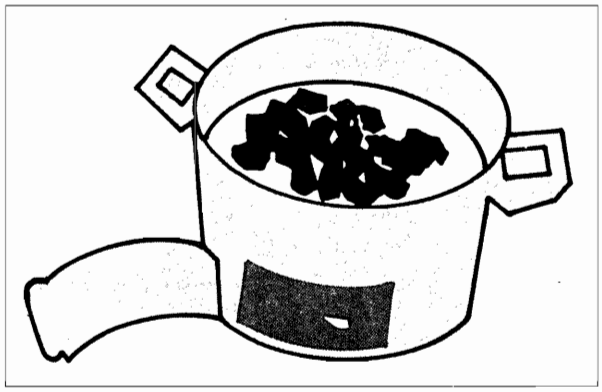


2- and 3-hole efficient wood-burning stoves.

Improved Charcoal Stove Project, Ghana

The Improved Charcoal Stove Project in Ghana, sponsored jointly by the National Energy Board (NEB) and the World Bank through ESMAP, was initiated in January, 1989. Its main objective was to design and promote the use of improved charcoal stoves in the country over a two year period. The target group was the urban population of whom 70% use charcoal exclusively for cooking.

During the selection of improved stoves for laboratory and field tests, a World Bank expert and two local manufacturers were given the responsibility of designing improved charcoal stoves. The expert made two designs (one was the normal traditional coalpot with a door and the other a combination of the Rwanda and sakkenal stove models). The local manufacturers also designed one each, similar to models already in use. The most preferred, with respect to fuel savings (30-40%), user acceptance (70%) and adaptability to cooking (83%), was one of the models designed by the local manufacturers.



Ahibenso, the Ghanian stove.

During a recent evaluation of the project by the Bank, one of the key issues was for the evaluation team to find out if the selection of the stove models was based on bias by the project team. The findings of the evaluation are not out yet. But they were convinced of the reliability of the choice.

The project document stipulated, amongst other things, that, after laboratory and field tests, there should be large-scale production and dissemination of the selected models. Findings from the project indicated that, not to have done that would have meant risking a high degree of failure. The NEB decided to include an intermediary phase which would involve a further demonstration and monitoring of the selected models in all the regional capitals in the country. This phase proved very beneficial since it gave an insight into the fact that the stove was too costly and also had some technical shortfalls when cooking certain dishes.

According to Michael Wuddah-Martey, the immense contribution made by the local stove manufacturers, the project team and host institution (NEB) shows that the only fundamental input that developed countries lack is finance.

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Renewable Energy Applications in Mongolia

The Mongolia People's Republic occupies an area of 1,565,000 km^2 with a population of 2 million people. Around 129,000 Mongolian families in rural areas rely on animal husbandry for their living, 81,000 of these families are essentially nomadic.

The Mongolian Government is keen to stem the flow of the population to the towns by improving living conditions in rural areas. The government has declared its intention to provide electricity to all rural families over the next few years. Renewable energy is playing a leading role in this initiative.

A typical family in a yurt (round tent) needs energy for lighting (5 hours per day), television (4 hours per day) and radio (15 hours per day), amounting to a daily energy requirement of only 150-200Wh. A single solar photovoltaic module of 40-60W is sufficient to meet this.

Several hundred photovoltaic systems have now been installed in Mongolian households. The Research and Production Corporation for Renewable Energy (part of the Ministry for Energy, Mining and Minerals), based in the capital Ulan Bator, has been assembling and distributing these systems, which originate from Europe, the USA and China, and evaluating their performance.

The Institute of Physics and Technology, meanwhile, has pursued a photovoltaic research programme. Photovoltaic cells on monocrystalline silicon wafers have been produced and then assembled into modules in Ulan Bator. The United Nations Development Programme (UNDP) has supported this activity and, following a market assessment undertaken by IT Power, a pilot production plant has been proposed.

Solar energy is also used for water heating. About 2000m^2 of solar collectors supply water to rest houses, hotels and children's "Pioneer Camps" which are mostly occupied in the summer months. The Research and Production Corporation has also developed large volume solar water heaters specifically for the warming of drinking water (from snow or ice) for livestock, to help these animals survive the harsh Mongolian winters.

In addition to solar power, the household electrical requirements of Mongolia's rural herdspeople can be met by wind generators. UNDP-supported trials of a one metre diameter 50W machine, manufactured by Marlec Engineering of the UK, met with good user acceptance. These machines can be installed or taken down in a few minutes. In 1989, following the trials, the Research and Production Corporation formed a joint venture with Marlec for the manufacture and assembly of 50W and 250W wind generators. This was the first joint venture to be signed by the Mongolian Government with a non-Communist country.

Because of the vast numbers of animals kept on state farms and by nomadic herders, biogas represents an obvious option for Mongolia. Portable small-scale digesters to produce biogas from animal waste have been proposed. (Source: Extracted from "World View : Mongolia," *REVIEW*, Issue 16, Summer 1991, pp.20-21.)

World Bank's Energy Environmental Fund

Environmental considerations are now at the top of the World Bank's agenda. The World Bank, the UN Development Programme (UNDP) and the UN Environmental Programme formally established in March 1991 a Global Environmental Facility (GEF) designed to channel funds to back projects which would not necessarily be economic unless environmental considerations were taken into account.

The GEF's brief is to provide money for projects which will help the global environment to an extent that they become economic in global terms, although they may not be economic in strictly national terms. The facility, which is headed by the World Bank's Wilfred Thalwitz, considers fuel substitution to be the most certain way to reduce CO_2 emissions.

Geothermal Project, the Philippines

A geothermal project at Leyte in the Philippines is expected to be one of the first projects to secure funding from GEF. The proposed project would help develop a 440 MW power station by making it competitive with the development of coal-based power generation. Under the GEF, incremental grant funding upto 7% of total project financing is to be made available. This $30m in financing will also attract $40m in Japanese co-financing. A further $350m in regular World Bank funding will also be added. The Bank argues that without GEF support the Philippines Government "would invest in a major coal-fired power facility generating substantial greenhouse gas emissions".

By providing $70m in GEF financing, the aim is to replace 440 MW of coal-based power plant with geothermal energy and to encourage exploration activities by the private sector to prove additional geothermal resources. Such additional resources, the Bank believes, could amount to a further 400-800 MW of power. The project would aid the environment by reducing CO_2 emissions by at least 500,000 tonnes a year or by as much as 1.5 million tonnes a year if additional geothermal reserves were proven and exploited.

China Methane Potential

A $10 million grant is likely to be made available for a coal-bed methane project in China. The project aims to capture methane being vented from the coal mines of Songzhao in southeastern Sichuan Province, where the coal is especially gassy. Methane has only recently been recognized as a problem for the world's atmosphere. It is also a sensitive issue as it is commonly responsible for major explosions in mines.

Coal-bed methane is potentially an important energy resource. In a joint report the three organizations that set up the GEF commented that "the gas that is released from the coal can be almost pure methane which is an exceptionally clean fuel and the lowest carbon dioxide producer of the fossil fuels. "Given China's position as the producer of 30% of the world's coal, and the type of coal it produces, the Bank argues that China might be estimated to produce approximately 40% of the World's coal-bed methane. This source of methane would be larger than the 150 billion cubic metres of natural gas which is being produced every year from China's oil and natural gas fields.

The report adds that at present only 1% of the gas vented from China's mines is reported to be recovered and utilized as fuel. If this figure could be increased to 20%, then 80 billion cubic metres of methane emissions could be contained and the total global warming forcing reduced by 0.1%

The GEF's sponsors argue that, without concessional financing, methane will continue to be vented at Songzhao at a high rate and since methane is a more potent greenhouse gas than carbon dioxide, burning the methane is a simple way of reducing greenhouse forcing.

They also believe that if methane is used and not just flared it will displace coal from the local fuel mix and further reduce carbon dioxide emissions.

Projects Submitted

Altogether, 35 governments have so far submitted projects for review. The GEF comprises two key elements: the initial Global Environmental Trust Fund (GET) which provides a core fund from which grants can be made, and specific pledges of co-financing. So far 21 countries, including India, Pakistan and China, have pledged SDR 663 million to the GET core fund.

The World Bank is determined that the GEF should be cost-effective. Only operations that achieve global environmental benefits at a low unit cost will be eligible for GEF resources. GEF will only provide "minimum concessional funding" to achieve those benefits. A basic qualification for countries seeking GEF funding is that they should have a sound overall policy, including a regulatory and institutional framework concerning CFCs, greenhouse gases and other environmental concerns, including water pollution.

The Bank emphasizes that "given the extremely limited resources likely to be available, eligibility criteria should be formulated to limit GEF financing to operations that would not go forward without the special assistance that the GEF can provide".

(Source: Extracted from "World Bank Sets Up Energy Environmental Fund", *Power in Asia*, 17th June 1991, pp. 4-6.)

Improved Charcoal Stove Project, Ghana

From P. 5

He has the opinion that the World Bank should concentrate on the funding and ensure accountability. Instead of insisting on strict adherence to their methods, targets and expertise, they should liaise with local experts based on local conditions. In selecting organizations for these projects, the Ghanian experience shows that government organizations can implement such projects despite the general notion of bureaucratic inertia.

(Source: Extracted from "Ghana: World Bank Stoves Initiatives" by Michael Wuddah-Martey, *RWEPA News*, No.7, August 1991, pp.1,2-3.)

How to Buy an Energy Efficient Central Air-Conditioning System

A new generation of air-conditioning available in the last few years is very energy efficient and uses about two-thirds the energy of previous similar systems. Purchasing a high efficient air-conditioning system is a good way to protect yourself against the higher electric rates utilities charge during the summer when the demand for electricity is high. The Wisconsin Energy Bureau has identified three key components that should be considered in purchasing a central air-conditioning system which are: size (cooling capacity), efficiency and price.

A central air-conditioning system's cooling capacity is measured in Btu per hour, which is the amount of heat it can remove from your home as it cools the air for one hour. The cooling capacity of models available today varies from 10,000 to 60,000 Btu per hour. The higher the Btu per hour rating, the larger the living space the system can cool.

How efficiently the system does its job is another matter. An efficient central air-conditioning system will have a seasonal energy efficiency ratio, or SEER of 11.0 or higher, except for units of less than 20,000 Btu/hour, where a SEER greater than 10.0 is considered efficient. The energy savings can be substantial. A central air system with a SEER of 12.0 will use 33 percent less energy than a system with a SEER of 8.0.

How can one get the best price on a central air-conditioning system? Shopping should not be made in summer. The best time to get a good price is in the spring or early fall.

The Wisconsin Energy Bureau has a free fact sheet listing, by size, the manufacturer, model number and seasonal energy efficiency ratio of the 50 most energy efficient central air systems available today. This fact sheet is one in a series of 12 fact sheets available from the Energy Bureau designed to help consumers identify energy efficient new home appliances.

The Wisconsin Energy Bureau suggests a few tips on reducing the cooling needs:

Try closing all windows and doors during daytime hours on hot days. Many homes will be cooler at the end of the day if kept closed up, and the air-conditioning system will do less work when it is turned on. Don't set your thermostat too low, usually 78 F is found to be comfortable. If you want the house to be cool when you come home after a hot day, use a clock timer to turn on the system a half-hour before you expect to arrive. Also, vent the house at night with fans if the temperature drops.

For more information about energy efficient air conditioners and other major home appliances, contact the Wisconsin Energy Bureau, P.O.Box 7868, Madison, WI 53707, USA; Tel: (608) 266-8234.

(Source: Extracted from "How to Buy Energy Efficient Central Air-Conditioning." *Wisconsin Energy News*, Vol.12, No.2, March-April 1991, p.3.)

Expansion of Geothermal Power Stations, Indonesia

The Indonesian Government plans to expand the capacity of the country's geothermal power stations by 910 MW by the end of the decade, to provide electricity for rural areas and small archipelagoes.

According to Earmansjah Jamin, President of the State Electricity Company, Pln, Indonesia had a potential capacity of 16,000 MW of geothermal power. Within the next three years, geothermal plants – with a combined capacity of 165 MW – would be commissioned in West Java.

The first Indonesian geothermal plant was built in Kamojang, West Java in 1983 with an initial capacity of 30 MW. This plant's capacity had since been increased to 140 MW.

(Source: "Indonesia Set to Expand Geothermal Power Station" *OPEC Bulletin*, Vol.XXII, No.8, September 1991, pp.20-21.)

Indonesia Plans to Depend Less on Oil

Indonesia plans to reduce its dependence on oil as an energy source to 58% by the year 1994, Faisal Abda'oe, the President of the state-owned oil company Pertamina said at the 2nd Annual Jakarta International Energy Conference, October 8, 1991. By utilizing gas, coal, hydropower and geothermal power, Indonesia had been able to reduce its dependence on oil from 79% 10 years ago to 64% in 1989. According to Abda'oe, coal and geothermal energy were the most likely substitutes as the size of land required for hydroelectric development might cause problems in densely populated areas like Java, where the most energy is required.

Pertamina has been given the responsibility to explore and exploit geothermal energy, basically to use for power generation. The government is also reviewing the terms of joint operation contracts with the aim of providing additional incentives to accelerate geothermal development.

(Source: *Bangkok Post*, October 10, 1991.)

Private Power in Thailand

The World Bank conservatively estimates that about $155 billion will be required during the next 10 years to expand electric generation capacity in India, Indonesia, Pakistan, the Philippines and Thailand to meet the growing electricity demand. Government owned utilities in the developing countries of Asia are looking to private power, in its many forms, to help finance this expansion.

Thailand's power sector is dominated by the government-owned Electric Generating Authority of Thailand (EGAT), which plans to include the private sector in its expansion efforts. In 1988, the National Energy Policy Office proposed three areas of private sector involvement in the power sector: (1) cogeneration and small power production; (2) independent power production; and (3) government divestiture of EGAT. Only the regulations for cogeneration and small power production have been

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Energy for a Habitable World: A Call for Action

Edited by Pierre Elliott Trudeau
Crane Russak. A Member of the Taylor & Francis Group, New York
ISBN 0-8448-1713-9, 1991, ix+174p.

The adoption of a rational energy policy counts among the most challenging and complex tasks faced by governments in the last decade of this century. The choice of a rational energy mix and policy – or the failure to make one – has profound strategic consequences as once again became so disquietingly evident during the Gulf crisis.

In 1989, the InterAction Council, a group of some 30 former heads of government, felt it timely to explore the interrelationship between ecology and energy options and to develop policy recommendations dealing with the multifaceted problems involved. Founded in 1983, the InterAction Council meets regularly to consider the most burning issues on the global agenda. It adopts proposals that are then presented to current government leaders and other decision-makers in an effort to seek their wide acceptance.

In preparation for the Council's deliberations of energy policy and energy options, a high-level expert group met in Montreal in April 1989. The report and recommendations emanating from the work of this outstanding gathering of internationally renowned and highly experienced experts formed the basis of the Council's debate. Its direct result was the adoption of policy proposals entitled "Energy for a Habitable World" which are contained in chapter 1 of this volume. Mr. Pierre Elliott Trudeau's report to the Council on the discussion and suggestions of the high-level group is presented in chapter 2. Chapters 3 through 6 contain various working papers that were either specifically commissioned for the high-level expert group or were made available to it. Some of the forecasts and scenarios outlined in these chapters may very well be affected by recent developments in Eastern Europe and in the world oil markets, but it is believed that the essence of the arguments presented remains valid.

To obtain the publication and for further information contact:
Taylor & Francis, Inc.
1900 Frost Road, Suite 101
Bristol, PA 19007, USA

Technology Transfer Organizations

WOT

WOT is the Dutch abbreviation of Working-group on Development Techniques. It is a non-profit organization based at the University of Twente, Enschede, in the Netherlands.

WOT aims to contribute to the improvement of economic and social conditions of poor developing countries. In cooperation with TOOL, a professional Dutch non-profit service agency in the field of technology transfer and development, WOT offers various ways of transferring technology. Their main activity is answering technical questions by mail. They also organize training courses and publish publications related to :

- wind energy applications
- solar energy applications
- water supply
- rural electricity planning
- small-scale water power applications
- briquetting of paper and wood

➥

Private Power in Thailand

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drafted. Specifically, the draft regulations cover cogeneration (minimum 20 percent thermal load) and "residual fuels" (minimum 50 percent renewable energy) projects with maximum sales to the grid of 50 MW each.

Under its own initiative, EGAT has recently forwarded to the National Energy Policy Office a proposal for a 100 percent privately financed 700 to 1,400 MW coal-fired project on the Eastern seaboard at Ao Phai Bay, to be completed by 1996. This is a build-own-lease project, with EGAT leasing back the facility from the project developer. EGAT's board of directors has reportedly approved the BOL scheme for a total of nearly 4,000 MW of new capacity.

(Source: Extracted from "Closing the Gap in Asia" by William Meade and Henri-Claude Bailly, *Independent Energy*, July/August 1991, pp.95-98.)

Lao PDR Receives Technical Assistance of $1,300,000 from ADB for a Hydropower Development Project

The Asian Development Bank (ADB) has approved a $1,300,000 technical assistance grant for a feasibility study of the hydropower development projects on the Nam Song and Nam Leuk rivers in Lao PDR. The Government's policies in the energy sector aim at reducing the use of fuelwood, developing lower cost indigenous fuels such as developing hydropower electric energy to meet local demand and for export.

The two projects together would provide about 40 MW of additional generating capacity and about 290 Gigawatt-hours per annum of incremental electricity for export to Thailand through existing power transmission arrangements.

The objective of the technical assistance is to study the technical feasibility and economic viability of diverting part of the Nam Song into the existing Nam Ngum reservoir; diverting part of the Nam Leuk into the Nam Ngum reservoir using a drop of 180 metres to generate electricity and to generate additional electricity at the existing Nam Ngum hydropower station; and integrating the electricity generated into the Vientiane Province electrical power system which is interconnected with the electrical power system in Thailand.

The study is to be carried out over a 10-month period and will require around 47 man-months of consulting services.

(Source: *ADB News Release*, No. 110/91, 16 July 1991.)

For further details contact:
WOT, Vrijhof 207
University of Twente
P.O.Box 217
7500 AE Enschede
The Netherlands
Tel: +(31-53) 892 845
Fax: +(31-53) 357 042

SATIS : New Headquarters in Dakar, Senegal

Satis is the full name of the organisation; the sub-title is: Global Union for Technologies for Environment and Sustainable Development.

From its new headquarters in Dakar, Satis will expand its world-wide services in information, communication and technology dissemination to its fast-growing membership.

The new address of Satis is:
Satis
Boite Postale 2664
Dakar, Senegal
Tel: +221.21 75 95
Fax: +221.21 26 95
E-mail: geo2:satis
Telex: (0906)51456 (pour satis)

SYNOPSIS

Synopsis has existed since 1977 and is active in the following fields:

- Research in thermal engineering, particularly in solar energy (lab and outdoor testing, computer simulation and method development).
- Development tests and production of specialized equipment for developing and industrialized countries.
- Planning, realization and evaluation of technical programmes in developing countries.
- Development of solar products for industrial or small scale production.
- Studies in the field of solar energy.
- Consultations for non-governmental organizations, international institutions, companies and individuals.
- Evaluation of renewable energy resources.
- Planning and implementation of research and development programmes.
- Specialized training in solar thermal energy.
- Conception and realization of teaching materials.

Synopsis has more than 20 international partners. It has 10 licenses for solar products and processes and has published more than 40 publications and 120 internal technical reports.

Some of the activities related to solar energy applications are as follows:

1. Solar Cookers for Institutions

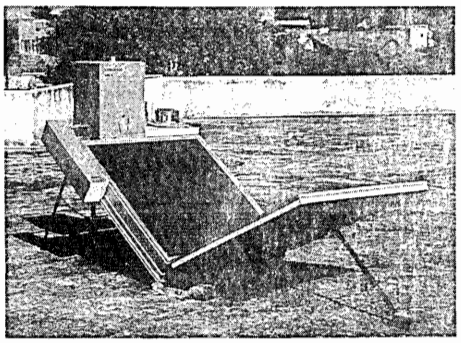
Five modular solar cookers MC35 were constructed under license agreement by Verein für Entwicklungshilfe der CIBA-GEIGY-Mitarbeiter. One of these cookers is being used for demonstration and the other four were sent to Rwanda and Cameroon.

Since 1986, 13 cookers have been installed in 5 countries.

A MC6 cooker in use at an Indian orphanage.

2. Evaluation of Solar Cooking Programmes

User acceptance of the cookers manufactured in India is being studied. A social worker regularly visits the installations to assess the weekly and monthly utilization of solar cookers in Yavello (Ethiopia).



Use of a SMS sterilizer in an indian hospital. Problems of inter-metal corrosion had to be solved through a technical mission.

3. Solar Sterilizers

In coopertion with WHO-EPI (World Health Organization's Expanded Programme on Immunization), a long term test of a SM5 sterilizer is in progress in India. In cooperation with Fordergesellchaft Angepaßte Technologien (FAKT/GER), Kindernohilfe (GER), and AMURT-Burkina Faso, Synopsis has also compiled specifications of a multi-energy sterilizer for six health centers in different countries.

For further details contact:
SYNOPSIS - Route d'Olmet
F - 34700 Lodève
France
Tel: 67 44 04 10
Fax: 67 44 06 01
Telex: 202139 F RCINF
(Attn MG35 GRUPP)

(Source: *SYNOPSIS Annual Report 1990/1991.*)

SERI's Cooperative Research and Development Agreements

The Solar Energy Research Institute (SERI) is operated by Midwest Research Institute of Kansas City, Missouri, for the U.S. Department of Energy.

SERI is the only U.S. federal laboratory devoted primarily to renewable energy R&D. It is the largest solar energy research center in the world.

SERI recently received Congressional authority to execute Cooperative Research and Development Agreements (CRADAs) with industry.

The Primary purpose of a CRADA is the effective transfer of SERI's technology,

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CTA Collecting Data for Directory of Resource Persons for Training in Agriculture Information

The Technical Centre for Agricultural and Rural Co-operation (CTA), with the collaboration of the International Development Research Centre (IDRC), has contracted with the Institute of Development Studies (IDS) at the University of Sussex to establish an on-going database and prepare a directory of persons with training experience in agricultural information. Such a resource should be of great assistance to all in the profession internationally. The impetus for this project is derived from CTA's General Programme for Training in Agricultural Information (PROGEFIA) which seeks to identify resource persons to assist training institutions and library schools, professional associations, information services and systems, and donor agencies. Those persons involved with any aspect of training in agricultural information who wish to be considered for inclusion in this directory should request further details and a survey form from one of the following.

Resource Persons Directory Project
c/o Jane S. Johnson
Information Consultant
8460 East Fernhill Drive
Tucson AZ 85715-2417
USA

Resource Persons Directory Project
c/o N.W. Posnett
Head of Information
Resource Unit
Institute of Development Studies
University of Sussex
Falmer, Brighton BN1 9RE
United Kingdom

Diary of Events

- **February 10-14, 1992, New Delhi, India**

6th International Photovoltaic Science and Engineering Conference (PVSEC-6)

For details contact:
B.K. Das, Secretary
PVSEC-6 Conference
National Physical Laboratory
Dr.K.S.Krishnan Road
New Delhi, India
Tel: (91-11) 572 6058 or
(91-11) 581 455

- **March 19-22, 1992, Cairo, Egypt**

International Conference on Application of Solar & Renewable Energy

The conference is sponsored by the Egyptian Section of the International Solar Energy Society and the Egyptian Solar Energy Society.

For details contact:
Egyptian Solar Energy Society
P.O. Box 487 Dokki, Giza, Egypt
Telex: 92135 ENFAC UN
Fax: (202) 781 236

- **March 31 - 3 April, 1992, Auckland, New Zealand**

The Crystal Ball Conference - an insight into your energy futures

This conference is intended for policy and financial analysts, business consultants, advertising agents, PR consultants, energy suppliers, energy consumers, consulting engineers and all those related to the energy market.

An international forum will be held at the Aotea Centre, Auckland, New Zealand; with an associated trade fair.

For details contact:
The Conference Company
P.O. Box 90 040
Auckland
New Zealand
Tel: (0064-9) 360 1240
Fax (0064-9) 360 1242

- **April 4-8, 1992, Honolulu, Hawaii**

1992 ASME International Solar Energy Conference

For details contact:
Jan F. Kreider
Joint Center for Energy Mgmt.
Campus Box 428
University of Colorado
Boulder, CO 80309-0428
Tel: (303) 492 3915
Fax: (303) 492 7317

- **April 7-16, 1992, Amman, Jordan**

International Seminar on the Commercialization of Solar and Wind Energy Technologies

For details contact:
Dr. Rizeq Ta'ani
Royal Scientific Society
Renewable Energy Research Center
P.O.Box 925819
Amman, JORDAN

- **April 8-26, 1992, Petten, The Netherlands**

International Course on the Implementation of Wind Energy

The course will cover the following topics:

1. Planning Phase ➡

SERI's Cooperative Research and Development Agreements

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processes, research and development capabilities, and technical know-how to the private sector. Enhancing U.S. competitiveness and protecting economic security are cornerstones of the new CRADA mechanism.

Industry may profit in two important ways: intellectual property developed under the agreement may accrue to the industry partner, and data generated may be protected from public disclosure for up to five years. SERI and the industrial partners share the costs and the results of the work.

Some of the other mechanisms one can use to access the research and development capabilities of SERI are:

- Collaborative research
- Cost-shared subcontracts
- Visiting researcher program
- Use of SERI's facilities
- Sponsored research.

For further details contact:
Solar Energy Research Institute
A Division of Midwest Research Institute
1617 Cole Blvd.
Golden, Colorado 80401-3393
USA

- Energy Planning
- Planning of Wind Energy Systems
- Finance

2. Pre-investment Phase
   Pre-investment studies
3. Implementation Phase
   - Technology Assessment
   - Procurement of Wind Turbines
   - Production, Installation, Monitoring
   - Infrastructure
   - Management
4. Operational Phase
   - Personnel qualifications
   - Training
   - Control and monitoring, maintenance.

For details contact:
N. Ridder
Netherlands Energy Research Foundation, ECN
P.O. Box 1, 1755 ZG Petten
The Netherlands
Tel: +(31-2) 246 4487
Fax: +(31-2) 246 3483

- **April 27-15 May, 1992, Trieste, Italy**

Workshop on Modelling of Energy and Environmental Physics

For details contact:
International Centre for Theoretical Physics
P.O.Box 586
34100 Trieste, Italy

- **May 4-26 June, 1992, Enschede, The Netherlands**

International Training Workshops on Rural Energy and Environment

The workshops are organized by the University of Twente (UT) in close co-operation with the International Institute for Aerospace Survey and Earth Sciences (ITC)

The workshops are scheduled as follows:

4 May-15 May
Photovoltaic Solar Energy Applications
4 May-15 May
Biomass Energy Technologies
18 May-22 May
Energy Technology Assessment
18 May-22 May
New Approaches in Forestry
25 May - 5 June
Energy Project Planning and Management
9 June-19 June
Energy and Environment
22 June-26 June
Energy Project Formulation.

The 1992-workshops replace the International Course on Rural Energy Planning and Environment, which was organized annually by UT – TDG and ITC from 1983 to 1990. Participants who attend the full sequence of 5 workshops, will have a programme comparable to the former training courses. However, the new workshops are more specialized and the structure is more flexible. Candidates who have limited time available, can limit their participation to the workshop(s) of their choice.

For further details contact:
The Course Administrator
Technology and Development Group
University of Twente
P.O.Box 217
7500 AE ENSCHEDE
The Netherlands
Tel: (31-53) 893 539
Telex: 44200 thtes nl
Fax: (31-53) 340 822

- **May 11-15, 1992, Interlaken, Switzerland**

Advances in Thermochemical Biomass Conversion

For details contact:
Dr.Tony Bridgwater
Chemical Engineering Dept.
Aston University
Birmingham B4 7ET
United Kingdom

- **May 11-15, 1992, Gatlinburg, TN, USA**

Fourteenth Symposium on Biotechnology for Fuels and Chemicals

For details contact:
Jonathan Woodward
14th Symposium on Biotechnology for fuels and Chemicals
Oak Ridge National Laboratory
P.O. Box 2008
Bldg. 4500 N, Oak Ridge Tennessee 37831-6194
USA

- **May 18-22, 1992, Toulouse, France**

International Symposium on Optical Materials Technology for Energy Efficiency and Solar Energy

This symposium is intended as a forum for exchange of information and discussion of recent advances, current scientific issues, and innovations regarding optical materials technology for energy efficiency and solar energy conversion. Researchers in universities, industry and national and international research institutions are urged to submit papers dealing with the following topics:

1. Chromogenics for Smart Windows
2. a) Selective Materials
   b) Solar Concentrators and Reflectors
3. Transparent Insulation and Super Window Materials
4. Photovoltaics, Photochemistry, and Photoelectrochemistry.

For details contact:
EUROPTO
c/o Direct Communications GmbH
Xantener Strasses 22
D - 1000 Berlin 15, FRG
Tel: ++(49-30) 881 5047
Fax: ++(49-30) 882 2028

- **May 19-24, 1992, Beijing China**

EP China'92 : 4th International Exhibition on Energy and Power

For details contact:
China Electricity Council Intl.
1 Lane Two, Balguang Rd.
Beijing 100761
Tel: 365 452
Telex: 22466
Fax: 326 0365
or
Adsale Exhibition Services, 2
21/F, 109-111 Gloucester Road
Wanchai, Hongkong
Tel: (852) 892 0511
Telex: 63109
Fax: (852) 834 5014

- **June 14-17, 1992, Washington D.C., USA**

World Conference on Ecology, Economics and Engineering

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Diary of Events
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For details contact:
ECO World'92
American Society of Mechanical Engineers
345 East 47th Street
13th Floor
New York, NY 10017, USA
Tel: (201) 882 1167
Fax: (212) 705 7143

- **June 15-18, 1992, Zaragoza, Spain**

Conference on Efficiency, Costs, Optimization of Energy Systems

For details contact:
ECOS Technical Committee
Dept. of Mechanical Engineering
University of Zaragoza
Maria de Luna, 3, 50015 Zaragoza
Spain
Tel: +(34-76) 516 200
Fax: +(34-76) 512 932

- **June 19-20, 1992, University of the Pacific, Stockton, CA, USA**

World Conference on Solar Cooking: Use and Technology Worldwide

For details contact:
University of the Pacific
102 Khoury Hall
Stockton CA 95211 USA
Tel: (209) 946 2377
Fax: (209) 946 3086

- **June 22-25, 1992, Paris, France**

9th World Hydrogen Energy Conference

For details contact:
Hydrogen 92 MCI
8 rue de l'Isly
F-75008 Paris, France

- **August 16-21, 1992, Washington D.C., USA**

9th International Biotechnology Symposium

For details contact:
Dr. John P. Cherry
Eastern Regional Research Center
Agricultural Research Service
U.S. Department of Agriculture
600 E. Mermaid Lane
Philadelphia, Pennsylvania 19118
USA

- **September 13-18, 1992, Reading, United Kingdom**

2nd World Renewable Energy Congress

Congress Topics:
- Photovoltaic and Material Technology
- Solar Thermal Applications
- Wind Energy Applications
- Biomass Conversion
- Solar and Low Energy Architecture
- Hydropower, Wave, Tidal and Ocean Thermal Energy
- Economics Management and Modelling
- Hydrogen Production Technology
- Climatology and Meteorology
- Economic and Political Issues

For details contact:
Prof. A.A.M. Sayigh
WREC, Dept. of Engineering
University of Reading
Whiteknights, P.O.Box 225
Reading RG6 2AY
United Kingdom

- **September 20-25, 1992, Madrid, Spain**

15th World Energy Council Congress

Further details from:
The Organization Committee
15th WEC Congress
Avda. de America, 32-9ª
28028 Madrid, Spain
Tel: (341) 255 7204
Fax: (341) 246 3540

- **October 5-6 November, 1992 Maastricht-Enschede The Netherlands**

Training Course on Energy Management in Small and Medium Scale Industries

The training course is organized jointly by the University of Twente, Technology and Development Groups and the International Institute for Management

The course programme consists of lecture, case studies, exercises, group discussions and industrial visits with respect to the following subjects :
- Management of small and medium scale industries,
- Economic issues,
- Project management,
- Energy Supply,
- Energy Assessment, and
- Energy Policies.

For details contact:
The Course Administrator
Technology and Development Group - VOK
University of Twente
P.O.Box 217
7500 AE ENSCHEDE
The Netherlands

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Library and Regional Documentation Center, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The "RERIC News" is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership along with the other four regular publications namely: RERIC International Energy Journal (formerly: Renewable Energy Review Journal); RERIC Holdings List; Abstracts of AIT Reports and Publications on Energy; and RERIC Membership Directory. For further details contact:

Regional Energy Resources Information Center
Asian Institute of Technology
G.P.O. Box 2754
Bangkok 10501, Thailand
Telex: 84276 TH
Tel: 5160110-29, 5160130-44 Ext. 5866
Fax (66-2) 5245870

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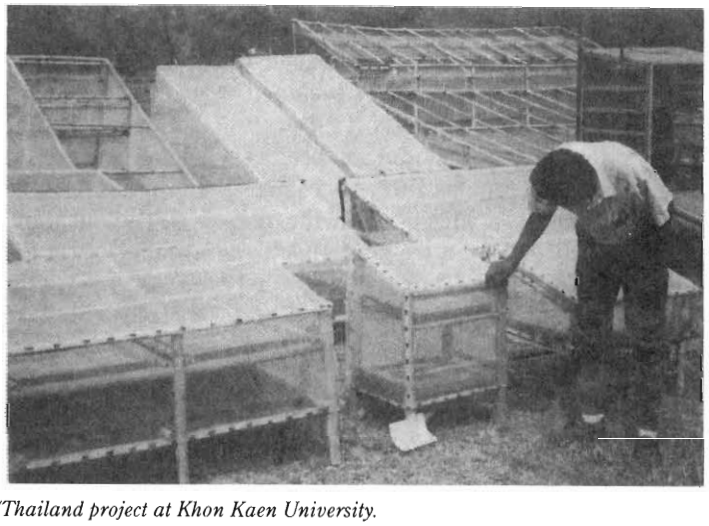
Rural Renewable Energy Project in Northeastern Thailand: Brace Research Institute's Collaboration with Khon Kaen University, Thailand

THE "Rural Renewable Energy Project in Northeastern Thailand" was a four-year project funded by CIDA under the Institutional Linkages Programme (ILP) with Thailand. A total disbursement of $ 493,389.00 from CIDA funds, aided by in-kind contributions from both Khon Kaen and McGill Universities, was expended in Project activities. The project started in August 1987 and ended in March 1992.

The ILP was designed by CIDA to "strengthen the capacity of Thai Universities to contribute to the development of Thailand, and to improve the knowledge and understanding in Canada concerning Thailand, its development priorities and possible opportunities". This project sought to accomplish the objectives of the ILP through a collaborative programme between Khon Kaen University (KKU), Khon Kaen, Thailand, and Brace Research Institute (BRI)), McGill University, Canada, in the field of renewable energy technology development and technology transfer. The project was led by Tom Lawand, Director of International Relations, the Brace Research Institute.

The Northeastern region of Thailand, the focus of this project, is predominantly rural, encompassing one third of the land area and containing one third of the total population of the coun-

Cont. P. 2



Testing solar agricultural dryers at the CIDA/Thailand project at Khon Kaen University.

INNERTAP

Incorporates news from the Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

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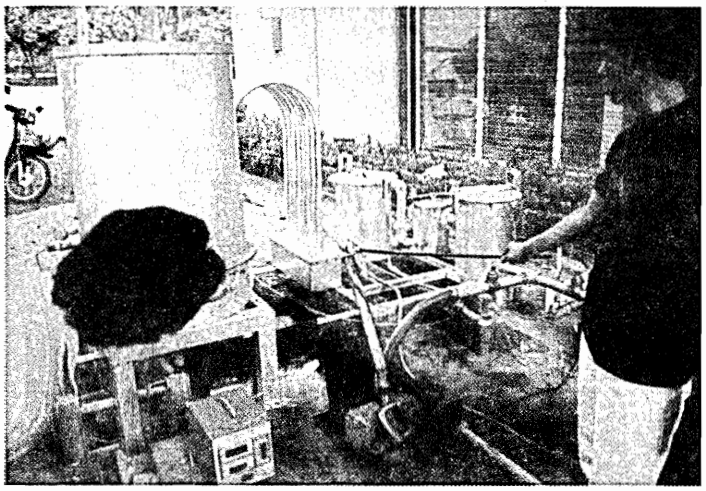
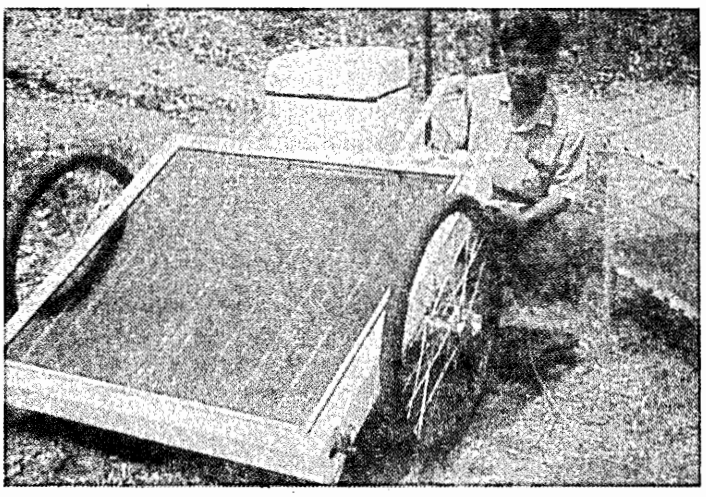




Development of gasification equipment and solar cookers at the CIDA/Thailand project at Khon Kaen University.

try. Nearly 80% of the population in the Northeast, whose annual per capita income is far below the national average, live in rural areas. This region relies heavily on fuelwood and charcoal for domestic and industrial energy supplies. However, present fuelwood regeneration rates can sustain only about 45% of the demand. This results in rapid depletion of standing forest reserves and degradation of the environment by way of soil erosion. In comparison with other parts of the country, the Northeastern region suffers from low soil fertility and long dry seasons.

Under this project, nine sub-project themes were developed to address renewable energy applications in the region and to serve as training mechanisms for KKU staff. These sub-projects provided KKU with a broad-based approach for developing and applying energy technologies based primarily on solar and biomas energy resources. Also, the importance of water in this relatively dry region was stressed. These themes included the following:

- Improvement and Dissemination of Wood and Charcoal Stoves;
- Development of Solar Steamers for Cooking Glutinous Rice in Village Households;
- Applications of Solar Energy for Small-Scale Food Processing Industries;
- Appropriate Biogas Reactor Development for Domestic, Farm and Small-Scale Industry Applications;
- Modification and Extension of Gasification Technology for Power Generation;
- Solar Disinfection of Rural drinking Water Supplies;
- Feasibility Study of Photovoltaic Water Pumping Systems for Irrigation;
- Development of a Multi-Purpose Grain Dryer; and
- Development of a Renewable Energy Database for KKU.

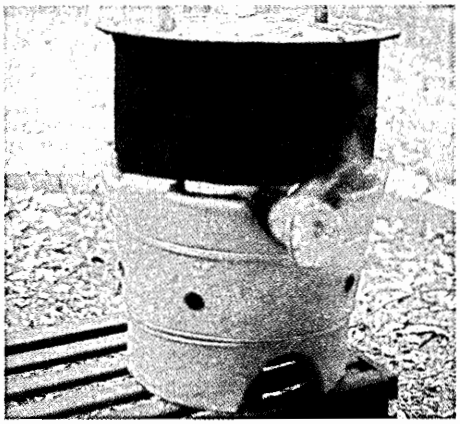
Implementation of these themes was accomplished through close collaboration between KKU and BRI whereby 39 staff exchanges were undertaken throughout the project period. These exchanges included 28 short-term (less than four weeks) and 11 long-term (minimum two months) training visits.

Technical training programmes in a number of renewable energy technologies were organized for KKU staff by BRI. In addition, a number of institute personnel were sent to Thailand to provide technical cooperation and assistance to the project team. Extensive construction, acquisition, research and testing of selected renewable energy technology prototypes and materials were undertaken at KKU and at BRI. This activity was undertaken by KKU staff working alone or in collaboration with BRI personnel and invited experts. Training community development workers and extension specialists and skill improvement of selected local manufacturers were also undertaken in order to achieve desired project results.

In September 1989, a Project Focal Point, amalgamating the project library and demonstration centre, was established in the Faculty of Engineering at KKU. Its main purpose was to improve the dissemination of information to the public and other centres interested in rural renewable energy development. At the same time it served to coordinate project research, monitoring, administration, management and transfer of technology to rural areas. By maintaining this Focal Point, KKU can directly benefit renewable energy resource development and dissemination in Northeast Thailand thereby maintaining and strengthening the direct linkage between KKU and the local community.

Prototype gasifiers of 5 and 15 kW size have been fabricated to operate on charcoal and rice husks. Field operation of one of the gasifiers has included pumping of irrigation water at several farm sites. The biogas project has run a two prong program – one aimed at diversifying feedstock through laboratory experimentation and the other oriented towards resolving operational and infrastructural problems relating to the use or disuse of hundreds of existing biogas plants in the Northeast. A multipurpose grain dryer has been developed and optimized for use on farms near Khon Kaen. Modifications to the unit have included integration of a biomass powered supplementary heat source. Several other solar dryers have been designed, built, tested and field tested. These have been used to dry Chinese sausage, chilies and various fruits. Some of the produce has been sold in local markets.

Improved efficiency wood and charcoal stoves have been developed and tested in a project which has resulted in the training of village stove manufacturers and the beginnings of a wide-scale stove dissemination program. A solar steamer for glutinous rice, developed by project researchers, has resulted in high-profile media coverage. However, this technology needs further modifications to reduce cost to a level that is affordable by the intended clients – street vendors of glutinous rice. The sub-project working on solar disinfection of rural drinking water supplies has completed its preliminary testing phase to determine decontamination rates and seasonal variations in the Northeast climate. Results are positive and the project is embarking on field trials of this simple technology.



Testing of a cooking stove at the CIDA/Thailand project at Khon Kaen University.

In November, 1991, an end-of project seminar was held at KKU to officially recognize all those who participated in the Rural Renewable Energy Project and to close down the CIDA-funded era of the programme. The seminar provided an opportunity for all sub-projects to present the results of their activities and to discuss how these findings will be used to better serve the Northeast region of Thailand. Experts in various renewable energy fields presented papers and participated in follow-up discussions. The seminar was attended by nearly 70 individuals representing government ministries, Thai universities, CIDA offices in Bangkok, and the local private and public sectors.

Source: Extracted from *Brace Research Institute Annual Report - 1 June 1987 to 31 May 1990,* Report number M-90, and from *Executive Summary March 1992,* Brace Research Institute, Faculty of Engineering, MacDonald Campus of McGill University.

Biogas from Cow-dung for Insect Control During Storage

A study on the use of biogas from cow-dung for insect control during storage was conducted by S. Mohan and M. Gopalan of the Department of Agricultural Entomology, Tamil Nadu, India and successful results were obtained. Using a specially designed air-tight bin of 100 kg capacity, biogas from cow-dung, comprising 60% methane and 40% carbon dioxide, was tested as a fumigant for insect control in certain pulses. The biogas fumigation did not affect seed germination, seedling vigour or grain quality of pigeonpea (the most important leguminous pulse crop of India) and no gaseous methane residues were left in the grain.

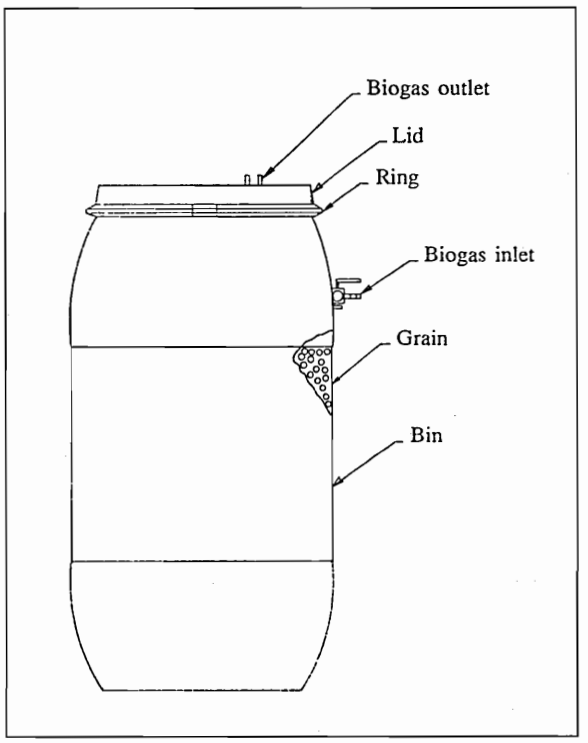


Fig. 1. Biogas fumigation-grain storage PVC bin, general view.

Chemical fumigants pose problems like handling hazards, residual effects and resistance development by insects whereas carbon dioxide, although an effective fumigant, has certain difficulties applying it, like cylinder availability and other requirements, at farmer's level. The effectiveness of biogas as a fumigant for control of pests during storage of paddy has been demonstrated under laboratory conditions. The present study investigates in detail the technique of biogas fumigation in pigeonpea for the control of the pulse beetle, *Callosobruchus chinensis L.*

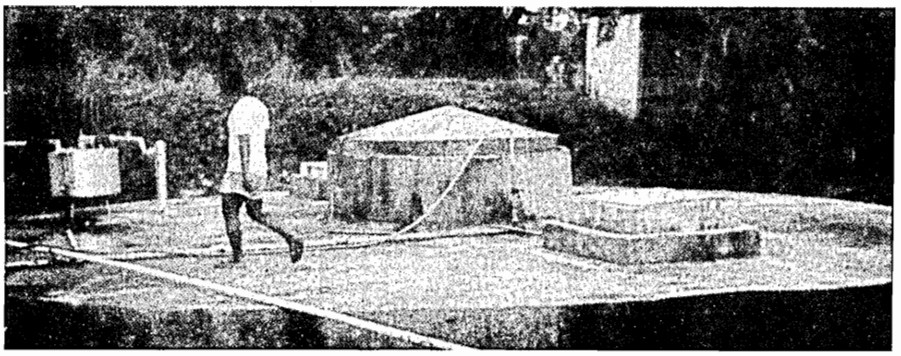
A leak-proof bin of one quintal (100 kg) capacity was developed for biogas fumigation. The bin was made of a special type of PVC. It was rectangular in shape with a circular top portion closed with a removable air-tight lid. The biogas inlet gate valve was fitted at three-quarters height of the bin so that the space below the inlet valve could be filled with pigeonpea seeds and the remaining space at the top would be occupied by biogas. An outlet was provided in the lid to facilitate checking for the presence of biogas.

The testing was carried out on 100 kg of grains placed in the bin and supplied with biogas at 1.4 kg/cm^2 pressure.

Test results showed that there was a significant difference in insect mortality between the different periods of fumigation (3,5,7,9,10 and 12 days) and for different layers of the stored-grain bed. One hundred percent mortality of eggs, grubs and adults in all layers was obtained on the 10th and 12th days of fumigation. This indicates that for adequate penetration of the biogas to different layers at the applied pressure of 1.4 kg/cm^2, a minimum period of 10 days is required. The seed qualities and grain cooking quality were not affected by biogas treatment. Analysis for methane in the treated grains did not show any significant residues. Such findings hold great significance for the future of agricultural produce storage. Moreover, this technology can be easily adopted as biogas can be made available in most of the farms in the developing countries.

(Source: "A Study on the Use of Biogas from Cowdung for Storage Insect Control," by S. Mohan and M. Gopalan, *Bioresource Technology*, Vol. 39, No.3, 1992, pp.229-232.)

Luz Farms and Renewable Energy Systems



Biogas digester converts hog manure to fuel gas.

With "savings" in the forefront, the Luz Farms, a hog breeding farm, owned and operated by the Sarmiento Group of companies, successfully implemented and realized the benefits of a biogas system and solar water heater. Located in a 30 hectare estate in Rosario, Bantangas, the Philippines, the farm has 21,000 hogs and markets Babcock breeder hogs, weanlings and feeders.

Motivated by the impressive performance of biogas plant in Maya Farms, a 300 cubic metre biogas system was built by Luz Farms in 1986, for processing manure from 10,000 pigs.

The biogas produced was utilized as fuel for a Ford V-8 engine coupled to a 125 kilovolt-ampere generator set, which partially supplied the energy needs of the plant. Initially used for lighting purposes, biogas was later used to power engines directly coupled to a hammermill, mixers and lagoon pumps. However, computers, air-conditioning units and other electrical appliances which are very sensitive to voltage fluctuations still get their energy from the grid.

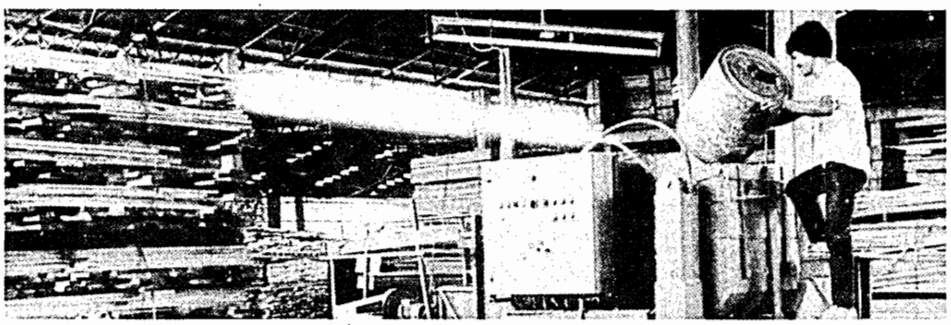
Problems like low quality gas production, inefficient second hand engines, unavailability of some engine spare parts and ineffective engine cooling system were encountered in the initial stage but assistance from biogas experts of Industrial Farm Corporation (INFARMCO) helped in remedying them and facilitated a smooth operation. Plans are underway to install a bigger biogas unit so as to process all the manure available in the farm.

Coupled into the farm system is a solar water heater for providing a compulsory hot bath to all the farm entrants. Thus, the combined use of a biogas system and a solar water heater helps cut down the farm's monthly electricity consumption by around 40%. Follow-up action can alleviate energy supply problems and help preserve the environment.

Energy saving measures taken up by the Luz Farms are exemplary for other similar farms.

(Source: Luz Farms: Renewable energy systems in action, *Energy Alternative*, Vol. VII , Nos. 3-4, 1991, p.3.)

Sawdust Briquettes as Excellent Fuel



Loose sawdust is fed into the briquetting machine.

Finished sawdust briquettes.

Production of sawdust briquettes has eliminated the problem of disposing of the timber cutting wastes of Cagayan de Oro Timber Company (CATIMCO) for the last five years. Moreover, these briquettes have proved to be excellent fuel – better than firewood and cheaper than bunker oil.

The main wood processing plant of CATIMCO in Misamis Oriental Province covers an area of seven hectares and turns out a large amount of sawdust. The German briquetting machine compresses sawdust into 6"x 2"x 2" blocks by sheer pressure without using artificial adhesives and can produce 600 pieces per hour.

Containing half a kilogram of sawdust, each briquette occupies only a tenth of the sawdust's original volume. The briquette has a heating value of 9,000 BTU per pound, higher than that of loose sawdust or firewood and is enough for a day's cooking requirements of an average household. Furthermore, it burns completely without giving off smoke or other fumes and leaves no harmful residue.

The demand for briquettes exceeds the current rate of supply as is evident from the fact that insufficient briquettes necessitates the use of loose sawdust to fuel the boilers for kiln drying. With priority to low income households, CATIMCO sells the briquettes to small retailers at 40 centavos a piece and to big commercial users at P 1500 a pallet of 6,000 pieces. The biggest buyer of CATIMCO's briquettes, the Marca Leon Oil Mill, requires about 14 pallets a day for its oil extraction and refining operation.

Sawdust briquettes are preferred over other organic fuels like coconut shell, ipil-ipil and others because of cheapness, and higher heating efficiency. CATIMCO, fully assured of benefits from and demand for briquettes is constrained in its expansion programme by a prohibitive taxation policy.

(Source: "Briquetting Turns Sawdust from Waste to Excellent Fuel," *Energy Alternatives*, Vol.VII, Nos. 3-4, 1991, p.2.)

Ethanol Option for Transport - Australia

Brazil's Experience

Brazil, the pioneering nation of the commercial development of renewable fuels, entered the field under President Giesel in 1975. The investigations of a motor vehicle fuels research group revealed that an alcohol and gasoline blend (gasohol) containing 22% ethanol gave satisfactory results with the available engines. Use of tetraethyl lead as an octane enhancer was reduced and has been totally phased out now.

Concurrently, successful research on the use of alcohol instead of gasoline as a motor fuel enabled many motor companies to manufacture appropriate car engines. Earlier problems like corrosion and cold starting have been overcome and the alcohol fueled engines now out-perform the gasohol fueled equivalents. As a result, there has been a proportionate increase in the number of alcohol fueled cars over the gasohol ones in Brazil and experience reveals a reduction in air-pollution by such use. Testings to replace heavy vehicle engines by alcohol powered engines are also underway.

At the same time, research was carried out to find the most economic source of alcohol. Large scale plantings of sugarcane went ahead, with the production of ethanol (ethyl alcohol) in the sugar industry. Trial development using cassava and timber to produce alcohol were also investigated. Commercial analysis of the research favored the use of sugarcane for alcohol production. Crop rotation and plantation of leguminous crops help maintain the soil fertility required for healthy sugarcane production.

An alcohol producing plant in Brazil, which services a cane area of 6,000 hectares can produce about 32,000 kilolitres of ethanol per year. In operation, the plant is energy self-supporting with bagasse (cane pulp) serving as boiler fuel. A steam turbine is used to drive the crusher and another turbine powers a 600 kW alternator to supply electricity for the plant. Only 60% of the bagasse is used in this manner, the remainder has varying uses such as feed lot fodder after hydrolising, paper manufacture, hard board etc. The motor car fuel is marketed at different purity content. For end use as fuel it is produced at 93.6% pure ethanol and marketed at the service station as 92.6% pure. For blending as gasohol it is produced at 96% pure.

Applying the Brazilian Model

Australia, sharing similarities with Brazil in issues like having an acute balance of payments problem, a well-developed sugarcane industry and an acute shortage of domestic crude, has a great potential to set up a sugarcane-alcohol industry. Cane production alcohol yield per hectare is double the Brazilian model, i.e. 10,000 litres per hectare. Data from the Australian Bureau of Statistics show that sale of leaded gasoline in Western Australia is some 115,000 kilolitres per month whilst unleaded gasoline sales amount to 32,000 kilolitres per month and increasing.

Following the Brazilian model and replacing the leaded gasoline with a 15% unleaded gasohol blend would require some 17,000 kilolitres per month of alcohol or 210,000 kilolitres per year.

Prime land available in the Ord River area is 70,000 hectares, more than sufficient to meet the demand for alcohol for gasohol for the foreseeable future. However, to meet total needs of the automotive industry in the long term, development of one or more "Ord Schemes" in the Margaret-Fitzroy Valleys would be required. Capital costs are not excessive and well within the costs of developing crude oil reserves of a similar size, knowing always that crude reserves are finite while agricultural development could have a life of centuries.

Environmental considerations are clearly in favour of the use of alcohol as a motor vehicle fuel. Engine efficiency would be increased as the costly environmental controls now fitted to car engines would be unnecessary.

Recent advances in fuel additives have stabilized the alcohol water interface at lower temperatures and, possibly, opens the way for the use of higher water content alcohol mixtures than the 92.6% pure ethanol presently being used in Brazil. Experimental work undertaken by the State Energy Commission of Western Australia (SECWA) indicates that even 80% fuels may be viable. This would be a significant cost advantage in alcohol production.

Reduction in demand for gasoline would create a problem for the oil refineries, as evidenced in Brazil. But Australia is a net importer of gasoline, refinery surplus of gasoline from refining domestic crude should not be a problem as the demand for gasohol would continue for many years after the introduction of alcohol fueled automobiles.

(Source: Extracted from "Transport : Australia's Ethanol Option", Solar Progress, Vol. 12, No. 1, Autumn 1991, pp.4-5.)

Avoid Hazards of Indoor Pollution

Pollution is a menace to the environment, indoor as well as outdoor, and efforts are needed to minimize or, if possible, completely eliminate it. Poorly ventilated houses, incomplete combustion of coal and fuelwood, room to room smoke movement, all create pollution and hence health problems indoors despite the presence of a chimney in the kitchen.

Respiratory diseases like Acute Respiratory Infection (ARI) in children and Chronic Obstructive Lung Diseases (COLD) in adults are caused by mixed gases – mixture of gases and suspended particles – emitted from burning of fuel. Certain gases like carbon monoxide are very toxic while other suspended particles can cause wheezing, bronchitis and pneumonia. Women and children are the worst sufferers of such problems due to their prolonged association with the kitchen. World Health Organization's (WHO) figures released in 1984 indicate that ARI accounts for more than a third of the deaths of children under five.

Building better kitchens for minimum pollution and offering people a healthy indoor environment, are the actual requirements. Effective measures include utilization of a chimney hood with a fixed chimney and possible separation of kitchen from the rest of the dwelling to avoid transfer of moisture, heat and soot produced in the kitchen to other rooms. Fuel with a low concentration of contaminants should be used.

(Source: "Avoid Hazards of Indoor Pollution," *Energy and Environment*, Vol. V, No.1, August 1991, p.5.)

Seeking Geothermal Incentives - Philippines

Of the total energy requirements in the Philippines, 20% is supplied by geothermal energy. But the development pace of geothermal resources is well below expectations as is evident from the fact that only five out of 30 potential sites identified over 15 years ago, have been developed.

According to Wenceslao de la Paz, Executive Director of the Office of Energy Affairs, inadequate fiscal incentives are mainly responsible for such an unsatisfactory situation. Efforts are underway to push through the passage of a House Bill which aims for active participation of the private sector in exploration, development and production of geothermal energy. The proposed incentives include:

- Royalty tax deferment for 8 years;
- Faster depreciation of physical assets such as machinery and equipment;
- Allowable recovery costs (ARC) equivalent to 90% proceeds of any month; and
- Development allowance equivalent to 60% of the cost to develop a new or unexplored contract area for steam production.

Additionally, the bill will assure independent power developers that their steam will be purchased by the state-owned National Power Corporation (NAPOCOR).

The Government intends to announce open bidding for the Maibarara 12 MW Build-Operate-Transfer (BOT) geothermal project within the near future.

While the Government is seeking to interest the private sector in geothermal development, a major development effort is already underway through the state-owned Philippine National Oil Company (PNOC). PNOC, contracted under Presidential Decree 1442, which plans to drill more than 300 geothermal wells within the next seven years. Philippine geothermal capacity is expected to double, from 850 MW to 1,750 MW by 1995.

(Source: *Private Power Reporter* (PPR), Office of Energy and Infrastructure, U.S. Agency for International Development, November 1991, p.9.)

Micro Hydro in Nepal: Prospects and Challenges

Nepal, a landlocked country, has a large rural sector and the rural life is very bleak. Agriculture, the major occupation, is primarily carried out at a subsistence level. The physical infrastructure is underdeveloped and the energy situation is very critical.

Power supply, both in mechanical and electrical form, to the rural areas is a major concern and is largely needed for cooking purposes (which has a large share in the country's total energy consumption). Fuelwood, the single largest source of energy in Nepal, is being harvested at a non-sustainable rate. Completely avoiding fuelwood usage is not possible, but looking at the deadly consequences like low agricultural yield, land slides and extreme scarcity of fuelwood at some locations, the problem needs to be tackled through improvement in forest management and provision of alternative sources of power. The geographic and economic conditions of

Ethanol Production by Extractive Fermentation

The productivity of conventional ethanol fermentations is limited since high ethanol concentrations in the fermentation broth decrease the ethanol production rate. Extracting the product ethanol from aqueous fermentation broths has the potential to reduce end-product inhibition, maintain high specific growth rates of the ethanol-producing micro-organisms and displace traditional distillation.

An extractive fermentation process has been developed at Queen's University to increase the ethanol production rate. Energy, Mines and Resources Canada, through the Bioenergy Development Program, is funding the development of this promising technology.

With the extractive fermentation process, ethanol is removed from the aqueous fermentation broth by extraction with an organic solvent which does not mix with water. A process development unit (PDU) has been designed, constructed and operated based on a continuous flow, 7L fermentation vessel and flash vapourization for ethanol recovery and solvent regeneration was used with this system.

According to Dr. Andy Daugulis, the project leader, with support from Energy, Mines and Resources, Canada, Queen's University is preparing to construct a pilot plant which will have a fermentor capacity of 150 L.

An economic analysis was conducted by computer simulation using a commercial package, PROCESStm, primarily used in the petroleum, chemical and synthetic fuels industries. The conventional plant simulation is modeled on a continuous-stirred tank fermentor with cell recycle. The extractive fermentation system has the extractive fermentation technology added to the fermentor. Both plants are based on a production capacity of 100 million L/y of azeotropic ethanol. The economics involved in retrofitting an existing ethanol facility with extractive fermentation technology were also investigated. The accuracy of the simulation results with respect to fermentor conditions at the predicted optimum flow rates were tested on the extractive fermentation PDU using the 7L fermentor.

The conventional plant, operating under optimum condition of cell concentration (75 g/L), aqueous dilution rate (0.20 h-l) and feed concentration (18% by weight fermentables), requires an ethanol selling price of 45.06 cents/L for a 15% return on investment. For the extractive fermentation simulations, the feedstock was fixed at 41.5%(wt) fermentables and at aqueous and solvent dilution rates of 0.15h-l and 1.25h-l, an ethanol selling price of 38.69 cents/L yields the same 15% return on investment. For the retrofit scenario, an ethanol selling price of 29.44 cents/L is required to maintain the same level of profit.

(Source: Extracted from "Economic and Process Optimization of Ethanol Production by Extractive Fermentation", *Bio-Joule*, Vol.14, No.1, September 1991, p.19.)

the country do not allow for large scale utilization of fossil fuels. Such a situation makes way for renewable energy sources as viable options.

Of the four choices, namely, solar, biogas, wind and hydro, water power appears to provide Nepal with its largest sustainable source of energy. Out of an estimated potential of 80,000 MW only 230 MW has been produced from six large hydro electric plants. High distribution costs prohibit electricity supply from large plants to the rural sector. Under such circumstances and with numerous fast-flowing streams, micro hydro plants are an ideal solution.

As regards micro-hydro schemes, the local community decides about the form and amount of power required, the ability to pay, and a time frame for the scheme. The costs can be kept to a minimum by employing local resources in plant related activities like manufacturing, installation and maintenance. Water power has been an indigenous technology in Nepal and although inefficient, has been in use in Nepal for hundred of years. The traditional water turbine is known as a *pani ghatta* and uses a simple wooden rotor to turn a millstone for grinding grains. These machines are simple to build and use, and there are still around 25,000 working *pani ghattas* in the country, even though they are not efficient and have a low power output. Since the 1960s, more efficient fabricated-steel water turbines, with the majority being Cross-Flow type, for small-scale rural applications, have gained in popularity. Power for mechanical as well as electrical purposes can be derived efficiently. Present data shows 10 schemes supplying electricity throughout the day with many others being used for part-time electricity supply.

The great versatility of electric power has resulted in a continuous move towards micro-hydro schemes.

The present government aim to electrify all the villages in the country seems bent towards massive support for micro-hydro schemes. The government has seen the benefits of these small water-turbines and has provided NRs.8 million (around £110 000) for subsidies on micro-hydro electric schemes this year (compared to NRs.2 million last year). The government is considering backing its optimistic aim of electrification within the next 15 years with serious changes in power legislation. At present, power plants generating up to 100kW are deregulated, and all larger schemes are owned by a government utility. It has been suggested that all power plants up to 1000kW (a size which would supply over 5000 rural households) should be deregulated, and that private companies should be allowed to run, under license, power plants of up to 50 000kW.

But whereas such proposals, entailing a huge amount of work, appear laudable they are equally threatening to the local companies specializing in micro-hydro plants. In an effort to hasten the intended process, the government may commit blunders by allowing inappropriate equipment through import or aid. Unable to compete with 'free' foreign machines, the local companies will wither away leaving a gap of expertise for repair and maintenance and thus becoming dependent on the import of expensive spare parts. Perceiving such a deadly consequence, joint efforts need to be made both by the government and the NGOs to add strength to the sector and offer a sustainable solution to the energy shortage.

(Source: Extracted from "Micro-hydro for Rural Energy in Nepal," *Appropriate Technology*, December 1991, Vol.18, No.3, pp. 6-8.)

New Insulating Material Improves Solar Collector Efficiency

Silica aerogel, a material developed by a German chemist in the 1930s, has excellent thermal insulating properties and can suitably be applied in solar collectors, buildings and greenhouses. The material, a foam containing air-filled pores in its normal state, has been further developed by AB Airglass, Sweden, to be manufactured in form of large sheets, under the trade name airglass.

A 60x60x2 cm airglass sheet retains most of the IR radiation (heat) and allows only 0.6 Watt per degree to pass through. The chemically interlinked structure of the material makes it homogeneous and a poor thermal conductor. The material with a refractive index of 1.04, does not reflect light and allows passage of more than 90% of the radiation. The material is also electrically insulating and 'sound-sluggish'. Brittle in nature, airglass is not suitable to be used for window panes but it could well be placed between two glass panes.

Tests carried out in Denmark show that the U value of airglass is more than twice as low as that of the best window with advanced insulating material, and three times lower than that of a triple-glazed window. Solar collectors insulated with airglass can improve heat retention from 20-30 percent to 80 percent on being heated to 1000C. As such, airglass holds great promise as a sound thermal insulator.

(Source : "New Insulating Material Improve Efficiency of Solar Collectors", *SIP Newsletter* from Sweden, No. 7a, April 17, 1991, p.5.)

Siemens U.C. Gets Solar Deal for African States

A DM30 million photovoltaic contract, which was the largest single contract ever awarded to a company in the photovoltaic industry, was awarded to Siemens Solar Munich by the Permanent Committee of Sahel States which was formed to combat the drought in this African region.

The contract covers the supply, installation and maintenance of photovoltaic systems with a combined capacity of 640 kilowatts in Cape Verde, Gambia, Guinea-Bissau, Mauritania and Senegal.

The project, scheduled to be completed over the next four years, will be financed by the Commission of the European Communities within the framework of the Regional Cooperation Programme.

The contract covers 410 pumping, 89 cooling, 303 lighting and 33 battery charging systems, all of which are powered by solar energy.

(Source: "Siemens Gets Solar Deal for African States", *Bangkok Post*, April 13, 1991, p.19.)

Development of Photovoltaic Technology China

China has nearly 80% of its 1.1 billion population residing in rural areas. Electricity supply to these geographically isolated areas assumes a difficult proposition. Under such circumstances the potential for solar energy applications is huge and photovoltaic systems present an ideal solution.

Chinese PV cells were first used in a satellite in 1971 and by the year 1989, the production capacity of PV cells rose to 4.5 MW. With ten Chinese manufacturers, 22 universities and 16 research institutions involved in research and development, great progress has been made. The China National PV Technology Development Centre (CPVC) is a PV R&D centre which brings together many of these institutions to work on PV under the leadership of the State Science and Technology Commission and the Ministry of Energy. Silk-screen printing technology has been used in the production process and increasing efficiency under lower costs has been made possible. High polymer film and silver paste can now be manufactured in China and both production process as well as products have been improved.

Through experiments it has been concluded that PV power supply proves economic over electricity when the ratio between consumption and grid to user distance is smaller than 100W/km. PV application in China is quite diversified and includes areas like navigation, communications, railway signals, broadcasting, agriculture, forestry, households and many others. Some of the reasons behind the stronghold of PV over conventional energy sources are its reliability and utility even in remote places, suitability for small independent units, economy at times and the wide availability of solar energy.

To make PV systems more reliable and affordable, the following targets have been set to guide PV technology development in the future:

- Full utilization of existing facilities and speeding up of technical improvement.
- Mass production of fundamental materials like wafers and silver paste.
- Emphasizing research in large scale crystal ingot and high-speed wafer-thin slicing and paying attention to manufacturing high efficiency cells with large surface areas.
- Improvement in efficiency and reliability of amorphous silicon and increasing the conversion efficiency and controlling the degradation of amorphous silicon cells.
- Research and development on compound semi-conductor cells.
- Emphasizing the importance of systems research including components development.
- Continuous demonstration and dissemination efforts.
- Establishment of a PV product testing center.
- Installation of a silicon material production line using the country's abundant silicon resources to ease the shortage of raw materials.

The size of the country and the unavailability of electricity to people in rural areas, together contribute to create a big PV market. According to the China National PV Technology Development Centre (CPVC), the potential market for PV products in China in the next five years is at least 10 MW. The Chinese government is supporting PV with favourable tax policies and financial support for research. If the development of new PV applications continues at its present rate, the living conditions of millions of Chinese people will improve remarkably.

(Source: Extracted from "Developing Photovoltaic Technology in China," *Appropriate Technology*, Vol.18, No.3, December 1991, pp.9-10.)

Solar Cooking Botswana

Cooking with the sun has been recorded since the 1700s, but until recently has been limited to the scientists' circle only. Now, the idea of cooking food from this free energy is slowly trickling down, especially among women.

Promoters Virginie Mitchem and Anne Haurath introduced the concept of solar cookers in a recent seminar on Women and Energy, organized by the Botswana Technology Center (BTC), a new member of the African NGOs Environment Network (ANEN). Two types of solar cookers, the parabola and the box cooker, were tested and participants were impressed by the quality of the cooked foods and the heating efficiency of the cookers. The designs for the cookers came from Solar Box Cookers International, a non-profit organization based in Sacramento, U.S.A. According to Mrs. Haurath, the designs were modified to suit their needs and the cookers were used daily for over a month during the testing stage.

Some of the food cooked in the solar cookers were staples such as rice, mealie meal, sorghum porridge, meat, and vegetables as well as cake, bread, cookies, bread pudding, baked apples, and delicious sun-roasted peanuts. These tests simply prove the capability of solar energy to reduce the usage of conventional energy sources and at a cheaper cost. The solar boxes were applied and appreciated in schools and fuelwood scarce areas.

With solar cookers, the cooking times and techniques are a little different and can be carried out during sunshine period only. The sun is best only in the middle hours of the day therefore it cannot be a complete substitute. It is very useful for poor communities and for areas lacking suitable energy resources. As such, significant savings in labor, time and costs for firewood and other fuels through solar cookers can be achieved.

(Source: Extracted from "Cooking with the Sun Saves Time and Money," compiled by Virginie Mitchem and Anne Haurath, *Energy and Environment*, Vol.V, No.1, August 1991, p.4.)

Solar Timber Seasoning – Indonesia

Seasoning of timber ensures economic use of the wood by increasing its resistance to biological decay and enhancing the dimensional stability. Higher quality raw material for high standard timber products can thus be achieved by such a treatment. A training and development project aimed to promote the seasoning of timber and create awareness of this requirement among small and medium-scale firms was organized by Yayasan Multihelp, a local Indonesian non-government organization (NGO) and financed by the German Agency for Technical Cooperation (GTZ) through GATE's "Small-scale Project Fund" programme.

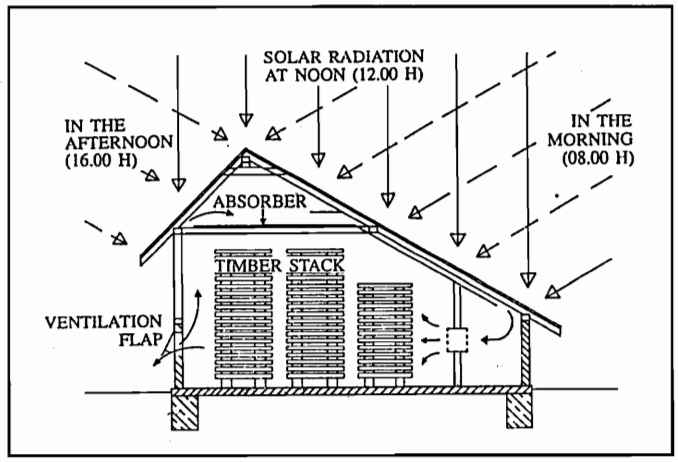
Traditional methods of air seasoning are time consuming and uneconomic while the artificial drying in industrial timber processing is not only complicated but also expensive. Recently developed solar kilns which obtain heat from solar radiation have a low drying temperature and thus minimize the interior climate control measurements and the drying defects.

The overall investment costs are reasonable for small and medium scale workshops, and their capacities meet their requirements.

The Project

The orientation and design of the demonstration kiln in Padang was optimized to obtain maximum possible radiation. The one metre high concrete hollow block wall stands on a 20 cm thick concrete floor slab. The main structure of the 2 x 7 m^3 capacity kiln consists of wooden beams of 6/12 cm. The design is principally the same as the one developed by the Oxford Forestry Institute and ITDG.

The collector was built with single sheeted glass and corrugated iron sheets painted black. In each kiln, five small ventilators with diameters of 45 cm circulate the air. The indoor climate is monitored by means of a portable meter for measuring the wood moisture content (MC) and a hygrometer for the air humidity. In the first tests, the indoor temperature rose to 52°C and 25% air humidity (outside 31°C and 87% humidity), achieving a drying time of 20 days for 30 mm "Jelutong" timber. The two-kiln system allows a combination of pre-air-drying, solar curing and storing, which appears to be the most economic solution for small capacities.



Two-chamber solar kiln, showing its orientation, solar radiation and how the air circulates.

The technique of solar drying is well established and operational but similar to other appropriate technologies, problems persist in their commercial application. Dissemination rather than further research needs to be concentrated on. For solar timber drying, such measures can include creating greater awareness among producers regarding seasoned timber's advantages and developing a clear market strategy to attract new buyers of quality products.

(Source: Extracted from "WAS Section", Wall Building Material Advisory Services at GTZ/GATE, Germany, *Basin-News*, January 1992, pp.9-11.)

ISAAC Solar Ice-makers for Mexican Fishing Village

In October, 1991, Energy Concepts Co. of Annapolis, Maryland and CIEDAC (Centro De Investigacion En Energeticos Y Desarrollo, A.C.) of Mexico City, Mexico announced an agreement for the manufacture and installation of seven Isaac solar ice-makers for Michoacan, in rural Mexico. The Isaac ice makers, developed by Energy Concepts Co., will provide 230 kg (500 pounds) of ice per day for fish preservation and another 300 kg (660 pounds) for cooling a chill storage room. Installation and testing of the system is expected in early 1992.

CIEDAC, a major developer of rural power systems under Mexico's PRONASOL (Programa Nacional de Solidaridad) program, is the first to use this technology for this application. The rural villages will derive substantial economic benefit from the availability of ice to preserve their catch and transport it to market. CIEDAC reports there are many hundreds of similar un-electrified fishing villages in Mexico.

Energy Concepts Company is a research and development company located in Annapolis, Maryland. It specializes in the development and commercialization of absorption refrigeration systems and absorption heat pumps.

For further information, contact:

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Fax: (301) 266 6539

Efficient Chinese Brick Technology in Nepal

The brick industry is one of the major energy consuming industries in the developing countries. As such, concentration on improving the efficiency becomes equally important. GATE, the German Appropriate Technology Exchange a division of GTZ together with the Ceramics Promotion Project (CPP) of GTZ in Bhaktapur/Nepal financed and implemented the transfer and testing of a new brick burning technology. Developed in China and still used extensively, the technology uses a continuous vertical brick kiln and in combination with an extruder to burn the hollow bricks, helps save more than 60% of fuel when compared to the bull trench technology. Furthermore, it uses coal dust instead of fuelwood and occupies only one seventh of the land thus reducing the investment cost.

Bull trench kilns are commonly used to fire bricks in the Kathmandu valley. The kilns are fired with a combination of imported coal, local lignite and firewood. About six plants make use of the Chinese extruders but most bricks are manually formed.

Hollow Bricks

The first phase of the testing programme demonstrated the production of hollow bricks using a small, cheap and easily manufactured extruder from Thailand. These bricks prove advantageous over the solid ones by fuel saving through its 30% lighter weight and providing a better insulation for houses. Hollow bricks are ideal for house construction using pillars and beams made of reinforced concrete and are easier to dry and fire evenly. The production of hollow bricks is in its early phase in Nepal and possesses varied potential despite doubts on its economic aspect.

Vertical Brick Kiln

Hundreds of vertical brick kilns are currently in use in China. High fuel efficiency, simple construction and operation make the kiln ideal for rural areas in developing countries.

The bricks are stacked in a shaft measuring 1 x 1 meter and with a height of 6 meters. Green bricks are loaded from the top in batches of 224 bricks set in 4 layers. At the bottom of the shaft, bricks are taken out at the same rate with a special unloading device. On average a batch is unloaded every 1 1/2 hours. The kiln has so far been tested only with coal dust. This is spread out evenly between each layer of bricks during setting. Combustion takes place in the middle of the vertical shaft.

The combustion air enters at the bottom of the shaft and moves up through the already fired bricks, so when the air reaches the combustion zone it is preheated to about 750 °C. After combustion the hot flue gases move up through the unfired bricks. The transfer of heat to the bricks is so efficient, that the temperature of the exhaust flue gas is low enough to hold a hand over the top exit.

Table1: Fuel consumption of Bull trench kiln and vertical shaft kiln.

	Bull trench kiln	Vertical shaft kiln			
		Int. combustion hollow brick	Hollow brick	Solid brick	Handmade brick
Fired brick weight in kg	2.05	2.00	2.1	2.6	1.75
Moisture content of green brick	abt. 10%	17.5%	15%	9%	10%
Kilo calories used per kg fired brick	550-650	182	206	181	160

Kiln Testing

CPP hired Chinese engineers for kiln testing and demonstration in Nepal. The kiln was constructed by local masons using local bricks and clay mortar. The net time taken for construction was 1 month, 2 weeks more than it takes in China. The inner shaft lining was laid with a layer of green bricks and the space between the inner lining and outer wall was filled up with a mixture of rice husk and brick clay.

Due to unavoidable circumstances, the operation was started in the unsuitable rainy season. Test firing was done with a number of different bricks and the figures on fuel consumption obtained are given in Table 1. Firing temperature is 850-900 °C. It is easily maintained by adjusting the addition of coal and by regular unloading. The kiln worked especially well when firing hollow bricks with coal dust mixed in the clay.

During the rainy season, batches of ➡

Table 2: Comparative analyses of kilns.

	Bull trench kiln	Hoffmann kiln	Vertical shaft kiln (6 shafts)
Brick production per 24 hours	25,000	30,000	24,000
Construction time	2 months	6–9 months	2 months
Construction cost (in Nepalese rupees)	300,000	6,000,000	900,000
Imported cost component	nil	US$30,000	nil
Maintenance cost in rupees (42 rs =1 US$)	100,000	50,000	negligible
Fuel consumption kcal per kg fired brick	550	450	200
Time before brick quality is known	20 days	10 days	20 hours
Average rejection rate of fired bricks	10%	5%	5%
Area required for kiln operation	700 m^3	1100 m^3	100 m^3

MICROCOSM: An Energy Sector Simulation

MICROCOSM is an energy sector simulation model of a developing country that has been developed by Dr. David J. Edelman, Associate Professor of Energy Planning and Policy, Division of Energy Technology, Asian Institute of Technology, Bangkok, Thailand and Dr. Donald M. Manson of DRI/McGraw-Hill in Washington, D.C., U.S.A. It was originally programmed in Applesoft-Basic for the Apple IIe computer in 1984. This new version of the model, Version 2.0, has been modified and expanded by Dr. Edelman. It has been reprogrammed for MS-DOS computers in Turbo Pascal V.6.0 using pull-down menus, a mouse and windowing technology by Mr. L. Dinh Long. Financial support was provided by the Swiss Development Cooperation (SDC) in Bangkok.

The model can be effectively utilized for energy analysis work of short duration in relatively small, data-poor economies. It is also quite useful for quick survey use on a regional or national basis in more complex economies and assists in early identification of sectoral bottlenecks in major energy planning projects. Its other major application is in the teaching and training of energy planners and policy-makers.

MICROCOSM is an indicative planning tool for professionals in the energy planning field. It does not present an optimal solution to balancing energy supply and demand, but is intended for circumstances where there are insufficient data to reach such conclusions. A user of the tool should be a knowledgeable energy analyst, and he or she is likely to be aware of such situations. The conceptual model has, therefore, concentrated on critical interactions within the energy sector. It encompasses causes, effects and relationships, but the output produced should not be considered numerically exact nor by itself form the basis of investment decisions. Nonetheless, the simulation is extremely useful in comparing different policy options or investment programs and in suggesting various combinations of actions that might be tested.

MICROCOSM is user friendly and quickly produces results of simulation runs. Its design allows an analyst the sort of interaction with all data that is not often possible in energy planning models. New data can be used at once. New ideas can be tested quickly, labelled, compared in tables or graphs and their results printed for discussion or reports.

The model is designed to balance the supply and demand of twenty-four energy products, both commercial and non-commercial, in a nine-sector economy over twenty-five years. The base year is user-specified. In addition, the length of the five five-year periods is set prior to data input and can be altered to suit the problem at hand. Thus, the model can be used for both short-term and longer-term studies by employing different databases. This flexibility allows the analyst to tailor the simulation to his or her specific county, region or problem.

Analysts change the input parameters displayed in clearly labelled and logically organized tables on both the supply and demand sides of the simulation to consider the effects of various policies. Investment programs in energy supply infrastructure can be explicitly studied and their cost flows compared on a discounted basis. Output can be printed at any time with the name of the simulation run noted for easy reference.

MICROCOSM is particularly suited to teaching and training. It is quite useful, for example, as the centerpiece of policy seminars for energy sector personnel. Simulating a country's energy problems and the different effects of various policy decisions quickly involves engineers, economists and planners in discussions of the complexity of their professional environment. Working in small interdisciplinary groups on specific problems and presenting the results to a larger group of colleagues is an effective way to employ the model in this context.

For more information, contact
Dr. Edelman at:
Division of Energy Technology
Asian Institute of Technology
G.P.O. Box 2754
Bangkok, Thailand
Tel: (662) 516 0100
Fax: (662) 516 2126
(until 1 July 1992)

WAP Wwerkstatt für Architektur
und Planung AG
Hofackerstrasse 75
CH-8032 Zurich
Switzerland
Tel: 41 01 382 0938
Fax: 41 01 382 0997
(after 1 July 1992)

bricks were unloaded every three hours during the first month of operation, but as the kiln dried and the rain stopped, unloading could take place every 60 to 80 minutes. This equals an output from each shaft of 4,000 to 6,000 bricks per 24 hours. 4 to 6 shafts are needed to replace the daily production of a Bull trench kiln.

Economy

Besides efficient fuel saving capacity the kiln operation has several other benefits, including: an even firing temperature; simple operation employing unskilled workers (special reference to Nepal where Indian migrants monopolize the operation of Bull trench kilns); and using cheap coal dust. A rough comparison of brick kilns as shown in Table 2 further states the utility of the kiln.

Although the testing is still in progress the results achieved so far clearly demonstrate the advantages of a vertical shaft kiln over the other types available in the developing countries. In such a country like Nepal, where the brick industry accounts for high energy consumption, the use of such kilns would not only improve overall economy through fuel savings but also reduce the pressure on forests and air pollution.

Planning to disseminate the kiln throughout Nepal is underway and GATE plans to introduce it in other developing countries too. Further information can be obtained from Klaus Rudolph, GATE, Deutsches Zentrum für Entwicklungs technologien, Dag-Hammarskjold-Weg 1, D-6236 Eschborn 1, Federal Republic of Germany.

(Source: Extracted from *Gate: questions, answers, information*, No.4, 1991, pp.38-40.)

THERMIE: Promotion of European Energy Technologies

The new THERMIE programme is an important Community instrument, designed to promote greater use of European energy technologies. With objectives like creating a sound energy policy, reducing the energy import (which amounts to more than half of the energy consumed) and resolving regional disparities THERMIE was introduced. It will run for five years (1990-1994). The Commission estimates that the Community contribution during this period will amount to 700 million ECU.

THERMIE is thus part of the Community's energy strategy and its aims are:

- to promote innovative energy technologies
- dissemination and market penetration of energy technologies
- encourage greater use of new and renewable energy sources
- to improve energy efficiency
- to improve environmental protection.

THERMIE differs from previous Community programmes in that it makes provision for:

- improved coordination with similar programmes in the Member States, to ensure that they are fully complementary;
- extensive dissemination of information on innovative technologies which have already been developed and are now ready to penetrate the market;
- the funding of associated measures (evaluation, follow-up, dissemination, cooperation) to promote energy technologies;
- cooperation with non-member countries to attain in full measure the programme's objectives;
- (from the outset and as a condition for eligibility) requirements concerning safety and environmental protection; and
- working with and supporting bodies which will promote innovative technologies in the Member States (including staff training).

Field of application

THERMIE covers a wide range of technologies for both the production, transformation and use of energy:

- rational use of energy in: industry (including the energy industry), buildings and transport;
- renewable energy sources: energy from biomass and waste, thermal and photovoltaic solar energy, wind energy, hydroelectric energy and geothermal energy;
- solid fuels, including the clean use of coal, the conversion of coal into gaseous or liquid products, the use or enhancement of gaseous, liquid and solid wastes and gasification integrated with a combined cycle;
- hydrocarbons: exploration, production, transport and storage.

The nature of the projects

The programme seeks to promote promising technologies, the implementation of which is hindered by technical or economic risk. This may be achieved by adopting a two-pronged approach.

- applying new processes or products on a sufficiently large scale for the first time: this is the aim of the innovatory projects; financial support 40% maximum;
- promoting broader utilization of techniques, processes or products which, in general, have already been applied once but have not yet penetrated the market; these are the dissemination projects, with 35% maximum financial support.

The Commission may also take steps to organize or coordinate the setting up of specific "target projects".

The THERMIE programme lays particular emphasis on the importance of close collaboration with and between bodies which are promoting innovative technologies in the Member States.

They are systematically involved where associated measures are concerned and provision is made for technical and financial support where necessary.

Another new element incorporated in the THERMIE programme is the provision for industrial cooperation with non-member countries.

Further information on the programme, calls for proposals or details of individual projects may be obtained from:

Commission of the European Communities
Directorate-General XVII-D
Rue de la Loi 200 - B-1049 Brussels
Telex: 21877 COMEU B
Fax: 02/235 0150

Laos Exports Power to Thailand

In 1987, Electricité de Laos (EdL) signed an agreement with the Electricity Generating Authority of Thailand to sell surplus electricity to Thailand for 10 years. EdL started the Xeset scheme to increase the export of power to Thailand, to reduce the country's dependence on imported fuels and to promote rural electrification in the south of Laos.

The scheme includes a plant on the Xeset river about 35 km from Saravane and about 800 km from the nation's capital, Vientiane. The river drains part of the run-off from the Bolovens plateau into the river Sedone, a tributary of the Mekong.

From a gross head of 157 m over 1.5 km of the Xeset, the plant develops 45 MWe from a flow of 33 m^3/s to produce 181 GWh each year.

The Xeset scheme consisted of the civil works and the supply of the hydraulic, mechanical and electrical equipment; the building of a 115 kV overhead line, a 115/20 kV substation; and the construction of pole factories for rural electrification projects.

The project took 32 months to complete and the erection time of the generators was 10 months.

The first transmission of electricity took place on 1st May 1991.

(Source: Extracted from "Laos Exports More Power to Thailand after Completion of Xeset," *Modern Power Systems*, Vol.11, No.9, 1991, p.22.)

Rural Energy Technology: Biomass Conversion

United Nations Economic & Social Commission for Asia and the Pacific
Bangkok, Thailand, 1991, v+61 p.

Sustained rural energy supply remains a major issue in developing countries where a vast majority of people reside in the rural areas. The traditional sources of energy make a substantial contribution to the rural sector, largely disconnected from the international energy market, to meet the basic household energy needs and rural production activities.

With limited options in hand, the development of efficiently operated, decentralized biomass conversion technologies gain importance in order to ensure a continuous supply of energy to rural areas.

The report entitled "Rural Energy Technology: Biomass Conversion" reviews and assesses biomass technologies relevant to household energy needs, production activities, energy conservation and waste management in the Asia-Pacific region. Also included are the reviews of major issues and problems in planning rural energy supplies and a case study of rural energy planning in China. Explicit discussions on biomass utilization for power generation and gasification, improved biomass conversion technologies, and biological conversion of biomass are presented. Biomass conversion technologies and their contribution to rural energy supplies in ESCAP region are treated in depth and the details cover economics, technical matters, application and promotional measures. This report is useful to policy makers and implementing bodies in judiciously applying the advantages of biomass.

Small Hydro Power in Developing Countries : A Review of Some Case Studies

F.P. Blankenberg and W.S. Hulscher
University of Twente
Technology and Development Group
P.O.Box 217
7500 AE Enschede, the Netherlands
ISSN: 0923-8700, July 1990, 61 p.

The development of national energy resources forms an important part of government policy in many developing countries and hydro power proves to be one of the relevant options. Big hydro power schemes which feed into the national electricity grids have been playing a substantial role whereas small scale hydro power, having limited significance in the national energy balance, possess the potential to suitably serve the needs of rural people. For the past few years, small hydro power has been receiving increasing attraction mainly because of new and better approaches towards its development and in many areas the potential is much wider than was known till recently.

As with other new technologies introduced in rural areas, the development of small hydro energy for rural users raises a number of questions. Such questions refer to what is the best technology, how can it be acquired and introduced, and how can it best be managed. Related questions are: who are the main beneficiaries, what are the linkages and adverse effects of the new technology, and what are the impacts at all, and at what costs? Such questions are of interest in development studies, particularly for a better understanding of the role of technology in rural change. But the questions are also relevant for governments and decision makers in development programmes, as well as for donor agencies which more and more seem to take an interest in small hydro power programmes.

With differences existing among the countries and their specific conditions in particular rural areas, general answers to these questions cannot be expected. To search for principles of a more general nature, the Technology and Development Group of the Twente University has endeavoured to study some examples of small hydro development. Nepal is the country where most of the studies are concentrated, as it appears to be rather successful in its approach to small hydro development. Other studies of the Group refer to India, Colombia, and some countries in East Africa. Where applicable, comparisons are made with information received from countries elsewhere. The studies were made by graduate students of the University, based on 4-6 months fieldwork each.

ASEAN-EC COGEN PROGRAMME

Call for Demonstration Project Proposals

The ASEAN-EC COGEN Programme aims to accelerate the implementation of proven technologies generating heat and/or power fom wood and agro-industrial residues through joint ventures between European and ASEAN companies.

In this framework, technical and financial assistance is available to implement in ASEAN one Full Scale Demonstration Project (FSDP) in 1992.

Eligible project proposals must meet the following criteria:

a) use a proven biomass energy technology;
b) offer a scope for a Euro-ASEAN joint venture;
c) offer technically and economically viable prospects of replication;
d) offer appropriate solutions compatible with safety and environmental protection requirements.

Further information and the complete project proposal form can be obtained from:

Mr. Phongjaroon Srisovanna
Energy Conservation Center of Thailand
c/o Department of Energy Affairs
17 Rama I Rd.
Phatumwan, Bangkok 10330, THAILAND

or

ASEAN - EC COGEN Programme
Asian Institute of Technology
G.P.O. Box 2754
Bangkok 10501, THAILAND
Fax: (662) 524 5396

The following studies have been carried out

- V.d Velde: Mini/Micro Hydropower in India - Bottlenecks in the dissemination;
- Siemensma: Small Hydro Power Units in Developing Countries (Tanzania, Burundi, Rwanda);
- Eysberg: A Feasibility Study on Load Control for Micro Hydro Power in Nepal;
- Huijboom: A Socio-economic Impact Assessment Study on the Nepalese Improved Ghatta;
- Koole: The Influence of an Inter-organizational Network on a Mill Innovation Project in Nepal.
- Sluijs: Systematic Guidelines for the Preliminary Selection of a Water Turbine for Developing Countries (Colombia).

This working paper reviews these studies and presents some of the main results in a comprehensive form.

Renewable Energy Technologies: Their Applications in Developing Countries

L.A. Kristoferson and V. Bokalders
Intermediate Technology Publications
103/105 Southampton Row
London WC1B 4HH
United Kingdom
ISBN 1 85339 088 7, 1991,
xviii+326 p.

There has been a growing awareness of the serious energy situation in developing countries and the often confusing signals about the supply/demand potential. As such, there is an emerging need for a review and assessment of the prospects of new and renewable energy technologies not only of technical but economical, environmental and social aspects as well as their effective absorption.

The book entitled "Renewable Energy Technologies: Their Applications in Developing Countries" provides an overview and introduction to the subject meant for non-specialists and aims to summarize and assess the present experiences of a number of new and renewable energy sources in a development context. The study focusses on renewable energy technologies for the rural sector which forms only one limited part of the complex energy problem in developing countries. Emphasis has been placed on breadth rather than depth, and on trying to give a sense of complexity and variety of the role of new energy technologies in developing countries.

The book presents an overall picture of the renewable energy sources like biomass, solar, hydro, tides – their potential and prospects. Efforts have been made to link the achievements in the renewable energy technologies with the complex and multi-faceted problem experienced in traditional households and modern industries. Renewable energy sources, are now being conceived as a partial solution to the energy problems in the developing world and their state-of-the-art is discussed extensively. This book aims to provide useful background information to practitioners, policy makers and others involved or interested in the field of energy and development.

Solar Photovoltaic Products: A Guide for Development Workers

Anthony Derrick, Catherine Francis and Varis Bokalders
Intermediate Technology Publications
103/105 Southampton Row
London, WC1B 4HH, United Kingdom
ISBN 1-85339-002x, 1991, vii+127 p.

Photovoltaics (PV) technology is in its mature stage and is proving its reliability through numerous applications, big and small. Small scale applications of PV in developing countries include water pumping, refrigeration, lighting and telecommunications and a large number of PV systems are currently being installed.

The proliferation of the technology has, however, created a need for accurate, reliable and objective information among field workers who seldom have the time to grasp the intricacies of all the various gadgets offered to them by manufacturers and agents. PV thus differs from several other renewable energy technologies in that it has already been proven under widely varying circumstances and that a major bottleneck to its dissemination is related not to the technology but the availability of information on its operation, cost and range of applications.

The book entitled "Solar Photovoltaic Products: A Guide for Development Workers" aims to address this shortfall of information and to assist anyone with a little technical experience but probably no previous knowledge of PV system to decide:

- if a power supply is suitable for the purpose in mind;
- the type of equipment needed; and
- how to proceed in implementing a project using PV products.

This guide book has been prepared by I.T. Power Ltd. of Eversley, UK and the Stockholm Environment Institute, Sweden, for the Swedish Missionary Council Office for International Development Cooperation and published by Intermediate Technology Publications Ltd.

This book is an updated version of the 1988 publication with the same name produced jointly by IT-power, the Beijer Institute, and the Swedish Missionary Council. It provides a brief introduction to photovoltaics and associated process, system types and implementation considerations. Applications considered include water pumping, vaccine refrigeration for health care, lighting, rural telecommunications and others. In each application, emphasis is placed on experiences, relative merits of systems under consideration, commercial availability, procurement and implementation procedures. A sample tender document is also included besides information on operation costs, range of applications and potential suppliers. This book can serve as a useful guide to the project designers as well as the decision makers.

Global Warming: Who is taking the Heat

Gerald Foley
Panos Publications Ltd.
9 White Lion Street
London N1 9PD, United Kingdom
ISBN 1-870670-22-1, 1991,
viii+104 p.

The purpose of this book is to provide a clear and concise account of the facts and arguments about global warming. It aims to provide the baseline knowledge required to understand the present position and follow the debate on global warming as it evolves in the coming years.

Chapter 1 outlines the facts on global warming as they are known today.

Publications Received

ENERGY AND ENVIRONMENT

* *Proceedings of the International Conference on Energy and Environment, Volume II*, 27-30 November 1990, Bangkok, Thailand, King Mongkut's Institute of Technology Thonburi, Bangkok, 1991, xxxviii+431 p.

ENERGY

* *EPI Equipment Performance Specifications*, 1991, WHO Logistics for Health Series (WHO/EPI/LHIS/91.1), World Health Organization, Geneva, Switzerland, June 1991, iv+93 p.

* *Review of Electricity Tariffs in Developing Countries During the 1980s*, Energy Development Division, Industry and Energy Department (PRE) Working Paper, Energy Series Paper No.32, The World Bank, Washington D.C., USA, November 1990, 39 p.

* *A Study of the Transfer of Petroleum Fuels Pollution*, by Kay McKeough (Energy Development Division, Industry and Energy Department, PRE) with Energy Security Analysis, Inc. and Petroleum Economics, Ltd. Industry and Energy Department Working Paper, Energy Series Paper No. 37, The World Bank, Washington D.C., USA, July 1991, 49 p.

* *Prospects for Gas-Fueled Combined-Cycle Power Generation in the Developing Countries*, prepared by Edwin Moore and Enrique Crousillat, Energy Development Division, Industry and Energy Department, Working Paper, Energy Series Paper No.35, The World Bank, Washington D.C., USA, May 1991, iv+71 p.

* *Summary 1988 Power Data Sheets for 100 Developing Countries*, by Jose R. Escay, Energy Development Division, Industry and Energy Department (PRE) Working Paper, Energy Series Paper No.40, August 1991, The World Bank, Washington D.C., USA, August 1991, v+102 p.+Annex.

* *Energy Consumption and Input-Output Relations of Field Operations*, REUR Technical Series 10, edited by Evzen Pick, Olle Noren, and Villy Nielsen, CNRE Study No. 3, Food and Agricultural Organization of the United Nations, Rome, 1989, 118 p.

* *Energy Conservation in Animal Houses*, REUR Technical Series 11, edited by S. Pedersen (ed.), CNRE Study No. 6, Food and Agricultural Organization of the United Nations, Rome, 1990, 62 p.

* *Energy for Rural Development*, Proceedings of the United Nations, Rome, Group of Experts on the Role of Renewable Sources of Energy in Integrated Rural Development, edited and introduced by M.R. Bhagavan and Stephen Karekezi, the New and Renewable Sources of Energy Section, Department of International Economic and Social Affairs (DIESA), United Nations, Stockholm, Sweden, 22-26 January 1990, the United Nations, 1992, xv+258 p.

* *Sectoral Energy Demand Studies: Application of the End-Use Approach to Asian Countries*, Economic and Social Commission for Asia and the Pacific, Bangkok, Thailand, Energy Resources Development Series No.33, United Nations, New York, 1991, iii+80 p.

* *EPI Technical Series: The Cold Chain Product Information Sheets*, 1991/92, No.1, WHO/UNICEF Technical Series, Production Information Sheets produced by WHO Expanded Programme on Immunization in Collaboration with UNICEF, Copenhagen, WHO/UNICEF/EPI.TS/91.1, 1991, vi+184 p.

BIOMASS ENERGY

* *Agriculture Residues as an Energy Source*, Proceedings of the Seminar-Cum-Study Tour on Gasification of Rice Husk and Other Biomass, Held in China and The Republic of Korea, 5-18 September 1990, Economic and Social Commission for Asia and the Pacific, United Nations, New York, 1991, vi+278 p.

* *Identifying the Basic Conditions for Economic Generation of Public Electricity from Surplus Bagasse in Sugar Mills*, a study prepared for the World Bank by Norland C. Suzor and P.E. Bouvet, Industry and Energy Department (PRE) Working Paper, Energy Series Paper No.34, The World Bank, Washington D.C., USA, 1991, 158 p.

* *Study on New Biogas Developments in Asia and the Pacific Region*, Economic and Social Commission for Asia and the Pacific, Bangkok, Thailand, United Nations, New York, 1991, vii+73 p.

* *Report of the Sub-Regional Expert Consultation Improved Cookstove Development Programme in South Asian Countries*, Udaipur, Rajasthan, India, 2-5 April 1991, Food and Agriculture Organization of the United Nations, Regional Wood Energy Development Programme in Asia (GCP/RAS/131/NET), Bangkok, June 1991, 279 p.

* *Doing More with Less: Sustainable Development of the Wood Energy Sector in Uganda*, by Stephen Karekezi, Stuart Marwick, George Sizoomu and Patience Turyareeba, KENGO Regional Wood Energy Programme for Africa (RWEPA), Nairobi, Kenya, 1991, xiii+111 p.

* *Planning Self-Help Forestry Projects in Asia*, Based on the Workshop on Planning Self-Help Fuelwood Projects in Asia, Chiang Mai and Khon Kaen, Thailand, 2-13 February 1987, Food and Agriculture Organization of the United Nations, Bangkok, 1987, 84 p.

Chapter 2 looks at what scientists are predicting for the next century. Chapter 3 looks at the implications, especially for the Third World, if these predictions are realized. Chapter 4 outlines the actions which can be taken worldwide to reduce the risk of global warming, and Chapter 5 discusses the policy implications for the Third World. The Appendix gives a brief description of the principal international organizations working on global warming and the main actions taken to date.

Diary of Events

- **February 4-7, 1992, Melbourne, Australia**

10th Australian Biotechnology Conference. Biotechnology: Is Australia Competitive?

For details contact:
Mrs. Barbara Arnold
Conference Secretary
Australian Biotechnology Association Ltd.
P.O.Box 303, Clayton
Victoria 3168 Australia
Tel: (03) 558 6988
Fax: 613 558 6031

- **February 17-20, 1992, Albuquerque, NM, USA**

SOLTECH 92

The objectives of this annual conference are:

- to highlight cost-effective, reliable and environmentally safe applications of photovoltaic and solar thermal products
- to present research results and check their impact on future use, design, implementation and operation of solar energy applications.

For more information contact:
Jeanne Little
Solar Energy Industries Association
777 N. Capitol St. N.E.
Suite 805
Washington, D.C. 20002-4226
Tel: 202 408-0660

- **March 2-6, 1992, Orlando, FL, USA**

16th Annual Conference on Energy from Biomass and Wastes

For details contact:
Susan Robertson
IGT, 3424 South State Street
Chicago, IL 60616, USA

- **April 7-16, 1992, Amman, Jordan**

International Seminar on the Commercialization of Solar and Wind Energy Technologies

Main objectives of the seminar include identification of areas of commercialization, analysis of associated factors, discussion on technical, economic and policy issues, dissemination network, problems and challenges faced.

For further information, contact:
Dr. Rizeq Ta'ani
Royal Scientific Society
Renewable Energy Research Center
P.O.Box 925819
Amman, Jordan
Tel: 844701/9
Telex: 21276 RAMAH JO
Fax: 844806

- **April 19-22, 1992, Cairo, Egypt**

ASRE'92

The meeting will focus on applications of solar and renewable energy.

For details contact:
Egyptian Solar Energy Society
P.O.Box 487 Dokki Giza
Tel: (01) 783258
Fax: (202) 781236
Telex: 92135 ENFAC UN

- **April 21-23, 1992, Boulder, CO, USA**

Energy, Economics and Environment: Imperatives, Realities and Balance

The 19th Annual International Energy Conference of ICEED will focus on the complex linkage between energy and environment that cannot be decoupled in the near to medium term. Costs, financial sources, regulatory instruments, multinational assistance and potential of natural gas will be the issues of discussion.

For further information contact:
Dr. Dorothea H. El Mallakh, ICEED
Campus Box 263
University of Colorado
Boulder, Colorado 80309-0263
USA
Tel: (303) 492-7667
Fax: (303) 442-5042

- **April 23-24, 1992, Boulder, CO, USA**

Pacific Basin Demand and Downstream Activities: Is Middle East Supply the Answer?

The 13th Annual International Area Conference of ICEED is premised on the solidifying of trade blocs globally and on these two regions representing major growth areas in energy demand and petroleum supply, respectively. Issues covered will include impact of investment change on world oil sector, joint ventures and supply arrangements and the role of trade blocs.

For further information contact:
Dr. Dorothea H. El Mallakh, ICEED
Campus Box 263
University of Colorado
Boulder, Colorado 80309-0263
USA
Tel: (303) 492-7667
Fax: (303) 442-5042

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Library and Regional Documentation Center, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The "RERIC News" is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership along with the other four regular publications namely: RERIC International Energy Journal (formerly: Renewable Energy Review Journal); RERIC Holdings List; Abstracts of AIT Reports and Publications on Energy; and RERIC Membership Directory. For further details contact:

Regional Energy Resources Information Center
Asian Institute of Technology
G.P.O. Box 2754
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RERIC news

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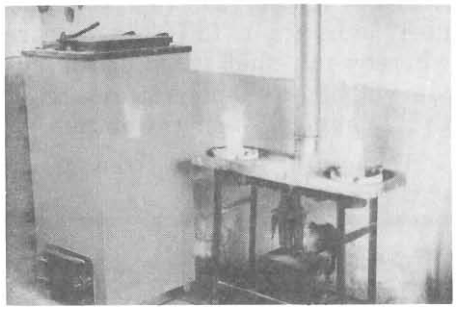
Biomass Domestic Gasifier Cooking Stove

Conventional biomass combustion for domestic cooking is slow, inefficient and highly polluting. Converting biomass into producer gas (which burns with high heat release and high combustion intensity) through effective technology can overcome these drawbacks and also lift the standard of living of the rural poor. An experimental "Biomass Domestic Gasifier Cooking Stove" (BDGCS) which uses wood chunks, corn cobs and straw to produce gas has been developed at the chinese Academy of Agricultural Mechanization Science (CAAMS), Beijing, China.

The gasifier-stove consists of a down-draft gasifier and a stove with two burners. The gasifier produces 12 m^3/hr of gas having a thermal energy content of 50 to 64 MJ from 4 kg of biomass. The drawings of the gasifier and stove are shown in Figures. The BDGCS was designed to cope with nonuniform biomass materials. It consists of a fuel chamber, a reaction chamber, a char-ash chamber, a gas flow system and a primary filter. The gasifier is square in shape from outside. The fuel chamber is 35 cm deep and has an internal diameter of 34 cm. It holds about 8 kg of waste wood or 7 kg of corn cobs or 6 kg of sawdust or rice husks, sufficient for about two hours of gas generation. The reaction chamber is made of cast refractory with an internal diameter of 28 cm, is cylindrical and has an 18 cm diameter constricted throat. The heat for gasification is supplied by partial combustion of the biomass materials to produce a gas rich in CO, H_2 and CH_4 (producer gas). Air enters the chamber from a 50 watt (W) blower through 10 nozzles around the circumference of the chamber and burns the biomass to produce

Cont. P. 2



Photographs show biomass domestic gasifier cooking stoves.

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Supplement: Small Scale Wind Energy Systems

Efficient and Reliable Grain Stoves

Biomass energy sources have remained a good form of alternative energy for both cooking and heating. But, with the apprehension of green house gases, ozone depletion, and a variety of other just as serious environmental and social issues, the need for appropriate alternative heating sources has intensified. Traditionally used devices like oil burners, wood stoves or heaters are either inefficient, expensive or environmentally unfriendly or need lot of maintenance and a strict operation procedure. In contrast, the pellet stoves, now coming onto the market, burn pellets of grain, or wood no larger than 2 cm in size at an efficiency of over 98% in some cases.

Dovetec stove and the space heater are two such sources of heat which use grain pellets as fuel. They produce a heat energy output of a constant 30,000 and 60,000 BTU per hour respectively while emitting only 1.6 to 2.7 grams per hour of particulate matter (well below the EPA particulate matter (PM) guidelines). With an air to fuel ratio of 68 to 1, far exceeding the wood heater at 35 to 1, the burning process is nearly smokeless. The high efficiency heat exchangers on the stove and space heater, coupled with low emissions, do not require elaborate chimneys and hence the cost of expensive insulated chimneys is not an issue. The exhaust from the stove and heater can be simply vented through a wall – much like a dryer vent.

The stove and heater are designed with state-of-the-art technology, each having an auger and hopper set-up, with the hopper capacity of around 30 kilogram (kg). Both have a set of controls used to set the blower and auger speed, along with a manual over-ride to increase the fuel rate if required. Thermocouples situated near and around the fire box help maintain a reasonable temperature. Although the chances of runaway fires are remote, the thermocouples also maintain a fail safe feature, whereby full shut down of the system will occur if temperatures exceed the recommended energy output.

Depending on the area of the building being heated, and the desired temperature, approximately 25 to 30 kg of grain per day is required to be burned. Using the electric auger and once the temperature is set, the energy output can be maintained constant for the whole day provided the hopper has some fuel in it. Pellet stoves, in general, are highly energy-efficient, clean burning and capable of producing a greater amount of energy per unit cost than any other solid fuel source. A more complete burn is obtained with pellets than with wood logs and as a result the ash percentage is only around 1 to 2 by volume (10 to 15 per cent in the case of wood logs). Disposal of ash clinker, which gets deposited in the bottom of the detachable fire box, is also very simple. Furthermore, the reliability, ease of maintenance, structural ruggedness and pleasant design of the pellet stove together make it an ideal method of heating.

(Source: Extracted from "Grain Stoves – All Fired Up!" by Todd Lohvinenko, *Bio-Joule*, Vol. 14, Issue 4, June 1992, pp. 5-6.)

Biomass Domestic Gasifier Cooking Stove

From P. 1

gas and charcoal (flaming pyrolysis). Most of the tars are consumed during this step. The gas is further reduced as it passes through the lower charcoal bed.

After use, the gasifier can be banked for over 24 hours. For restarting, it is only necessary to switch on the blower and the gas will be produced in 1/2 to 1 minute. The producer gas travels through a pipe to a chimney (for initial start-up) and to the stove. The gasifier is typically located outdoors and the cooking is performed in a shed or the kitchen for safety reasons. While the gas is toxic due to the CO content, it also contains a residual, acrid tar and hence the stove must be ignited immediately or the gas turned off. The stove consists of two conventional burners with Venturi air mixers and regulating valves. A typical gas composition is (in volume %): CO: 15.3; H_2: 14.6; CH_4: 3.1; CO_2: 16.3; N_2: 49.2; C_nH_m: 0.84. The heating value for this sample is 5.12 MJ/m^3.

Five litres of water, at an initial temperature of 9°C, can be boiled within 12-15 minutes. Compared to a 12% efficiency for direct combustion cooking, the efficiency in the case of gas-fired cooking is estimated to be 35%. This stove has several advantages like simple construction, low cost fuel, easy operation, clean, fast heat and a number of these stoves, tested for over a year, have been received positively. The gas can also be used for lighting, gas refrigeration, and water heating in rural homes.

(Source: Extracted from an article on "Biomass Domestic Cooking Gasifier Stove for Use in Rural Areas of Developing Countries" by Gao Xiansheng, *Chinese Academy of Agricultural Mechanization Science (CAAMS)*, Beijing, China, June 1992.)

GTZ and Global Improved Cookstoves Programme

The German Agency for Technical Cooperation (GTZ) which has implemented and assisted stove projects in over 14 countries in Africa, Asia and Latin America now has the most extensive global improved cookstoves programme of any aid agency. The credit went to GTZ due to the scaling down of the World Bank's household energy programme. GTZ's lead was apparent at the recently held Workshop on Household Energy from August 31 to September 4, 1992 in Mauloff, Germany, which was attended by participants from Burundi, Niger, Mali, Kenya, Pakistan, Afghanistan, Tanzania as well as representatives of the Intermediate Technology Development Groups (ITDG), Lund Centre for Habitat Studies (LCHS) and the Foundation for Wood-stove Dissemination.

The Integrated Household Energy Systems Division (IHV) office of GTZ located at Eschborn, Germany, coordinates and provides technical backup support for this Energy Programme. The IHV is also undertaking a number of key long-term initiatives that include the implementation of technical and socio-scientific research work and cross-sectoral studies and strengthening of international cooperation. The Workshop was organized by the IHV to provide a forum for GTZ project managers to share experiences, information on household energy projects and identify priority subject areas. The participants advocated additional work on policies, project evaluation, awareness promotion and dissemination strategies. Technical training and adaptation of selected technologies were perceived important for the success of the programme. The maintenance of a global database on household energy technologies was stressed.

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(Source: Extracted from "GTZ Household Energy Programme - Setting the Global Agenda" by Catherine Gathoga and Stephen Karekezi, *Stove News,* No.9, September/October, 1992, p.1.)

Thermochemical Biomass Conversion Database – An Overview

A considerable amount of work has been done, worldwide, on the processing of biomass and wastes to form fuel, energy, chemicals and for other uses. In order to compile all the available information on thermochemical biomass conversion, the International Energy Agency Biomass Agreement (IEA Biomass Agreement), one of whose main objectives is to exchange information, formed a Thermochemical Biomass Conversion Database (TBC Database). The scope of this database includes all aspects of gasification, pyrolysis and liquefaction including pretreatment, upgrading, analyses, and product utilization and covers all forms of biomass and wastes. Set against a background of encouraging international cooperation, the target group for both information provision and its usage includes researchers, manufacturers and energy planners.

Considerable information from a variety of sources like open literature, conferences and personal contacts has been collated on thermochemical biomass conversion activities around the world over the last 6 years and compiled into a database. This has been published in hard bound form covering 1984 to 1989 and made available as a text based computer file. The database has been maintained since 1989 and updated to early 1992. The format of the database was developed in close consultation with both the sponsoring countries in the IEA Bioenergy Agreement and active researchers in the field to provide as much relevant data as possible without overwhelming the user with too much information or placing too much burden on the information providers. The output from the Thermochemical Database consists of three levels:

List – a one line entry of organisation, activity and year of last known activity sorted by country.

Directory – a summary of each activity giving organisation name, contact, activity, and full address details, sorted alphabetically.

Survey – the full database consisting of as much technical and commercial information as has been possible to collate.

The data collected have been analysed in terms of activities by type, by region, by type of organization, by country, by year, and by full details on each activity. Users of the database should be able to identify opportunities to promote interaction and collaboration at research, development and commercial levels, by direct reference or through enquiries to the authors.

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Generating Power from Sugarcane Leaves, India

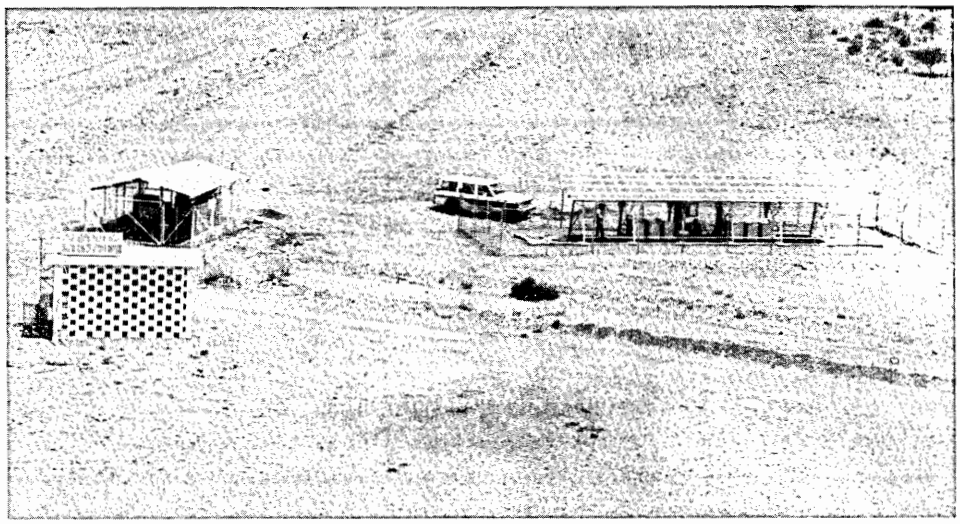
Scientists from the Nimbakar Agricultural Research Institute (NARI), at Phaltan in Maharashtra, India, report to be the pioneers in gasification of sugarcane leaves. The biogas, so produced, can be used for power production – a unique technology of power from loose leafy biomass. Sugarcane leaves, millions of tonnes of which go waste in India every year, can thus be used for power generation, diesel savings and production of enough heat to run jaggery units or even burn bodies in crematoriums.

In view of the pressing need in India to identify indigenous, renewable sources of energy, the NARI scientists initiated a project funded by the Department of Non-Conventional Energy Sources (DNES) on power production in the range of 10-15 kilowatts (kW) through gasification of sugarcane leaves. Tests on a 15-kilo-Volt-Ampere (kVA) diesel genset powered by a sugarcane leaves gasifier showed that 70-90 per cent diesel substitution could be achieved with 5 kW loads. The NARI gasifier, safe and non-polluting, also produces char which is 15-28 per cent of the fuel. The char boosts the overall efficiency of the system to 80-85 per cent and forms an excellent briquetting fuel for cooking, when mixed with a suitable binder.

In their studies, the NARI scientists used sugarcane leaves chopped into 1 to 5 centimeters long pieces and sun-dried. The biomass and air are fed from the top and ash and char continuously removed from the bottom into a water seal. The gasifier is an open top unit, without any neck or constriction, and has an inner steel cylinder and an outer jacket. To deal with the problem of tar formation in the gasifier, the NARI team has designed an elaborate but effective cooling and cleaning system. Also, the total contaminants in the gas which finally comes out is far in excess of the maximum recommended levels (10-20 times higher than that in wood gasifiers). To overcome this problem a safety filter system, needing solvent cleaning every 10-20 hours, was used.

The NARI scientists also designed a gasifier-powered diesel generator set comprising of a gasifier, a cooling-cum-cleaning system and 15 kVA diesel engine genset. This system, with few or no controls, is more suitable for study and uniform loads like in pumpsets. At present cost, the gasifier seems to be more suitable economically for direct heat application rather than for shaft power use.

(Source: Extracted from "Sugarcane Leaves to Generate Power," *Urja*, Vol. 32, No. 3, September 1992, p.24.)



This photograph shows a Solarpak system which has replaced a diesel system in Oman.

Solar Photovoltaic Power on Oil Platforms

Solapak Limited, UK, has earned major orders of the year's significant photovoltaic (PV) contracts in the oil and gas industry. A US$ 5 million turnover from seven major contracts in this sector alone amply proves their dominance. Hyundai Heavy Industries and Samsung Heavy Industries have awarded contracts to Solapak to power telemetry, emergency shut-down systems and navigational aids for oil platforms being built for ONGC (Oil and Natural Gas Commission of India) in the Bombay High Offshore Field. Established in the PV business for nearly twenty years, Solapak is internationally recognised as the leader in system design and power control.

The company supplied 8 large (8904 watts peak) solar systems for the protection of over 100 km of pipeline in North Africa. The company also won a contract to power gas detection and telemetry for platforms in the gas fields of Abu Dhabi. The company will be utilising their new control system, Disc Network, which through reduction of heat dissipation from the master control offers an immense advantage in an enclosed explosion-proof application. This low-cost, highly reliable control system has been used for a telecommunication project in China. Similarly, the company has an exceptional record working on petroleum development projects in Oman.

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Tata BP to Go for Solar Refrigerators

Tata BP Solar, a joint venture between Tata of India and British Petroleum (BP) manufacturing solar photovoltaic equipment, is entering the international market with big plans. After two years of research in product specification and standards, the company has started the production of solar-powered refrigerators. Well-established and utilized worldwide for immunization programmes, the refrigerator units will be targeted for inaccessible parts of Asia, Africa and Latin America.

The company's solar refrigerator, with recognition from the United Nations Children's Fund (UNICEF), is expected to have certification from the World Health Organization (WHO) shortly. A major cost and location advantage is expected by the company over the competing manufacturers from Spain and The Netherlands. BP has recognized Tata BP Solar as their major source for solar photovoltaic modules for their factories in Spain, Australia and the United Kingdom. The domestic market within India itself is huge with nearly 90,000 villages devoid of electricity from the grids. The company thus hopes not only a spurt in the export of solar modules but a big expansion in the domestic market as well.

The company, which started out with a project cost of Rs. 2.65 crore (US$ 0.9 million) is estimating the turnover to shoot up from less than Rs. 2 crore (US$ 0.7 million) in 1991 to Rs. 7 crore (US$ 2.4 million) in 1992. Not only will the maiden profit be notched up but a landmark among the solar photovoltaic companies of the world, still struggling to make profits, will be established.

(Source: Extracted from "Solar Refrigerator from Tata BP" by C.J. Punnathara, *The Times of India*, Wednesday, September 9, 1992, p.11.)

Solar Cell Station for Rural Areas, Thailand

The Ministry of Science, Technology and Environment, Thailand and the New Energy and Industrial Technology Development Organization (NEDO), Japan reached an agreement to allot THB 22 million (approximately US$ 880,000) to a four-year experimental project on solar-electricity for the rural areas of Thailand. NEDO, a semi-governmental organization, will provide equipment for the construction of a solar cell electricity charging station at Kao Kang Reng village in Srisawat district, Kanchanaburi, Thailand.

This is one of five projects supported by Japan to encourage energy conservation in Thailand through the use of renewable sources of energy. The first phase, costing THB 2.1 million, will go to install fifty-six 79-watt solar panels which will provide four kilowatts of electricity to the village. If the first phase proves feasible, the capacity of the solar cell panel will be expanded to generate 40 kilowatts (kW). NEDO will also provide a sulphuric acid-lead battery to each of 146 households in the village for electricity storage along with recording meters and devices to prevent overcharging.

(Source: Extracted from "Solar Cell Station Agreement," *The Nation*, Thailand, Tuesday, December 1, 1992, p.B7.)

Simple Solar Process for Water Purification

A low-cost and simple method of purifying small amounts of lightly polluted water has been developed by researchers at the Brace Research Institute in Quebec, Canada, in collaboration with the Integrated Rural Energy Systems Association, a group of research institutes sponsored by the United Nations University in Tokyo. The technique involves exposing one to three litres of water kept in clear glass or plastic containers or transparent polythene bags to direct sunlight for up to five hours. Related to ultra violet light intensity, the method does not require specific temperatures and the disinfection is found to be most effective with a minimum solar radiation intensity of 500 watts per square meter.

The method, particularly suited for preparing diarrhoeal rehydration salts (ORS) to avert child death from dehydration, finds important implications for communities in developing countries without safe drinking water supplies. The method virtually destroys all the pathogenic bacteria present in the lightly polluted water found in streams, rivers, and unprotected wells but is ineffective for heavily polluted (by faecal coliform bacteria, chemicals etc.) water. The technique was pioneered in 1984 by a group of scientists at the American University in Beirut, Lebanon, led by Dr. Aftim Acra. His research, sponsored by Canada's International Development Research Center and the United Nations Children's Fund (UNICEF), was partly prompted by UNICEF's concern that the beneficial effects of ORS may be lost if mothers used contaminated water to prepare the solutions. UNICEF and the World Health Organization advocate boiled or otherwise uncontaminated water as priority for preparation of ORS. The technique needs minimal supervision and has the potential to reduce the dependence on fuelwood required for boiling water. Researchers are now seeking to establish guidelines for the different exposure times required to ensure the sterilization of the bacteria.

(Source: Extracted from "Purifying Water by a Simple Solar Process," *Agricultural Information Development Bulletin*, Vol. 13, No. 4, December 1991, p.28.)

Third Generation Solar Collectors

Concern for environmental factors and the increasing cost of fuels have led to a growing interest in solar energy – the most "agreeable" of renewables. The most common use so far of the huge supply of energy from the sun, and the most mature is for the generation of low temperature (up to 150°C) heat, specially for the production of household and industrial hot water. The conventional simple flat plate solar collectors are effective under sunny and warm climates but their benefits are greatly reduced during cold, cloudy and windy days. Furthermore, weathering influences such as moisture and condensation cause early deterioration of internal material resulting in system failure.

A breakthrough in solar technology has been achieved by Thermomax Ltd. through the development of an advanced evacuated "heat-pipe" solar collector. The new collector, designed to be effective throughout the year, is highly efficient and durable. The collector gives high performance not only on bright sunny days but also on cloudy, windy days – the real weather conditions any solar system is likely to encounter over the year.

The solar collectors convert direct and diffused solar radiation into heat. They efficiently collect and transfer this energy through a collector plate and heat-pipe in an evacuated glass tube to a highly insulated manifold heat exchanger. The collector plate has a special non-reflective "selective" coating suitable for high vacuum operation. This converts the maximum amount of solar radiation into heat whilst having very low losses. The vacuum eliminates convection and conduction losses and also protects the heat-pipe and collector plate from external adverse conditions. The heat-pipe is a super-efficient conductor of heat and when incorporated within an evacuated solar tube it gives exceptional results far superior to any other type of solar collector.

The heat is transferred from the absorber plate to the water via a "heat-pipe", an efficient heat conductor having very low capacity but fast conductivity. The heat-pipe also provides the system with a diode function, i.e. a uni-directional heat transfer from absorber to the water and not the reverse. Due to the physical properties of the heat-pipe fluid, the maximum working temperature can be controlled. Hence the need for a complicated control unit is eliminated and the system safety is ensured.

The special fluid inside the "heat-pipe" evaporates when heated and thus transfers the heat to the top of the "heat-pipe", the vapour condenses inside a special condenser (which is located within the water of the user's circuit) and the fluid then returns to its original position due to gravity and the cycle is repeated continuously. The active system consists of a stainless steel manifold, stainless steel supports and solar collector tubes. The manifold which has a minimum liquid capacity, is made from a high grade of 'marine quality' stainless steel and is sealed in a weather resistant metal cover. There is a thick polyurethane foam insulation jacket between the manifold and its cover.

Thermomax has developed an advanced controller to take maximum advantage of the performance characteristics of the collector. The controller compares the temperature of the collector with that of the system circuit and signals a small pump when to start or stop. In addition, the controller saves energy since it avoids operating the pump when the solar energy gain is too low. The design of an advanced vacuum solar collector and the specially developed materials together help in providing years of reliable and efficient service. A dynamic production process and strict quality control have brought about a product which has proven successful over an almost ten year period in more than thirty countries around the world.

(Source: Extracted from "Third Generation Solar Collectors," *Energy Digest*, Vol. 21, No. 2, 1992, pp.26-28.)

Solar Powered Health Center – New Zealand

The Great Barrier Island, only 80 kilometers from Auckland, New Zealand, has poorly developed infrastructure and lacks electricity supply from the mains. There life is hard and frustrating, especially in the winter. Diesel generators, wind or solar panels serve as the sources of power available on the island. There are houses built with overlay purposely suitable for the installation of solar or wind power systems.

About 45 years ago the concept of a health center, in a mobile form, came into practice. Later, the efforts of the local people resulted in the establishment of a fixed health center with clinical and emergency facilities, computerized records, X-ray facilities and a short stay room. Attention was paid to design the building and operate the medical center as close as possible to energy self-sufficiency. As of now, the latest compact fluorescent lighting is used throughout the center.

Power is primarily generated by eight photovoltaic (PV) solar modules charging a 24 volt bank of high capacity deep cycle storage batteries. Power is then distributed throughout the building at 230 volts for appliances, lighting and the X-ray machine from a high efficiency 2000 watt inverter. A back-up power supply from a diesel generator serves at times of excessive power consumption or during cloudy days. When the inverter senses the generator's input voltage it becomes a high power battery charger automatically transferring input to output via a changeover relay. A separate emergency lighting system using quartz halogen lights runs off a 12 volt battery, also solar PV charged. Water heating and cooking jobs are done with LPG appliances. Thus the islanders are making right use of the available natural resources in an effort to improve their living standard.

(Source: Extracted from "Solar Charged Health Facilities" by Janet Page, *Solar Progress*, Vol. 13, No. 2, Winter 1992, p.25.)

Increasing focus on Solar Power, Switzerland

Solar energy is beginning to play an important role in meeting Switzerland's energy demands. Dozens of giant solar panels tilted skywards in the high Swiss Jura mountains symbolize Switzerland's nascent revolution in energy production. Perched at an altitude of 1,200 meters is Mont Soleil, Europe's largest solar power station.

Mont Soleil, Switzerland, poses a small solution in the search for viable alternatives to environmentally damaging fossil fuels. A 10-year moratorium on building nuclear power stations in 1990 and a decision to cut hydro-electric power output whilst stabilizing the energy demand, can duly support the promotion of renewable energy sources such as the sun. The government hopes renewable energy can meet 0.5% of Swiss electricity needs by the year 2000. Research suggests it would take 17,000 Mont Soleils to power all Swiss homes.

Situated 45 km (28 miles) northwest of Berne, Mont Soleil is run on public and private funds. In bright sunlight it produces 500 kilowatts of electricity – enough to power around 200 homes. In fact, Switzerland is a pioneer in solar installations like Mont Soleil, linked to the national grid. Per person, it has more such systems than anywhere in the world. Mont Soleil electricity at present costs around 10 times that produced by traditional sources. Start-up costs were more than 8 million Swiss francs (US$ 6.25 million). Despite high costs, people's strong purchasing power has resulted in solar panels springing up all over Switzerland for applications like boats, cars and even funicular railways.

Scientists in Switzerland last year developed a cheap but powerful solar cell that raised the prospect of the world's first large-scale electricity generation by the sun. Switzerland also boasts the world's biggest solar power association. Solar power even finds application in dairies isolated high above the national grid.

(Source: Extracted from "Swiss Focusing More on Solar Power for Energy Production" by Andrew Long, *Bangkok Post*, September 10, 1992, p.25.)

Development in Solar Car

Kyocera Corporation has developed its fourth solar cell-powered racing car, named "Son of Sun", an improvement over its existing third model. The new single-seater car is designed to achieve a maximum speed of 110 km/h by using a nickel-lead battery and single crystal silicon type solar cells. The new model weighs 136 kg, 14 kg lighter than the previous model, and has a comparative higher speed by around 10 per cent. The car is due to enter several domestic races in 1992 and Kyocera has plans to put this upgraded car into the world's longest race for solar cars which will cross Australia in October 1993.

(Source: Extracted from "Solar Car Upgraded," *South China Morning Post*, Tuesday, August 4, 1992.)

Struggling for An Affordable Solar Power

Sanyo Electric Co., Japan, is struggling hard to bring down the costs of electricity generation from solar photovoltaic cells. The company's factory on Awaji Island, Western Japan, has been utilizing the photovoltaic panels to turn solar energy into electricity to power the air-conditioners.

With increasing concerns for global warming and pollution, the solar cells have attracted more and more interest worldwide. Electricity generation from solar cells, which started just 15 years ago, rose to 55 megawatts (MW) in 1991. Japan, the United States (US), and the European Community (EC) had a share of 36%, 30% and 24% respectively in solar cell production in the year 1991. So far, the application of solar power is limited to low-power equipments only, mainly because of costs. Sanyo Electric Co. has cooperated with Misawa Homes Co. Ltd., Japan, in building a solar house. Solar cells are seen to possess high potential in power production but for their penetration, the conversion ratio needs to be raised along with a reduction in production costs.

The most efficient cells (conversion ratio of 16%) called poly-crystal silicon are produced by Kyocera Corp., Japan. The production process is expensive and involves a temperature as high as 1500°C (2730°F). Sanyo's amorphous silicon cells are easier to manufacture, requiring only a 300 Celsius (570 Fahrenheit) process. The company says it takes only one year to retrieve the energy used in production. But they are less efficient in turning the sun's rays into electricity, with a conversion ratio of only about 10%. Sanyo has so far spent US$ 80 million to build solar-powered products ranging from watches to air-conditioners. According to a company source, the production cost, which at present lies around US$ 5 per kilowatt (kW), is expected to decline sharply with mass production. The cost is targeted to be around US$ 1 per kW by the end of this century. If successful, the applications will be diversified to outdoor lamps, electric cars and buildings.

Looking to the future, Sanyo scientists have proposed a project called GENESIS (Global Energy Network Equipped with Solar cells and International Superconductor grids), a plan for vast arrays of solar panels covering the world's deserts to send electricity to population centres via a network of superconducting cables. Although impossibly expensive now, the prospects are expected to improve in the future. The Paris-based International Energy Agency thinks solar power will account for 30 per cent of energy used after 2001. With multifold drop in the cost of solar-cell electricity since 1976 and with increasing conversion efficiency, solar-power signals a bright future for mankind.

(Source: Extracted from "Japan's Sanyo Struggles to Reduce Cost of Solar Energy," *Bangkok Post*, September 16, 1992.)

Regional Solar Programme in the Sahel Region

Utilization of solar energy is to be promoted on a large scale in the Sahel countries through a major initiative, the Regional Solar Programme (PRS). The Programme was supported in 1986 by the 9 member states of CILSS, an international organization with its headquarters in Ouagadougou, which aims to combat desertification in the Sahel region.

PRS aims to popularize the use of solar energy at the rural community level and to stimulate income-generating activities. It will focus on the use of solar appliances – water pumps, lighting systems, vaccine refrigerators – and battery charging stations. Under the programme a total of 1,000 solar water pumps, 106 refrigerators for vaccine, 356 lighting systems and 76 battery charging stations will be supplied to communities which are prepared for active involvement in the project and participate in the initial investment and the maintenance of the equipment. Under the contract, maintenance will be provided by the supplier or its agent and the funds for the contracts will be raised through community involvement. The World Health Organization (WHO) has been approached for advice and collaboration in the implementation of this project.

The WHO/EPI proposes to undertake the following actions in interested countries:

- Initiate collaboration between the ministry of health and the local PRS unit in drawing up a strategy for implementation of the equipment.
- Provide short term consultants to negotiate with local WHO and UNICEF offices to identify sites and implement plans of action and to prepare reports that will provide CILSS with clear recommendations on the use of the equipment.
- Invite some of the suppliers (their local technicians) to participate in WHO-sponsored solar refrigeration training courses.
- Evaluate the operation of a sample of solar refrigerators in comparison to gas and kerosene refrigerators.
- Evaluate the economic components of the community equipment project.

(Source: Extracted from "CILSS Regional Solar Project," *Technet News - Logistics for Health*, Issue 92.2, August 1992, p.1.)

Solar Cell Plant Comes Up – India

A pilot plant has been set up for the development of amorphous silicon solar cell (ASSC) technology in Haryana, India. The plant is seen as a forerunner to commercial exploitation of solar energy. The plant stems from a joint venture of seven research labs and the power equipment maker Bharat Heavy Electricals Limited (BHEL). The Ministry of Non-Conventional Energy Sources (MNES) funded the venture with a grant of Rs 170 million (US$ 5.6 million).

The MNES has chosen to develop the amorphous silicon as compared to the single crystal silicon solar cell (SCSC), the most successful method of producing photovoltaic cells. This is based on an assumption that the amorphous silicon photovoltaic panels, when mass-produced, will sell for Rs 60 (US$ 2) per peak watt, about a quarter the existing Rs 220 (US$7.4) cost of the SCSCs.

However, the technology is not suitable for more than 2 megawatts (MW). Efforts are underway to make the technology commercially feasible. BHEL is trying to develop bigger cells for power generation on a large scale. The photovoltaic technology holds great promise for 100,000 unelectrified villages in India.

(Source: Extracted from "Solar Power Cell Plant Set Up," *Power in Asia*, Issue 111, October 5, 1992, p.12.)

Successful Field Trials of a Thermal Solar Refrigerator

A thermal solar refrigerator/icepack freezer developed by Professor Flechon of the University of Nancy, France, passed both the laboratory tests and the field trials. Successful testings amply prove the appliance's suitability for use in immunization programmes.

The refrigerator operates on a day/night refrigeration cycle. During daytime, a mixture of ammonia and calcium chloride is heated up in the solar collector. As the ammonia is released, it gradually accumulates in a tank. During the night, it flows from the tank into the evaporator and evaporates – thus cooling the cabinet and freezing the icepacks. It then gradually recombines with the calcium chloride to repeat the cycle the following day.

With neither a battery nor any moving part, the appliance is almost treated as maintenance-free, with maintenance required for cleaning up the solar collectors and sometimes defrosting the cabinet only. However, it does have two disadvantages. The first relates to its large size which makes transport to remote areas difficult, whereas the second disadvantage concerns its physical configuration which limits the maximum distance between the solar collector and the refrigerator to three meters.

The volume of the vaccine compartment and the ice compartment is 38 litres and 5 litres respectively and the expected price of the unit ranges from US$ 4,000 to 5,000. The refrigerator is designed for use in areas with direct insolation of at least 5 kWh/m^2/day. Negative temperatures may be recorded at the bottom of the vaccine compartment especially during winters. After the first installation, the appliance needs to be kept empty for at least a week to yield effective results.

(Source: Extracted from "At last: A Solar Thermal Appliance," *Technet News-Logistics for Health*, Issue 92.2, August 1992, p.2.)

Solar-Powered Mesh Cap

Hong Kong based Solarex Electric Ltd, a subsidiary of its US namesake, is offering the safari hat and the mesh cap, both versions fitted with a solar-powered fan to keep cool on a hot day. The company's head office in Maryland, USA, ships solar panels and cells to Hong Kong for assembly along with hats from Taiwan. The panels carry a 90-day warranty. Wrapped under the headpiece are two batteries which can be switched on indoors or when there is no sunlight. A mini fan is placed at the front.

Ex-factory price for a mesh cap is US$ 9 whereas the price is US$ 16 for the safari hat. The two products come in five different colors but for special orders, other colors are also accepted. Reports indicated good sales in Germany, Italy, Switzerland and Thailand.

(Source: Extracted from "Staying Cool in Scorching Sun," *Hong Kong Trader*, No. 78, October 1992, p.4.)

Plans for Harnessing Wind, New Zealand

Electricorp has announced its plans to build New Zealand's first full scale wind turbine in one of the hillside suburbs of Wellington. The base will be 25-35 meters high and the blades will measure 12-17 meters depending on the model and the plant will have the generating capacity between 200 and 600 kilowatts (kW). Electricorp wants to run the wind turbine for 15 years to check for the electricity generation and assess the maintenance costs. So far, only small scale wind turbines have been tested in New Zealand.

(Source : Extracted from "Plans to Harness Wellington Wind," *Modern Power System*, Vol. 12, Issue 3, March 1992, p.9.)

Plans for First Offshore Wind Farm in America

The first offshore wind farm in America, consisting of 20 or 30, 500 kilowatt (kW) Danish Vestas V39 turbines, to be sited on a breakwater near Los Angeles is in the planning stage. The plan could re-energize the image of wind power in America by siting a project of the latest turbines near the second largest metropolis in the country. It would also be highly visible as the first offshore project in America. Significantly, the project so far has the backing of the South Coast Air Quality Management District (SCAQMD), which oversees air quality in the smoggiest region in the U.S.

Wind energy technology, because of zero emissions, is treated as a superior air emission technology. The support of the main agency governing air quality in the Los Angeles region is noteworthy. The agency also has a role in lobbying other government agencies for technologies that do not cause emissions. Moreover, with Los Angeles area exceeding both the state and federal standards of air pollution, the wind energy technology gets added importance. The area has strong wind flows and is quite famous for wind surfing. Getting permission from the U.S. Army Corps of Engineers which oversees America's waterways is a big hurdle for project implementation but it is hoped that the project will be completed by 1994 and will bring numerous benefits to the area. The sea breezes in the area correlate well with peak demand for electricity in the afternoon and early evening, which is also when the air is smoggiest. Some local residents, however, object to this technology citing noise, ugliness, threat to bird life, etc.

Vestas would build and operate the project on a turnkey basis. The company has already installed 300 MW of power in California. The power generated would be sold to the Los Angeles Department of Water and Power. Together with Southern California Edison, the municipal utility announced in May 1991 that it would cut carbon dioxide emissions by 20 per cent over the next 20 years.

(Source: Extracted from "Los Angeles Plans Offshore Wind Farm" by Ros Davidson, *WindPower Monthly*, Vol. 8, No. 11, November 1992, pp. 10-11.)

Collective Endeavor to Build Big Wind Farm in Washington State

A 50 megawatt (MW) windpower project designed, developed and operated by the U.S. Windpower Inc. (USW) in the Rattlesnake Hills in inland Washington state is through for joint collaborative work by four investor-owned electric utilities. The construction of the wind farm, consisting of 140 of USW's new 33 M-VS turbines, could begin by early 1994 and be ready by 1996. Idaho Power Co., Portland General Electric Co. and PacifiCorp of Portland along with Puget Power have agreed for the joint ownership of the first large wind farm project in the Pacific Northwest. The annual average wind speed in the Rattlesnake Hills lies around 16 miles per hour (mph) and averages 20 to 30 mph during winter and spring, the seasons of high power demand.

Renewables are expected to play an increasingly important role in providing future energy needs. The joint venture could be a major step in broad-based development of wind power in the region including the states of Washington, Oregon, Montana, Idaho, and areas of Wyoming also where transmission across the Rockies is complicated and expensive. The utilities which serve a total of 2.1 million customers share the risk of USW's new turbine. The development of the variable speed turbine has provided a major breakthrough in the exploitation of wind energy. The utilities would work with Bonneville Power Administration to ensure the efficient use of power.

(Source: Extracted from "Utilities Team Up to Build Big Wind Farm in Washington State" by Ros Davidson, *Wind Power Monthly*, Vol. 8, No. 9, September 1992, p.10.)

An Optimistic Trend for Wind Energy, UK

The development of wind energy in Britain has been slow, primarily due to a lack of suitable commercial incentives. However, following the introduction of the Non-Fossil Fuel Obligation (NFFO) with privatization of the UK electricity supply industry, wind energy in the UK has begun to take off. This requires that a percentage of generation comes from sources other than fossil fuels or nuclear power and has provided a welcome stimulus although it is not the perfect solution. The premium price guaranteed for the developers runs among the foremost reasons for wind energy technology to flourish. Available until the end of 1998, the premium price of 11 p/kWh will be reduced to 2.5 p/kWh thereafter. But the short pay-back time and the apparently high price involved in wind technology may generate negative publicity for wind energy.

The second NFFO selection process was more formal and protracted than the first. The published list of successful contracts in 1991 showed 49 wind energy projects with a total of 192 MW capacity. In practice, the projects must have planning permission before finance can be obtained and so far only 13 projects totalling around 100 MW have the planning permission.

National Wind Power Ltd. also had a hectic time getting the official conditions fulfilled and by the end of February 1992, it entered into an agreement for the construction of three wind-farms costing US$ 54 million. For this a US$ 33 million loan facility has been provided by Barclays Bank and the rest will come from the Department of Energy and other agencies. This is the biggest financial deal for wind power yet concluded in the UK and will fund the construction of 65 wind turbines, at Cemmaes and Llangwyryfon in Wales and Cold Northcott in Cornwall. Similarly, Renewable Energy Systems Ltd has made an arrangement to finance a 6 MW windfarm at Carland Cross in Cornwall, costing US$ 12 million.

Besides the complexity and cumbersome nature of the NFFO bidding process, there are other factors contributing to the slow development of wind energy in the UK. There have been lengthy discussions about the visual effects of turbines, potential noise, radio and T.V. interference and the disturbance of the local ecology and it has occasioned substantial delay and additional expenditure. To overcome some of these difficulties, the Department of the Environment has now issued draft planning guidelines. The need for these guidelines is urgent in a country like Britain where the best areas for the development of wind farms, on the western side of the country, tend also to be attractive regions of countryside.

One advantage of the late entry of the UK into the wind market is that UK wind farms will benefit from the maturation of the technology which has taken place during the past ten years. Wind turbines have developed not only technically but also aesthetically and both will aid the acceptance of wind energy technology in the UK. The existence of near-proven technology is clearly an important asset, given the constraints imposed by the NFFO timetable. According to two recent studies, the energy generation costs are continuing to fall as a result of a combination of lower capital costs, higher output and availability and lower maintenance costs. A report from the United States indicates that further substantial improvements in energy generation may be possible through the use of advanced aerofoil sections for blades. Efforts to reduce costs have also resulted in progressive reductions in the weight of wind turbines. Aerodynamic efficiency falls with the number of blades (about 5 per cent in going from a three to a one bladed rotor) but this loss is offset by the weight reductions. Similarly, other technical debates related to the efficiency of wind energy plant are also on the surface.

Experience at Britain's first wind farm offers good omens for the future as far as the reliability of the wind energy technology is concerned, and the speed with which it can be deployed. The Delabole wind farm, completed in the late 1991 after a moderate delay, have machines of 34.8 m diameter rotors and an output of 400 kW. The National Wind Power wind-farms at Cemmaes, Cold Northcott and Llangwyryfon will use 33 meter diameter, 300 kW machines manufactured by the Wind Energy Group. These will be the first large UK projects to use British wind turbine technology. Despite initial obstacles, the next round of the NFFO with an expected improved form of calls for proposals or rolling programmes, and the final version of the planning guidelines, are likely to open gates for further development of wind energy technology in the UK.

(Source: Extracted from "Wind Energy Advances across a Broad Front" by D.J. Milborrow, *Modern Power Systems Supplement*, Vol. 12, Issue 7, July 1992, pp.55-57.)

Wind Power Progress in Germany and Sweden

A 3 megawatt (MW) wind turbine is currently being installed in Sweden in a joint venture with Germany to develop megawatt scale wind power technology. Trials with this machine are scheduled to begin in late 1992. A similar machine was installed in Germany this summer at the Jade Wind Park near Wilhelmshaven. The new turbine in Sweden has been installed on the concrete tower once occupied by a 2 MW turbine which suffered a major blade failure. A special lifting sledge brought from Germany was used to install the nacelle and the blades over the tower.

The wind turbine model has been designed and developed by MBB Windenergie and Kvaerner Turbin of Sweden for the German utility Preussenelektra, and for Vattenfall. Aeolus II, the wind turbine in Germany uses glass and carbon fibre material for its blades. Blade weight has been reduced by more than half compared to the earlier model Aeolus I and thus the new model has cheap and durable blades. According to Preussenelektra, the German half of the project has cost DEM 26 million and fifty per cent of this has been borne by Preussenelektra with the remaining 50 per cent coming from state, federal, and European Community coffers. With good wind locations far and few, large turbines represent

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Renewable Energy Statistics Database, UK

RESTATS, the Renewable Energy Statistics Database, containing information on the contribution of renewable energy sources in the UK to electrical and thermal energy production, has recently been developed. Naturally available renewable energy like wind, solar, hydro, oceanic and geothermal energy and energy from wastes have been included in this database.

Whereas, of the total world energy consumption, the renewables approach a figure of around 20 per cent, the contribution of renewables to the total energy consumption in the UK is less than 2 per cent. However, concerns about the limited availability of fossil fuels, environmental problems and the need for diversified energy supply have increased interest in the development of renewable energy sources in the UK. Although few technologies are presently attractive for immediate deployment they hold good promise for the future. The UK Department of Energy encourages the development of economic and environmentally sound renewables technologies through programmes designed to overcome both technical and non-technical barriers. With an increasing number of renewables projects, the measurement of their contribution to the UK's energy sector becomes necessary. Besides, such monitoring is also necessary to assess the effectiveness of these projects and to determine future requirements. Thus in 1990, the Biomass Resources (Biofuels) Section of the Energy Technology Support Unit was commissioned by the Economics and Statistics Division of the Department of Energy to develop a database of UK renewable energy sources. Support for this work was also received from the Statistical Office of the European Communities.

The first phase of the project carried out during 1990-91 consisted of six activity tasks:

1. The identification of all relevant renewable energy sources and the range of information available in each of these sources that is appropriate to the database to be developed.
2. The identification of a centre of expertise and a contact within that centre for each of the renewable energy sources.
3. The definition of all information to be entered onto the database for each renewable source, and the definition of a proforma for data collection.
4. The construction of localised databases for each energy source, and aggregated screen definitions required to contain and manipulate the data.
5. The collection and input of all data identified in the required standardised form, where possible, for the years 1988, 1989 and 1990.
6. The identification of those areas where information is scarce or unavailable, and to make recommendations as to how such shortcomings might be overcome.

The outputs from RESTATS show that in the UK in 1990, there was a total renewable energy generation equivalent to some 2.1 million tonnes of oil. The majority of this generation arose from large scale hydro schemes and biofuels technologies, with other sources contributing less than 1% of the total. The results from this initial project were used to provide data for an Annex on Renewable Energy Statistics that was included in the 1991 Digest of UK Energy Statistics.

As noted in the Digest Annex, the work during the initial phase of the project identified the information held to be either incomplete or as an estimate. Further work is therefore underway to improve the quality of this data. In fact, RESTATS will be the main source for providing the data to compile the Annex of Renewable Energy Statistics that will be included in the UK Energy Statistics Digest each year. A system of ongoing data collection is therefore being set up to provide accurate and up-to-date statistics for this Annex. This system will request annual returns from each of the renewable energy projects on the RESTATS database, providing information on energy inputs and energy outputs from the previous year. New projects will also be added to the database as they are commissioned.

Information held on individual projects within RESTATS is held as "commercial-in-confidence", that is, information held on individual projects or companies cannot be given out or made public without the permission of the project or the company. However, aggregated results can be a valuable source of information for both government and industry. All information collected within RESTATS is provided voluntarily, and therefore it is particularly important that those who contribute project information to RESTATS can see that RESTATS is of benefit to their industries. Other information dissemination activities about the RESTATS database will include the production of information panels showing the capabilities of RESTATS, which will be used at conferences and exhibitions. The RESTATS database marks an important milestone for progress in renewable energy technologies, by enabling accurate details of annual returns of these renewable sources to be compiled efficiently and effectively in a way that is compatible with existing Government data collection systems.

(Source: Extracted from "Compiling Renewable Energy Statistics" by E.M. Aitchison, A.J. Hardcastle and K.M. Richards, *International Journal of Ambient Energy*, Vol. 13, No. 2, April 1992, pp.75-83.)

Wind Power Progress in Germany and Sweden

From P. 10

a sensible path to the most effective use of existing wind potential.

The Swedish and German machines will be evaluated until 1996. In the meantime, the project partners are already planning a third generation of 3 MW turbines, with the manufacture of five machines in 1996 followed by the installation of an offshore machine in 1997. For the past year Preussenelektra has also been commissioning a 1.2 MW MAN turbine at Windenergiepark Weskueste. This project has cost some DEM 15 million. Problems have arisen over harmonic disturbances in the grid, which have not been experienced with the other 1.2 MW turbine on the island of Helgoland where the electricity is fed into a much smaller grid.

(Source: Extracted from "Megawatt Progress in Germany and Sweden" by Lyn Harrison and Sara Knight, *WindPower Monthly*, Vol. 8, No. 11, November 1992, p.14.)

Joint Effort to Promote Renewables, EC

With growing energy and environmental concerns, the renewable sources of energy are gaining increasing importance day by day. One of the many programmes proposed by the European Commission (EC) is the ALTENER programme, a proposal for five years of specific action by members of the European Community to boost the use of renewables. If implemented, this programme will do more for renewables than any other European legislation to date. Notably, it is the first time the Commission has ever quantified the contribution of renewable energy to the overall energy budget.

ALTENER proposes a 150 per cent increase in the use of renewables and an increase in wind's contribution to the overall energy demand in Europe by 17 to 24 times the current level (see Table). Individual targets have been set for five renewable energy sources namely wind, small hydro under 10 MW, biomass, geothermal and solar. Whereas the contribution from wind and small hydro is limited to the production of electricity only, the remaining renewables will be used to provide other forms of power also like heat, bio-diesel from vegetable oils etc.

ALTENER has been drawn up in response to a request from the joint Energy/Environment Council for concrete measures to reduce carbon dioxide emissions and EC's objective is to stabilise CO_2 emissions at the 1990 level by the year 2000. With regard to this, the role of renewable energy sources has been viewed as quite significant. ALTENER establishes that a 180 million tonnes reduction in $C0_2$ emissions can be achieved in 2005 by:

- roughly doubling the current contribution made by renewables to meeting the overall energy demand;
- trebling the production of electricity from renewables, from an installed capacity in 1991 of 8 gegawatt (GW), generating 25 TWh, to 27 GW for 80 TWh generation; and
- securing for biofuels a market share of five per cent of total fuel consumption.

Maximum focus is laid on the development and utilization of biomass and its technology as compared to other renewables and this issue tends to be a bit controversial. Also the statistical method for conversion purpose adopted by ALTENER markedly varies from the widely used conventional statistical method. Despite these shortcomings, efforts for renewables promotion are being made and the legislative framework for creating a renewables market is already in place and a proposal for an ecotax on polluting emissions is being considered.

ALTENER defines four groups of flanking measures – market promotion, financial and economic, training and information, and third country cooperation. The proposed budget for the five year duration of the programme from 1993 to 1997 is 40 million ECU. ALTENER puts considerable stress on the need to harmonise existing technical standards and regulations. Under the wind section, safety, performance and environmental impact of aerogenerators will be thoroughly studied. Market promotion of the renewables will be taken up actively. Incentive measures have been proposed to encourage investment in the exploitation of renewables. ALTENER stresses the need for measures to promote third party financing of renewable power plant. Feasibility studies into the possible role of renewables in all major construction activities have been advocated.

(Source: Extracted from "Europe Gets Clean Away," *Wind Power Monthly,* Vol. 8, No. 9, September 1992, pp.18-20.)

New and renewable energy targets for 2005

The European Commission's ALTENER programme proposal

	Production 1991				Objective 2005			
	GW	TWh	MTOE[1]	MTOE[2]	GW	TWh	MTOE[1]	MTOE[2]
Electricity								
Small hydro (under 10 MW)	5.0	15.0	1.3	3.3	10.0	30.0	2.6	6.6
Geothermal	0.5	3.0	1.9	0.7	1.5	9.0	5.4	2.0
Biomass and waste	2.0	6.3	2.7	1.4	7.0	20.0	8.6	4.4
Wind	0.5	0.9	0.1	0.2	8.0	20.0	1.7	4.4
Photovoltaic	0.0	0.0	0.0	0.0	0.5	1.0	0.1	0.1
Total elec. excl. large hydro	8.0	25.2	5.6	6.0	27.0	80.0	17.6	18.4
Large hydro	74.8	154.5	13.3	34.0	88.6	198.5	17.1	43.7
Thermal								
Fuelwood			20.0	20.0			50.0	50.0
Other biomass (biogas, waste etc.)			2.7	8.0			2.7	8.0
Geothermal			0.4	3.0			0.4	3.0
Solar			0.2	1.2			0.2	1.2
Total thermal			23.3	23.3			62.2	62.2
Biofuels			0.0	0.0			11.0	11.0
(Total contribution exclusive large hydro:			29.3	28.9			91.6	90.8)
Total Contribution of renewables:			**42.6**	**62.9**			**108.7**	**134.5**
*Total energy consumption			1160.0	1160.0			1400.0	1400.0
Percentage share of renewables			**3.7**	**5.4**			**7.8**	**9.6**

1) Following Eurostats statistics for conversion of TWh into mtoe which uses different conversion factors for primary electricity (wind and hydro) and geothermal, waste and biomass. 1 TWh of wind produced electricity is equivalent to 85,000 tonnes of oil.

2) Following the "substitution convention" used by OECD for which ALTENER uses a conversion factor of 1 TWh=220,000 toe.

* Estimate after taking account of new and renewable energy sources not yet included in the statistics.

SOURCE: EUROPEAN COMMISSION

RERIC OCCASIONAL PUBLICATION

Biocoal: Technology and Economics

S.C. Bhattacharya and Ram M. Shrestha

1990, 495 p., ISBN 974-8201-414

Industrial biocoal production technology has been known for nearly four decades but has received little attention in terms of research and development effort commensurate with its potential. The available literature is sparse and scattered and therefore an attempt is made through this book to present a consolidated picture of the state-of-the-art work, the technology, the economics, and scope of biocoal production. The outcome of the studies under the biocoal project conducted by the Asian Institute of Technology (AIT) and the German Agency for Technical Co-operation (GTZ) have been reported. Various aspects of biocoal resource and its market in Thailand are also covered. The book intends to attract the researchers, the producers, the end-users as well as the policy-makers through its comprehensive coverage on the subject.

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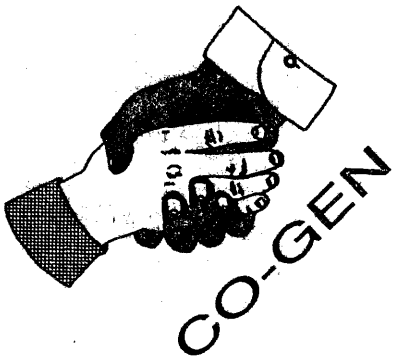

RERIC OCCASIONAL PUBLICATION

Proceedings of the ASEAN/AIT/USAID Senior Executive Seminar on Cogeneration and Private Power

9-11 November, 1988, Hua Hin, Thailand
Edited by W.K. Foell
1990, 105 p., ISBN 974-8201-937

Participation of the private sector in power generation is getting added importance and is considered necessary because of expected shortfalls in generation capacities and the large public investments needed for expansion of generation capacity of the public sector power plants. Private power generation and conservation policies including cogeneration and electricity economics are the current topics of wide concern throughout the world and particularly so in the ASEAN region. But, major barriers to their implementation are found to be institutional rather than technical. To address this issue a Seminar held in Hua Hin, Thailand, from November 9-11, 1988 brought together top energy/electricity policy makers in ASEAN and a team of counterparts from the U.S. where similar problems had been or were being addressed.

This publication serves as a medium to sort out and solve the complications emerging out of the new relationship between utilities, producers and the government and is largely useful for all concerned with power generation.

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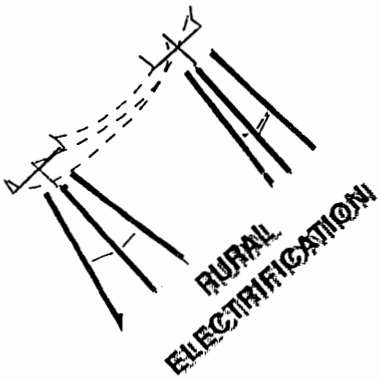

Rural Electrification Guidebook for Asia and the Pacific

Edited by G. Saunier

1992, 469 p., ISBN 974-8209-15-6

Supply of electricity to the rural communities involves complex issues of economic planning and technology transfer. Solution to the intricate network of social, economic and technology issues, well beyond the resources of developing countries, needs conjoint use of all the experience and technological skill available in developed countries along with that existing locally. This guidebook serves as an easy access to the facts, findings, analyses of impediments at political, organizational and technical levels which affect the development of rural electrification and proposes guidelines for future actions. Rural planners as well as the power users have been targeted to directly benefit from the use of this guidebook.

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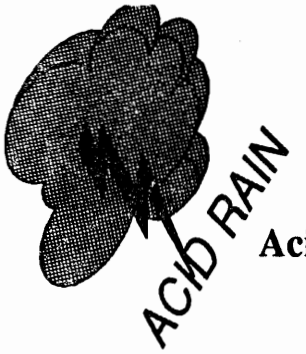

RERIC OCCASIONAL PUBLICATION

Acid Rain and Emissions in Asia - 2nd Annual Workshop Proceedings
19-22 November, 1990, Bangkok, Thailand

Edited by W.K. Foell and Deepak Sharma

1991, 253 p., ISBN 974-8209-016

Recently there has been a growth in national and international concerns about the issue of atmospheric emissions and acid rain in Asia. With far stretching global implications these emissions have the potential to significantly damage the natural environment and local sectors like forestry, agriculture and tourism. Hence an integrated program to formulate and assess the long-term strategies to confront the related emerging problems becomes necessary.

This publication is a compilation of papers on current status of the problem, on research proposals, and specific action plans deemed important to ameliorate the potential impacts at both the national and regional (Asia-wide) levels. Experiences gained in North America and Europe in this area are also cited and these could act as pointers for further work.

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- Modeling and Control of Acid Deposition
- Overview of Wet Deposition Monitoring Activities in the Asian Region Relevant to the IGAC DEBITS Activity
- Relative Sensitivity, Critical Loads, Target Loads and their Inclusion in Acidic Deposition Abatement Strategy Models
- Energy Technology and Emissions Control for Acid Rain Abatement in Asia
- Acid Rain in Asia: An Economic, Energy, and Emissions Overview
- Description of Acid Rain Problem in India
- Descriptive Analysis of the Acid Rain Problem in Indonesia: Identification of Source and Acidification Processes
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Methane for Energy and Safe Environment

Methane is naturally available in coal mines and can also be generated, along with carbon-dioxide, by the decomposition of solid waste in a landfill. The gas can be used for multiple purposes like electricity production, methanol production, as diesel fuel, as boiler fuel and others. Environmental Technologies Incorporation (ETI), Calgary, Canada is making use of both these sources for electricity production.

ETI in joint venture with Tai Energy Resources Corporation of Calgary and John Eric Hopkinson Management Inc., Nova Scotia, has signed a long-term Power Sales Contract with Nova Scotia Power Corporation (NSPC) to supply NSPC with 4 megawatts of power for a period of twenty years. (One megawatt of electricity will provide all electrical requirements for approximately 700 to 800 homes.) The electricity will be generated utilizing vented methane gas from the Phalen Colliery, New Waterford, Cape Breton, Nova Scotia. A similar agreement by the venture company has been signed with Cape Breton Development Corporation (CBDC), operators of the coal mine. Associated methane reserves for this project are estimated at 10.8 BCF. Total capital cost for the project is estimated to be US$ 6 million and annual gross revenue is projected to be US$ 2 million. Financing is being provided by the Canadian Imperial Bank of Commerce.

ETI has also undertaken a project to supply 3.8 megawatts of electrical power to NSPC over ten years using landfill gas to be extracted from the Halifax landfill. At Edmonton, ETI developed the Clover Bar Landfill Gas Project and in April 1992, gas sales commenced from the US$ 2.5 million facility. The facility will collect and sell approximately 70,000 cubic meters per day of methane gas from the older half of the landfill. These volumes will double in a few years when gas can be collected from the remainder of the landfill which is still open. The gas is being extracted from the landfill, cleaned and transported via a dedicated pipeline to Edmonton Power's Clover Bar Generating Station. The medium Btu gas is used as boiler fuel by Edmonton Power to generate electricity. The expected life of the project is 20 years. Similarly, a series of horizontal and vertical wells collect the gas through perforated pipe and mechanical blowers or compressors are used to draw the gas to a central location.

(Source: Extracted from "Waste Gases Used for Energy and Safe Environment," *Bio-Joule*, Vol. 14, Issue 5, September 1992, p.9.)

American Overseas Aid Raised for Renewable Projects

American foreign aid for renewables projects has been increased for the fiscal year 1993, which started October 1, 1992. As per the new bill, $ 15 million has been set aside for replicable renewable energy projects overseas and the budget available to the Office of Energy of the U.S. Agency for International Development (USAID) has been increased from $ 20 million to $ 25 million. For the first time cash has been allocated to replicable renewables projects overseas and the first budget increase for the USAID Office of Energy in several years that can be applied to wind projects.

The bill also includes $ 10 million for the Committee on Renewable Energy Commerce and Trade (CORECT), the Environmental Technology Export Council (ETEC) and the International Fund for Renewable Energy Efficiency (IFREE). Of the $ 10 million, $ 1.5 million is for IFREE, an increase of 50 per cent from last year's $ 1 million. Moreover, money for various American Wind Energy Association (AWEA) programmes is expected to increase because of the higher funding overall for renewables and US Aid for International Development (USAID). The USAID energy office has also spent some $ 60,000 on a preliminary economic and technological assessment of a wind project in Costa Rica. Money for the study, which was completed in late September, was also provided from the Global Environment Facility (GEF) and the International Development Bank.

With changing priorities especially favorable to renewable energy sources, significant global wind power development is quite likely. Also, the USAID funding increase is a part of an overall trend on Capitol Hill, USA. In fact, USAID, a semi-independent part of the U.S. Department of State has both a development and trade function and its Office of Energy, one of several special offices within the organization, is involved in activities related to energy except transportation. USAID's structure is decentralized and most of its foreign aid cash assistance is distributed to the various missions. The budget for energy projects lies around $ 200 million to $ 250 million per year and is handled either through missions in each country or through the Office of Energy.

(Source: Extracted from "More Renewables Projects as American Overseas Aid" by Ros Davidson, *Wind Power Monthly,* Vol. 8, No. 11, November 1992, p.16.)

On a Competitive Edge – Clean Alternative Fuels for Transportation

Growing environmental concerns have encouraged the search for transportation fuels which burn without harmful emissions. However, production, transportation fuel infrastructure, energy content and economics play an equally vital role and should be paid due consideration while commercializing the new, harmless fuel. A conference on the topic of clean transportation fuels was organized by the Canadian Energy Research Institute in collaboration with Energy, Mines and Resources, Canada, Environment Canada, Industry, Science and Technology, Canada and Transport Canada, during April 12-14, 1992 in Ontario, Canada. The importance of treating transportation as a system, rather than as individual components was one of the predominant themes of the conference.

The measures taken up in the United States and Canada on fuel regulation based on environmental factors were extensively discussed at the conference. Jim Boyd, Executive Officer, California Air Resources Board (ARB) threw light on zero-emission vehicles by 1998. Although electric vehicles have the lowest emissions, the resources for electricity generation can be extremely polluting. ARB's clean fuel regulation requires that each alternative fuel used to certify over 20,000 LEVs (low-emission vehicles) be made available at gasoline stations. Methanol, natural gas and electricity are alternative fuels likely to be used in the near future.

The three-day conference on transportation fuels had sessions on policy, fuel quality, fuel sources and resources, distribution and refuelling infrastructure, meeting the customers needs and commercialization of the alternatives. Representatives from major North American automobile companies like General Motors, Chrysler Co. and Ford Co. also took part. They suggested utilization of a combination of gasoline and alcohol and the provision by alternative fuels of various benefits such as equal safety (compared to conventional fuels), lower vehicle emissions and operating costs, and exceptional consumer satisfaction. Harmonization of vehicle regulations was felt important to help commercialize the alternative fuel vehicles.

Reformulated fuels (changing the composition of fuels) was found to be the favourite of the hydrocarbon industry. One of the energy policy objectives of the federal government of Canada is to provide a mix of energy sources and use the most appropriate energy sources in particular regions. Various fuel options, like methanol, ethanol, natural gas, propane, hydrogen and electricity will receive necessary support needed for commercialization in Canada. Representative from Mohawk Oil Co. Ltd. discussed properties of ethanol which can serve as a suitable gasoline blending component. Similarly, production and benefits of methanol, natural gas, electricity were also discussed in the conference.

It was concluded that there is no best choice and one has to look at both the advantages and disadvantages of a vehicle and fuel. The three biggest concerns for fuel commercialization are batteries, infrastructure and cost. New technology allows diversification of options and improved fuel efficiency has been achieved through better design. Future emission standards, cost and security of supply are also taken up for the evaluation of alternative fuels.

(Sources: Extracted from "Commercializing Clean Fuels for Transportation" by Beth Candlish, *Bio-Joule*, Vol. 14, Issue 4, June 1992, pp.7-9.)

Waste Tyres to Fuel Largest Individual Electricity Generator from RE Sources in UK

Elm Energy and Recycling (UK) Limited is to design, construct and operate a 30 megawatt (MW) electricity generation plant using whole rubber tyres as its primary fuel source. The plant will be both the first of its kind to be built in Europe as well as the largest individual generator of electricity from renewable energy sources in the UK. The total cost of plant will be in the order of £49 million for which The Barclays Bank and The Fuji Bank together will provide a £35.1 million loan.

The project has employed private sector funding to provide a solution to the long standing problem of tyre disposal in the United Kingdom. The technology will utilize waste tyres for electricity generation to boost the local electricity distribution network in Bilston, Wolverhampton without polluting the environment, and side by side, producing valuable reusable by-products. Contracts for the supply of electricity have been secured under the first tranche of the Government's non-fossil purchasing arrangements.

The plant will be the subject of a Turnkey Design and Build contract with TBV Power Limited and will use Pulse Hearth incinerators constructed by Basic Energy (UK) Limited. The incineration of tyres at carefully controlled temperatures together with one of an advanced three stage flue gas clean-up system ensures that emissions are controlled to levels well within EC requirements, and considerably lower than those found in coal-fired plants. In addition, the process produces valuable usable by-products principally high grade steel and zinc. Completion is scheduled for Autumn 1993.

The plant will consume some 90,000 to 100,000 tonnes of waste tyres per annum. An adequate supply of tyres is guaranteed by a series of supply contracts with the leading tyre manufacturers, retreaders and the national network of tyre service companies. According to an estimate, 0.4 million tonnes of waste tyres are produced in the UK each year and with landfill space getting scarce, the technology can be employed for multiple gains.

(Source: Extracted from "Waste Tyre Fuelled Power Station," *Energy Digest*, Vol. 21, No. 2, 1992, pp.20-21.)

Czechoslovakia Opts for Clean Coal Technology

Asea Brown Boveri (ABB) Carbon AB, a Sweden-based company in the Swedish-Swiss ABB group, will supply a combined heat and power (CHP) plant designed for clean coal technology to one of the utilities of Czechoslovakia. The plant will supply 60 megawatts (MW) of electricity, 100 MW of district heat, 100 MW of process steam to Ostrava, a city with 350,000 inhabitants, east of Prague.

The pressurized fluidized bed combined-cycle (PFBC) clean coal technology will ensure a dramatic reduction of sulphur dioxide and nitrogen oxide emissions, while giving a high output of electricity in relation to the district heating load and process steam extractions. ABB, which has pioneered the PFBC technology over the past 15 years, will deliver the new plant in cooperation with the Czech producer of thermal power plants PBS and other subcontractors. Commercial operation is scheduled for 1996.

(Source: Extracted from "Big Czech Order to ABB for Clean Coal Technology Power Plant," *SIP The Swedish-International Press Bureau*, Stockholm, 1992.)

Development of a New Waste Disposal Process, India

The scientists of Vasantdada Sugar Institute (VSI) in Pune, India, have developed a modified incineration technology, described as a one step-zero technology, with the advantage of generation of energy and potash as by-products. The VSI scientists claim that its drying, incineration and energy generation (DIEG) technology eliminates the need for any external source of energy in the distillery and its effluent treatment plant. A pay back period of five years for this latest technology, with an investment of about Rs 40 million (US$ 1.33 million), has also been claimed by the scientists.

At present, effluent disposal is a major impediment in the growth of the molasses-based alcohol industry, and there is no suitable, economically-viable disposal technology available. The three effluent treatment processes currently available are incineration, anaerobic digestion followed by a secondary treatment, and composting. But none of these is highly effective. Whereas the incineration process is costly and cumbersome, the composting technique needs a lot of scientific perfection from the pollution point of view. The bio-methanation process technology, though perfect, does not offer a solution to the secondary treatment of effluents.

(Source: Extracted from "New Waste Disposal Process Developed," *Urja*, Vol. 32, No. 4, October 1992, pp.21-22.)

Conversion Technology Shows Prospects in Developing Countries

Simple conversion technology of motors into generators and water pumps into turbines proves capable of providing cheap electricity to countless homes in the developing countries. An electric motor, a water pump (optional), a length of metal piping and a simple to construct electrical device are all that is required to make an improvised generator to work on a reasonably steep hillside. Intermediate Technology (IT), a Third World charity based in Warwickshire, Britain, has been demonstrating the field operation of its home-made generator. Similar motor converted generators have been installed in Nepal and Pakistan where running water is plentiful, cheap electric motors and water pumps are widely available but electricity is scarce and costly.

Generators designed specifically for hydro electricity, are not only scarce but frequently break down when needed to run at high speeds. In contrast, the generators, made simply by converting the electric motors prove much cheaper and reliable. In fact, the electric generators use just the reverse principle of operation of that of electric motors. For electricity generation, the mechanical twisting action is provided by the turbines driven by the running water but in the conversion technology the pumps act as turbines with the water put in the other way round. A programme has been worked out by IT to teach the villagers to fabricate the turbines from waste metal available locally.

Capacitors, devices for short time electricity storage to smoothen the voltage variation, are the only external requirements for motor to generator conversion. The generators, made from converted motors, cost less than the purpose-built generators for powers of up to20 kilowatts – enough to supply up to 30 homesteads. Furthermore, these generators easily last 10 years without repair mainly because of heavier duty bearings in the motors. An electrical controller, easily manufactured locally, manages the flow of electricity and directs excess electricity at low demand periods to the heaters.

IT has as its objective, the raising of living standards of the rural people in the developing nations and accordingly demonstrates ways to achieve modest but significant technological advances through application of local skills and materials. Training on specific aspects of micro-hydros are also imparted from time to time and with increasing success in Pakistan, Nepal, Sri Lanka and Peru. More developing nations can be targeted for such applications.

(Source: Extracted from "Converted Motors Shed Light on Rural Homes," *Urja*, Vol. 32, No. 2, August 1992, p.62.)

Power from Waste at Europe's Largest Landfill

A 185 kilowatt (kW) biogas compressor has been installed at Europe's largest landfill in Brogborough, Britain, to compress the methane-rich biogas for conversion to electrical power. The gas, recovered from over 80 gas wells sunk into biodegrading household and industrial waste, is used to fuel a pair of 2 megawatts (MW) generating sets supplying power to the local electricity grid.

Low pressure fans extract the gas from the site and deliver it to a 1.2 cubic meter receiver vessel feeding the CompAir Broom Wade VML 2000 water-cooled, V.twin-reciprocating compressor. This forms part of a compressor package, engineered by CompAir Broom Wade, to deliver the highly flammable biogas to dual-fuel Mirrlees engines at a steady 60 psig. Power generated by the complete installation supplies electricity at 11 kV via a dedicated line, to a local Eastern Electricity 11-33 kV substation.

Over 2 million tonnes of household and industrial waste from London and the South East are brought to the converted London Brick clay pit every year. This is restored progressively with a two-meter clay layer, enabling microorganisms to convert its organic content into useful methane for periods of 30 years or more. The Brogborough site, designed to give the highest standards of waste storage and energy recycling through gas utilization, has important, long term potential to produce power from waste. Plans have been made to increase the present 4 MW supply to 9 MW with the installation of two more compressors and additional engines.

(Source: Extracted from "Power from Waste at Europe's Largest Landfill," *Wastes Management*, May 1992, p.25.)

Carbonate Fuel Cell Demonstration Programme

A 15-year effort led by Energy Research Corporation (ERC) of Danbury, Connecticut, US, has resulted in a carbonate fuel cell demonstration plant, the development program of which is to be executed by the Santa Clara (California) Demonstration Group (SCDG) of the US. The final engineering work for a US$ 45 million demonstration of the world's first two-megawatt (MW) molten carbonate fuel cell is expected to begin in May, 1992. Soon after the completion of the final engineering work, work on the construction of the fuel cell plant itself will commence.

The completed plant, as per the schedule, will begin to generate electricity from July, 1994 whereas the next project milestone – actual delivery of a commercial fuel cell power plant – is scheduled to take place sometime in 1998. A consortium of utilities has negotiated supply and participation agreements. The Santa Clara plant will operate at 50% electrical efficiency but with the introduction of commercial units and the addition of cogeneration plant, the efficiency rating is expected to peak around 80%.

Molten carbonate fuel cells, like more common phosphoric acid fuel cells, produce electricity electrochemically. Chemical reactions within the cell produce hydrogen ions, which then pass through the molten carbonate electrolyte and combine with oxygen atoms. This process produces a small electric current at electrodes on either side of the electrolyte. As with all fuel cells, molten carbonate designs are virtually emission-free. They are also compact and quiet, making them an ideal generation option for utilities that operate in restrictive urban areas.

(Source: Extracted from "Carbonate fuel Cell Demonstration Nears" by Leonard S. Greenberger, *Public Utilities Fortnightly*, Vol. 129, No. 9, May 1, 1992, p.40.)

Hydrogen: Potential Energy Storing Medium

According to a preliminary study sponsored by the US Department of Energy and performed by the National Hydrogen Association (NHA) of the US, hydrogen can be a competitive utility fuel and energy carrier if the ongoing development efforts lead to high efficiency fuel cells that cost US$ 1,000 per kilowatt (kW) or below. The study found that hydrogen supplied for about $11 per million British thermal units (BTUs) to a high efficiency cell would generate electricity for roughly 10 cents/kW, delivery costs excluded. Although costing higher than the average cost of new, conventional base load generation (about 5.5 cents per kW), the inclusion of environmental costs of fossil fuels make the hydrogen-powered fuel cell a cheaper alternative.

Hydrogen may also solve the problem of power shortage that continues to hamper development of some renewable energy resources. With their cost reduction and technological advancement, the hydrogen fuel cells can become virtually interchangeable with electricity. Subsequently, hydrogen can be produced by electricity through electrolysis and the vice versa is possible through a fuel cell. Power produced by inconsistent renewable resources can be converted to hydrogen and stored until needed. Depleted oil fields are believed to be usable for hydrogen storage and the existing network of oil or natural gas pipelines can be used for distribution purpose.

(Source: Extracted from "Hydrogen: Solving the Energy Storage Problem" by Leonard S. Greenberger, *Public Utilities Fortnightly*, Vol. 129, No. 9, May 1, 1992, p.39.)

Long Term Energy Demand and Supply Analysis for P.R. China

(ADB Technical Assistance Project in P.R. China Updates)

The Energy Research Institute (ERI), under the State Planning Commission of P.R. China, has been conducting a major energy research project on long term energy/electricity demand and supply since July 1992, with a technical assistance grant from the Asian Development Bank (ADB)(see RERIC News, September 1992).

The Asian Institute of Technology (AIT) was contracted by ADB to provide consultancy services to the project. Prof. T. Lefèvre (team leader), Dr. R.M. Shrestha and Dr. Y. Zhai from the Energy Technology Division of AIT form the core of the consultant team with expertise on energy supply and demand modelling, energy database and energy pricing. The AIT team is strengthened by Dr. B. Chateau, Dr. B. Lapillonne and Dr. D. Finon, well known energy economists in France, and Prof. Kou Jisong as energy database specialist from Tianjin University, China.

The consultants have recommended MEDEE-S and EFOM as energy demand and supply models to be used for long term energy demand and supply analysis in China. To support these models, provincial energy databases will be set up based on the existing China National Energy Database developed by ERI and DBA-VOID developed by AIT. As an integral part of the project, various energy pricing methodologies as well as pricing experiences in foreign countries will be introduced to the ERI research team.

Asian Institute of Technology (AIT), Thailand and Lawrence Berkeley Laboratory (LBL), USA have been selected as hosting institutions for the on-the-job training of the ERI research staff. The on-the-job training at AIT permits ERI research staff to learn and to adapt selected energy planning models/databases while the training in LBL is focused on integrated resource planning and demand side management. Also within the framework of the project, two group of Chinese energy planning officials have made (in November/December 1992) technical surveys to Europe (France, Germany and Belgium) and North America (USA, Canada) in order to broaden their contacts with the international energy community and acquire experience of and information on energy planning in other countries.

ADB Approves US$ 107 M Loan for Industrial Energy Conservation Project in PRC

The Asian Development Bank (ADB) has approved a US$ 107 million loan and a technical assistance grant of US$ 600,000 to the People's Republic of China (PRC) for an industrial energy conservation and environment improvement project. The technical assistance will be financed from the Japan Special Fund. The loan will be drawn from the Bank's ordinary capital resources (OCR) and have a repayment period of 20 years, including a five-year grace period.

The Project will support the Government's program to increase energy efficiency in selected industries through financing of the implementation of energy conservation and environmental improvement measures and introduction of modern energy and environmental management systems in the energy-intensive fertilizer, cement and metallurgical industries. The Project will establish and strengthen energy and environmental management systems and facilities, modify production processes to make them more energy efficient, install energy-saving equipment, "retrofit" energy conserving equipment and facilities, improve environmental protection in production areas through recovery of usable material and elimination of hazardous substances from wastes, and provide engineering services and overseas and domestic training of managerial and technical personnel.

The Project will cover two fertilizer plants, two large-scale iron and steel industries and three cement plants, situated in different provinces of the country. Unit energy consumption will be reduced and the discharge of gaseous emissions and liquid effluents will be controlled in these plants. The technical assistance grant will assist the PRC government in managing and accelerating the implementation of its energy conservation program. The Project with a total cost of US$ 233.7 million including a local currency cost of US$ 126.7 million is expected to be completed by the end of 1995.

(Source: "ADB Approves US$ 107 Million Loan and a Technical Assistance Grant to PRC for Industrial Energy Conservation and Environment Improvement Project," *ADB News Release*, No. 150/92, September 24, 1992.)

North-South Transmission Line Commences Operation – Thailand

Thailand's new 500 kilovolt (kV) transmission line, built at a cost of US$ 214 million for the Electricity Generating Authority of Thailand (EGAT), from the North to the Central Plains, has commenced operation. The new line enables EGAT to deliver more electricity from its Mae Moh lignite-fired power station, in the North, to the Central region with high power demand concentration. The transmission line spans a distance of about 500 km from the power station in Lampang southward to Nakhon Sawan, about 250 km north of the country's capital. With two more units coming into operation, the generating capacity of Mae Moh complex has increased to 2,025 megawatts (MW).

(Source: Extracted from "North-South Line Starts," *Power in Asia*, Issue No. 112, October 19, 1992, p.12.)

Incorporating Proven Energy Conservation Measures in Solar Lab Building – USA

The National Renewable Energy Laboratory (NREL) in Colorado, USA, which will house a hotbed of experiments on solar energy but whose internal systems use proven technology, is expected to beat the national public-building energy-use guidelines by 30 per cent. NREL's $ 15.8 million Solar Energy Research Facility (SERF) will be a showcase for energy conservation. The most visible component is a stepped clerestory roof that eliminates the need for ambient artificial illumination during the day in the two 10,000 square feet, open-plan office areas with high-ceilings. Six different types of low-energy-loss glazing were selected to optimize transmission and shading coefficients. There also will be photosensitive lighting controls.

Heat recovery, however, will conserve most of the energy. In winter, cold outside air will be warmed by internal air. And direct and indirect evaporative cooling will enhance the chilled water system, limiting chiller use to the summer. The chilled water system will have a heat exchanger to precool the returning water before it gets back to the cooling tower. Although the lab will be used for demonstration of solar panels for hot water, heat and electricity, the building will rely on non-renewable fuels including energy efficient electric lighting, variable frequency drives on fans and certain pumps, and high-efficiency motors.

The laboratory incorporates the Solar Health Laboratory, the Solar Fuels Laboratory and the Solar Electric Laboratory. SERF researchers will conduct experiments in areas such as chemistry, electronics, physics, optics, lasers, photolithography and superconductivity. Though well-insulated throughout, the back wall of the building will be pushed up against an existing hill to take advantage of the earth's natural insulation. The construction work which started in June, 1992, is to be completed by October 1993.

(Source: Extracted from "Solar Lab Building No Experiment" by Nadine M. Post, *Engineering News Record (ENR)*, Vol. 229, No. 6, August 1992, p.28.)

Clearance for Offshore Power Plant – India

The Central government of India has given the clearance for a project to install a 100 megawatts (MW) offshore power plant based on Ocean Thermal Energy Conversion (OTEC) technology on Tamil Nadu's (TN) east coast with the aid of a US firm. The defence authorities have given the permission to set up the OTEC plant off Kulasekharapatnam near Tuticorin and the financial aspects have to be worked out. OTEC plants exploit the temperature difference between the warm surface sea water (28 degrees Celsius) and the cold deep sea water (five degrees Celsius) present 800-1000 meters below.

The US firm has proposed to sell the power to Tamil Nadu Electricity Board (TNEB) for 20 years. Whereas the company will, at its own cost, set up the plant, lay cables up to the shore 40 km away and install a receiving plant, the state of TN has to provide land and pay for transformer and switching stations. The cost of power from the plant is estimated to be Rs. 2.10 (US$ 0.08) per unit and if the venture proves successful, the plant capacity will be raised to 400 MW.

A 100-MW plant will take in and discharge about 14,700 cubic meters of warm sea water and 8,200 cubic meters of cold sea water every minute. The warm water is discharged at a temperature five degrees Celsius higher that at which it enters the plant. The system works on the rankine cycle. Warm sea water is evaporated by flash evaporators under vacuum and low pressure. The low pressure steam formed is passed through a steam turbine coupled with a generator. The exhaust vapour then flows into a condenser which is cooled by water pumped from the ocean.

(Extracted from "TN Offshore Power Plant Cleared," *National Herald*, India, September 11-17, 1992, p.5.)

Asia's Biggest Hydel Turbine Unit in Operation – Pakistan

Engineers of the Water and Power Development Authority (WAPDA) of Pakistan have put Asia's biggest hydel turbine unit of 432 megawatts (MW) capacity into operation at Tarbela, Pakistan. The total installed capacity of Tarbela Hydel Power Station has thus been raised to 2182 MW.

Despite the water level behind the Tarbela Dam well below 118 feet, the turbine successfully generated over 350 MW of power. The contribution of this unit especially during the summer season with high load is envisaged as invaluable. The unit, installed by WAPDA at a cost of over Rs 11 billion (approximately US$ 450 million) including a foreign exchange component equivalent to Rs 5 billion (approximately US$ 200 million), is the first of four units, each of 432 MW, to be added at Tarbela Hydel Power Station. With the other three units, expected to come into operation within a one year period, the generating capacity of the plant will reach around 3,500 MW and thus make the plant among the biggest hydel power stations in the world. This figure is likely to rise above 3,800 MW under full lake conditions. With this, the total contribution of the Tarbela plant will lie around 45 per cent of the total power in the WAPDA system.

The station has already been connected with major consumer centers through 500 kV extra high voltage lines and another 500 kV line is being extended for industrial and domestic consumers. The Tarbela hydro electric extension project is financed by the Asian Development Bank (ADB), KFW of Germany and CIDA/EDC of Canada. Besides local manpower, the workforce included people from 16 international firms from eleven countries.

(Source: Extracted from "Asia's Biggest Hydel Turbine Unit Put into Operation," *The Pakistan Times*, Thursday, 14 May, 1992, p.8.)

Training Courses/Workshops

International Training Workshops on Rural Energy and Environment

May 10 – July 2, 1993, The Netherlands

Rural areas in many developing countries are facing severe and interrelated problems of energy and the environment. Growing shortages of traditional fuels, such as wood, are often due to increased population pressure on land, biomass and other limited resources. The environmental impacts of new and intensified production processes aggravate the degradation of ecological systems. The exploitation and further development of biomass energy sources is inextricably linked with broader environmental considerations. Also, the production, transport and use of fossil and renewable energy sources raise a number of important environmental issues. Resource depletion, multiple uses of resources, and environmental pollution are often specific to local needs, local resources and local constraints. Viable solutions to sustainable development are equally specific for particular rural areas. Global concerns about the impacts of fossil fuel utilisation add to the complexity of the energy-environment nexus. The development and dissemination of energy technologies has a variety of social and environmental implications. Such technologies are to be thoroughly evaluated and selected.

Policies for rural energy and environment are to be integrated within, on the one hand, a framework for overall rural development and, on the other hand, sustainable national energy policies. Such policies need additional efforts in decentralised planning and management of local rural resources and the environment. Based on this concept, a series of workshops related to Rural Energy and Environment will be organized from May 10 to July 2, 1993. A total of eight workshops are to be run in parallel or simultaneously:

- Photovoltaic Solar Energy Applications
- Energy Technology Assessment
- Energy and Environment
- Energy Project Planning and Management
- Energy Project Formulation
- Biomass Energy Technologies
- New Approaches in Forestry
- Energy in Agriculture.

A participant can join a maximum of five workshops in sequence.

The training workshops are organized by the University of Twente in cooperation with the Netherlands Energy Research Foundation (ECN). The training workshops will include introductory lectures, exercises, case studies, discussions, demonstrations and site visits. The participants themselves will contribute by giving a presentation on their own work experience.

For details contact:

The Course Administrator
Technology and Development Group/VOK
University of Twente
P.O. Box 217
7500 AE ENSCHEDE
THE NETHERLANDS
Tel: 31-53-893539
Fax: 31-53-340822
Telex: 44200 utes nl

HYDROEQUIP '93 (International Exposition and Workshop on Medium–Small Hydropower Equipment)

June 21 – 25, 1993, Hangzhou, China

The five day exposition and workshop on medium-small hydropower equipments will be organized by Hangzhou Regional Centre (Asia Pacific) for Small Hydro Power (SHP) and co organized by:-

- The China International Centre for Economic & Technical Exchange
- China Association of Local Water Resources and Electric Power Enterprises
- China Ningbo International Economic & Technical Cooperation Corp.

Recognized as a socially and environmentally sound mature technology, medium-small hydro power is extensively adopted in rural areas of many countries and acts as a clean, convenient and cheap source of energy which helps the rural economy to flourish. The recent development of small hydro power was stimulated by the increase of the energy price, the worsening of the ecology, technical progress and equipment modernization. To further stimulate the hydro power development it is time to summarize and exchange experience of medium and small hydro technology and its equipment.

China has the largest number of SHP stations in the world and is a big market for SHP as well. Although knowledge in SHP has been accumulated through practical experience, a lot of improvements need to be introduced. The five day exposition and workshop programme, through discussions and exchange of views, aims to promote technology transfer, personnel exchange, equipment import and export for further developments in SHP.

HYDROEQUIP'93, will be conducted in two parts:

Part A) Equipment exhibition and trade talks;

Part B) International workshop on small and medium hydro equipment and technology

The range of products to be exhibited are:

- Medium-small hydropower equipment
- Grid equipment & materials
- Automation & control equipment
- Energy saving & other electromechanical products

The workshop will focus on the state-of-the-art of small and medium hydro power technology. The Exposi-

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tion & Workshop will offer a wonderful opportunity for the manufacturers of small & medium hydro power equipment to introduce their products and provide consultancy services. Meanwhile, it may help users to gain first-hand information on the selection of more suitable products.

For details contact:

Mr. Ding Huishen
Hangzhou Regional Centre for Small Hydro Power
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Workshop on Materials Science and Physics of Non–Conventional Energy Sources

August 30 – September 17, 1993, Trieste, Italy

The International Centre for Theoretical Physics (ICTP), Trieste, Italy, will conduct a Workshop on Materials Science and Physics of Non-Conventional Energy Sources, to be held from 30 August to 17 September, 1993. This Workshop is co-sponsored by the National Research Council (CNR), Italy, the Italian Commission for New Technologies, Energy and Environment (ENEA), Italy, and other institutions.

The emphasis will be on those aspects of materials science and technology which are particularly relevant to solar energy conversion and storage. Concrete projects and realizations, as well as environmental, economical and social aspects will be adequately considered. The activity will be based on plenary lectures given by an international faculty, plus seminars by visiting experts, study groups, laboratory activities and site visits. The Workshop is open to scientists from all countries of the world that are members of the United Nations, IAEA or UNESCO.

For details contact:

International Centre for Theoretical Physics
Workshop on Materials Science and Physics of Non-Conventional Energy Sources
P.O. Box 586
I - 34100 Trieste
ITALY

Training Course on Micro Hydro Power

September 13 – October 8, 1993, Pokhara, Nepal

Intermediate Technology Development Group (ITDG) will hold a 26 days training course on Micro Hydro Power in the Himalayan country of Nepal from September 13 to October 8, 1993. This is in line with ITDG's efforts to assemble the skills and knowledge acquired by micro-hydro practitioners in Nepal and to share this knowledge with engineers in other parts of the world as well as in Nepal.

Micro-hydro has proven to be a cost effective and reliable source of energy and there has been a growing interest in its technology. But, micro hydro-electric schemes require a substantially different approach than the large hydro-electric schemes in all aspects – from ownership and management to site survey, design, installation and maintenance. Drawing on its expertise at village level and small industrial hydros built up over a dozen years in six countries, ITDG has held a number of similar training courses to emphasize these differences.

The forthcoming training course will include lectures, discussions, practical design exercises, field visits to micro-hydro installations and in-depth training on a topic of the participant's choice. The participants will have the opportunity to select a site and undertake a full design study, and can exchange experiences with participants from other countries.

The course is useful for engineers, technicians and funders from all countries on the design, planning, implementation, component manufacture, and operation and maintenance and the ownership and management of hydro schemes from 0.5 kW – 300 kW.

For details contact:

Co-ordinator
Micro Hydro International Course
Intermediate Technology Development Group
P.O. Box 2325
Kathmandu, NEPAL
Tel: 977-1-220572

or

Co Co-ordinator
Micro Hydro International Course
Intermediate Technology Development Group
33 1/1, Queen's Road
Colombo 3, SRI LANKA
Tel: 941-586504
Fax: 941-502850
Telex: 21579 BIMBO CE

International Training Course on Renewable Energy Sources

September 1 – October 15, 1993, Chengdu, China

The International Training Course on Renewable Energy Sources will be jointly organized by Chengdu Xingguang Development Corporation for Appropriate Science and Technology (DCAST) and Chengdu Biogas Research and Design Institute (BRDI). Study tours, workshops, and classroom lectures together will form the course which will have the following contents:

i) Scientific Principles of Renewable Energy Sources;
ii) Technical Feasibility of Renewable Energy Systems;
iii) Biogas Technology;
iv) Solar Energy; and
v) Rural Micro-Hydropower.

The technical study tour will include visits to rural and urban biogas plants of various sizes, solar energy projects in rural areas and rural micro hydropower stations.

For details contact:

Mr. Song Yuhua
Director of DCAST
No. 17, Yulin East St., People South Road
Chengdu 610041
Sichuan, P.R. CHINA
Tel: 551659
Fax: 581849
Telex: 60109 JJH CN

Book Review

"Asian Energy News"

Asian Energy News is a monthly press review on Asian energy and energy related economic and environmental issues. Stellar economic growth in Asia during the past decade has not only imparted huge benefits to the energy sector but has resulted in complicated problems like pollution, over-population and others. Thus, with the aim to provide readers with a comprehensive picture of the region's energy sector, the newsletter takes up relevant issues from both supply and demand standpoints. The first issue of the newsletter, a publication of the Energy Technology Division of the Asian Institute of Technology (AIT), was released in August 1991.

Published in collaboration with organizations like ASEAN-EC Energy Management Training and Research Centre (AEEMTRC), Jakarta, Indonesia; Depth News Asia, Philippines; ENERDATA s.a, France and IEPE, Grenoble, France. The financial support for the press review comes from the Ministry of Foreign Affairs, France, and Agence de l'Environment et de la Maitrice de l'Energy (ADEME), Paris, France.

Information from abundant local and international sources is garnered, selected, compiled and analysed. Information agencies in many Asian countries provide the clipping services. The publication section of this newsletter welcomes publication exchange programs with all interested energy sector organizations worldwide. Researchers, energy sector industrialists, government officials, and consulting engineers are targeted to form the user group of this publication.

For details write to:

Asian Energy News
Energy Technology Division
Asian Institute of Technology
P.O. Box 2754
Bangkok 10501
Thailand
Fax: (66-2) 524 54 41

The Yearbook of Renewable Energies 1992

EUROSOLAR Publications
P.O. Box 12 06 18
D-5300 Bonn, Germany
ISBN 3-920328-04-3, 1992, 269 p.

The energy sources presently in use are the main cause of the much debated global environmental threat. Questions related to the environment, agriculture, industrial production, transport, health, social welfare, development aid and other sections of our present society (which has almost reduced itself to merely thinking and acting according to the division of labour) are not merely incidental questions but serious political – and economic – energy questions, affecting international politics and the community and regional structures to an extent which is widely underestimated. The questions of power or dependence, wealth or poverty, privileges or equality, the ruin or survival of human society have always been decided by the availability of energy. Under such circumstances, the renewable sources of energy, available worldwide, can assume a vital role in warding off the misconsequences of energy unavailability. This yearbook reviews the status of various renewable energy (RE) sources available worldwide and puts forward a comprehensive scenario of the possible contributions and economics of RE.

Section I reviews various analytical studies on RE sources. Strategies for solar power development, solar power potential, activities related to nuclear power, hydropower, biomass, all with special emphasis on the European perspective are also outlined. Section II discusses the developments made in the field of RE. Progress achieved in this field in Switzerland, China, Japan, Denmark, French Polynesia, European Community (EC) is presented. Present status and policy matters including formation of RE networks is taken up. RE technologies in Africa and the progress of soft technologies to the market place are also dealt with.

Section III deals with issues of economics – economic prospects, payback time, environmental costs related to RE sources. Solar energy is given particular emphasis and solar photovoltaics (PV) is extensively discussed. Environmental degradation and possible solutions through solar energy applications and afforestation are important topics covered. Section IV is devoted to boosting up the use of RE sources and various incentive plans are presented. Formation of networks of research centers, United Nations (UN) involvement and solutions for an environmentally sustainable world are put forward. At the end, reports on some of the RE conferences held in the year 1991 are included.

Petroleum Energy and Environment

by Rashid Ahmed
Director, Third World Resource, Energy and Environment Centre (TWREEC)
Sialkot, Pakistan
1992, xxiii + 430 p.

At the present time, the human race, petroleum, and environment are closely interlinked and either of these three, if poorly safeguarded, will be negatively effected by the others. Impoverished nations are confronted with bitter realities in the petroleum sector caused by both internal and external factors. These include an accelerated global energy race, marginal production and exports, lack of requisite resources and experience, difficult indigenous reserves, absence of effective national policy and others. As a consequence petroleum energy has ultimately become a subject of political danger, environmental animosity, and economic pride worldwide.

This book on petroleum energy and the environment tries to offer reasonable help in alleviating the global petroleum plight through:

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- Greater rapport among Oil and Petroleum Exporting Countries (OPEC), independent exporters, industrialized importers and full-blown consumer nations.
- Less victimization of poor countries by aggressive petro-politics.
- Understanding the true significance of national needs and potentials.
- Reconsideration of investment priorities, programs, and action plans.
- Evolution and reinforcement of indigenous know-how and a dependable national workforce.
- Right acquisition, implementation, and upkeep of state-of-the-art engineering and technology.
- Effective resource and environment management without sacrificing one at the expense of the other.

Chapter 1 introduces the potential, prospects and problems of the petroleum energy industry and reviews major alternatives to petroleum like coal, nuclear power and hydro-power. Chapter 2 discusses the organizations involved and the economic, environmental and technological facts of the industry. Chapter 3 and 4 stresses the role of governments in curbing petroleum associated problems, forming favourable strategies and policy amelioration steps. Chapter 5 points out at the technological weaknesses and suggests solutions to overcome them. Chapter 6 stresses the need to strengthen the petroleum industry and reorganize its structure.

The next four chapters discuss the value of petroleum assets and issues related to its exploration, processing, financing and safety measures. Chapter 11 explains facts about environmental degradation from petroleum related activities and ways to curb the ill-effects. Global warming, breakdown of the ozone layer, acid rain are, to name a few, some of the negative contributions of the petroleum industry. The last chapter throws light on the engineering and management aspects of the petroleum industry.

Global Environment Protection Strategy through Thermal Engineering

Keizo Hatta and Jasvo Mori, Editors
Hemisphere Publishing Corporation
Taylor & Francis Ltd
Rankine Road, Basignstoke, Hants.
RG24 OPR, United Kingdom
ISBN 1-56032-146-6, 1992, viii+345 p.

Global environmental problems such as the increase in carbon dioxide concentration in the atmosphere, the destruction of the ozone layer by chloro-fluorocarbons (CFC) and other gases, acid rain and desertification have been a matter of global concern for the past few years. Counter measures proposed earlier for these problems have not been concrete and a wide gap between discussions and actual deterioration of the global environment may exist. These problems are expected to become more serious in the coming years and hence should be discussed on a global scale. A research subcommittee entitled "Energy Consumption and Thermal Engineering Study of Global Environmental Problems" was established by the Japan Society of Mechanical Engineers (JSME) to study the relationship between the global environment and thermal engineering and to propose possible countermeasures to the global problem. This book is a compilation of the subcommittee's final report on the issues and measures for such a global problem.

The second chapter of this book deals with the present and future situation of energy demand and supply with the emphasis on electric power. Chapter 3 based on the observed data and results of a geophysical calculation, concretely explains the problems of global warming by carbon dioxide, methane etc. and ozone layer destruction by CFCs. Chapters 4 and 5 discuss measures to protect the atmosphere when hydrocarbon fuel is burned. Chapter 6 explains in detail the international restrictions on CFC use, decomposition of CFC for acceptable utilization and new alternative materials. Carbon dioxide which is closely connected with life on the entire planet, is also dealt with. Chapter 7 focusses on the problem of acid rain and the production of harmful NO during combustion.

Many alternative energies have been studied for practical availability not only from the energy development perspective but also from environmental protection point of view. Chapter 8 presents the current status of such alternative energy technologies. High temperature, gas-cooled nuclear reactor (HTGR), the only energy system which produces electricity and produces hydrogen with least environmental problems has been discussed in detail in Chapter 9. In Chapter 10, energy conservation technologies associated with large power plants and newly developed technologies for plants and equipment of middle and small scales are discussed, particularly emphasizing several kinds of recently designed heat pumps. Chapter 11 describes the various types of energy concerning small equipments for domestic and commercial use along with their performances. Thus the last two chapters focus on energy effectiveness in relation to environmental protection.

Publications Received

BIOMASS ENERGY

* *Biotechnologies for Pollution Control and Energy* (Proceedings of the Third Workshop on the Working Group on Biogas Production Technologies, Braunschweig, Germany, May 5-7, 1992), edited by W. Baader, REUR Technical Series 21, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy, 1992, 544 p.

* *Charcoal Production and Pyrolysis Technologies*, edited by Per Thoresen, REUR Technical Series 20, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy, 1991, 179 p.

Diary of Events

- **September 1 – 4, 1992, Calgary, AB, Canada**

2nd International Conference on Environmental Issues and Management of Waste in Energy and Mineral Production

For details contact:

Margaret-Anne Stroh
Conference Office
The University of Calgary
2500 University Drive NW
Calgary, Alberta T2N 1N4
Canada
Tel: +1 403 220 6229
Fax: +1 403 284 5696

- **September 15 – 17, 1992, Maastricht, The Netherlands**

Energy Economy 1992

For details contact:

RAI Gebouw bv
Europaplein
1978 GZ Amsterdam
The Netherlands
Tel: +31 20 549 1212
Fax: +31 20 646 4469

- **September 21 – 23, 1992, Leeds, United Kingdom**

Incineration and Energy from Waste

For details contact:

Mrs. Dianne Taylor
Department of Fuel and Energy
University of Leeds
Leeds LS2 9JT
United Kingdom

- **September 23 – 24, 1992, Singapore**

ASEAN Conference on Social and Economic Growth through Development in Energy Technology

For details contact:

SCNCER Information Officer
ASEAN Subcommittee on Non-conventional Energy Research
P.O. Box 51, Ratburana
Bangkok 10140
Thailand
Fax: +66 2 4278077

- **September 23 – 25, 1992, Cambridge, MA, USA**

Application of Fluidized–Bed Combustion for Power Generation Utility Conference

For details contact:

Linda Nelson
Conference Coordinator
Electric Power Research Institute
3412, Hillview Avenue
Palo Alto, CA 94303
USA
Tel: (415) 855-2127
Fax: (415) 855-2041

- **October 1 – 2, 1992, Hamilton, ON, Canada**

Energy Technology Options for the Twenty–first Century

For details contact:

McMaster Institute for Energy Studies
McMaster University
Hamilton, ON L8S 4M4
Canada
Tel: (416) 525-9140 Ext. 4527
Fax: (416) 521-8232

- **October 4 – 6, 1992, Calgary, AB, Canada**

11th CERI International Oil and Gas Markets Conference

For further information contact:

CERI Conference Division
3512-33 Street N.W.
Calgary, AB, T2L 2A6
Canada
Tel: (403) 282-1231
Fax: (403) 284-4181

- **October 5 – November 6, 1992, Enschede, The Netherlands**

Training Course on Energy Management in Small and Medium Scale Industries

For details contact:

Course Administrator
VOK/WB T505
University of Twente
P.O. Box 217
7500 AE ENSCHEDE
The Netherlands
Tel: 31-53-893539
Fax: 31-53-340822

- **October 6 – 8, 1992, Philadelphia, PA, USA**

4th Annual Eastern Regional Solid Waste Symposium

For details contact:

SWANA
P.O. Box 7219
Silver Spring, MD 20910, USA
Tel: (301) 585-2898
Fax: (301) 585-0297

- **October 6 – 9, 1992, St. Louis, MO, USA**

Bio Based Products Expo'92

For details contact:

Expo'92
c/o St. Louis Scene, Inc.
10601 Baur Blvd.
St. Louis, MO 63132, USA
Tel: (314) 569-0333
Fax: (314) 569-0249

- **October 15 – 16, 1992, Toronto, ON, Canada**

Global Energy Education

For details contact:

Lina Price
Ontario Ministry of Energy
56 Wellesley St. W.
Toronto, ON M7A 2B7
Cananda
Tel: (416) 327-1486
Fax: (416) 327-1514

- **October 15 – 21, 1992, Charlottesville, VA, USA**

5th Annual Bioprocess Technology Seminars

For details contact:

Raj Manchanda
The American Society of Mechanical Engineers
345 East 47th Street
MS 5A, New York
NY 10017-2392, USA
Tel: 212 705 7722
Fax: 212 705 7674

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Diary of Events

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- **October 19 – 21, 1992, Atlanta, GA, USA**

INFORUM : International Joint Power Generation Conference & Exposition

For details contact:
Ms. Kathleen M. Kane
American Society of Mechanical Engineers
345 East 47th Street
New York, NY-10017-2392
USA
Tel: (+1) 212 705 77 22
Fax: (+1) 212 705 76 74

- **October 19 – 22, 1992, Athens, Greece**

Energy Efficiency in Process Technology

For details contact:
Dr. P.A. Pilavachi
Commission of the European Communities
DG XII – SDME 3/34
Rue de la Loi
200, B-1049, Brussels
Belgium
Tel: +32 2 2353667
Fax: +32 2 2363024

- **October 22 – 23, 1992, Herning, Denmark**

Collective Biogas Plants: European Experience in Combined Manure and Waste Processing

For details contact:
Renewable Energy Information Centre
Danish Technological Institute
P.O. Box 141
DK-2630 Taastrup, Denmark
Tel: (45) 42 99 6065
Fax: (45) 42 99 4744

- **October 27 – 30, 1992, Derby, United Kingdom**

International Conference on Landfill Gas

For details contact:
Ms. Carol Johnstone
ETSU, Building 149
Harwell Laboratory
Oxon, OX11 ORA
United Kingdom
Tel: 0235 432383

- **October 28 – 30, 1992, Atlanta, GA, USA**

1992 World Environmental Engineering Congress

For details contact:
Ted Kurklis
WEEC
P.O. Box 1026 Lilburn
GA 30226
USA
Tel: (404) 925-9648
Fax: (404) 381-9865

- **November 1 – 6, 1992, Miami Beach, FL, USA**

Biotechnology for Fuels, Chemicals and Materials

For details contact:
Dr. C Wyman NREL
1617 Cole Blvd. Golden
CO 80401-3393
USA
Tel: (303) 231-1753
Fax: (303) 278-3692

- **September 8 – 10, 1993, Bangkok, Thailand**

Workshop on Global Warming Issues in Asia

Tentative agenda:

(1) Evidence of global warming, sources and sinks of greenhouse gases, climate modelling, and prediction.

(2) The potential impacts of global warming on agriculture, water supply, sea water level, etc.

(3) Control measures to alleviate global warming, e.g. renewable energy, energy conservation and efficiency, fuel switching, reforestation/afforestation etc.

(4) Policy options to alleviate global warming and their implications.

Deadline for submission of the abstracts: March 31, 1993.

For details contact:
Dr. S.C. Bhattacharya
Energy Technology Division
Asian Institute of Technology
GPO Box 2754
Bangkok 10501
THAILAND
Tel. (66-2) 524-5403
Fax. (66-2) 516-2126

- **December 13 – 15, 1993, Hong Kong**

Third Asia Pacific Symposium on Wind Engineering

For details contact:
Secretary, APSOWE III
Dept. of Civil & Structural Engineering
University of Hong Kong
Pokfulam Road
Hong Kong

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Library and Regional Documentation Center, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The "RERIC News" is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership along with the other four regular publications namely: RERIC International Energy Journal (formerly: Renewable Energy Review Journal); RERIC Holdings List; Abstracts of AIT Reports and Publications on Energy; and RERIC Membership Directory. For further details contact:

Regional Energy Resources Information Center
Asian Institute of Technology
G.P.O. Box 2754
Bangkok 10501, Thailand
Telex: 84276 TH
Tel: 5245866
Fax (66-2) 5245870

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SMALL SCALE WIND ENERGY SYSTEMS

Published with financial support from the Netherlands Minister for Development Cooperation
Editors: Goezinne & Veldkamp, Renewable Energy Consultants

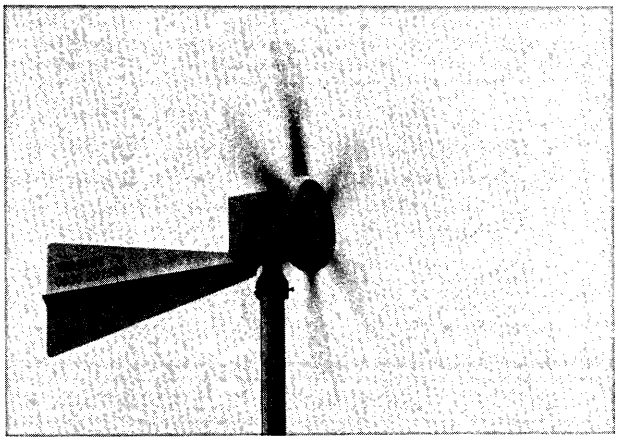
EDITORIAL

Every technology knows its success stories. For small wind generators the 'Mongolia case' is such a story. In Mongolia small wind generators have become very popular in the recent years; first they were imported, but now they are manufactured locally. Two of our regular contributors report on the Mongolia case: one of them has actually been 'on the spot'. Furthermore there is an article from Marlec, the company involved.

If you are out there in the field and have wind energy plans but not too much information, beware of doing things that have already been done by others (especially making mistakes). Writing to a wind energy information centre before starting a wind energy project may help to avoid double work and errors. In this issue there is an article on such a centre.

Frank Goezinne/G&V

MARLEC – EXPANDING IN A RECESSION



England has become the scene for expansion in large scale generation of electricity by wind energy. The recent changes in the structure of the UK power supply industry have meant that many consortiums are going to install large wind turbines in the next year or so.

With all the excitement generated by large turbines it is easy to forget that one of the most successful European manufacturers of wind turbines, one that has been growing steadily for years, produces small wind generators. Marlec has been producing 50 W (rated) wind turbines for years and has sold thousands. They have been used in diverse locations from Cornwall (South of England) to Mongolia. Nomadic Mongols pack them onto their horses and carry them hundreds of miles, then set them up to power their portable television. British campers pack them into the boot of theirs cars to produce power in their holidays tents.

The success of Marlec can be seen in the strong foundation laid by the enthusiast John Fawkes. Unlike many others innovators, the Marlec system started with a purpose built generator, and the rest of the design (rotor, tower, housings, control box) flowed from that point. Indeed only in the last few months has Marlec updated its blades to be more effective in its aerodynamics and to give an even better overall performance. Originally they were copies of a standard fan on a motor vehicle radiator! Although the old blades proved reliable and functional for many years, the company has made the change to make the wind turbine more cost effective.

Simon Batchelor/Gamos

MONGOLIA HOLDS GOOD PROSPECTS FOR SMALL WIND TURBINES

In the southern part of Mongolia, the Gobi Desert, more than 60% of the population are nomadic, moving around with their tents, following the migrating livestock. There is an increasing demand for electricity to power light, televisions sets, radios etc., but no access to the national coal fired grid or the small local diesel powered grids.

The wind resources in the Gobi are favourable for small wind generators with annual average wind speeds of 5-6 m/s. So far a small number of Chinese windchargers has been imported. Local manufacturing of 50 W wind battery chargers has recently been initiated in a joint venture agreement between the MPR and the British company Marlec. The joint venture, called Monmar, was established as part of a UNDP supported project, that has now ended. So far Monmar has manufactured and sold 250 sets, including windcharger, regulator and battery. The systems are easily moved and installed.

The power demand in the Gobi is however rapidly increasing, and plans are under way to design and manufacture larger wind generators. Monmar

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JOINT VENTURE: UK AND MONGOLIA

The first joint venture between the Mongolian People's Republic (MPR) and a western nation resulted from their Government's promise to provide a power source for the majority of their cattle breeding population. These cattle breeders live a nomadic lifestyle in and around the Gobi Desert and the Steppes where temperatures are extreme and communications poor.

The United Nations stepped in with a recommendation that a small portable wind generator could supply sufficient power for lighting and radio and it was the Rutland Windcharger, designed by a British engineer, Mr John Fawkes, that was proposed. The unit was rated to charge 4 amps in to a 12 volt deep cycle battery at a wind speed of 10 m/s but most importantly to start charging at a low speed of just 2 m/s. This could amply supply 4-5 hours of evening light for reading and radio listening per day, enhancing family life for the typical nomad.

In 1983 the UN arranged and funded an initial 30 wind generator systems that would be trialled for 5 years before the project progressed to a further stage. After successful trials local assembly was a natural progression but as Marlec, the original manufacturer of the Rutland Windcharger, began more direct communications it was clear that language, particulary of the technical nature, would be an obstacle requiring great personal effort of the parties involved. There was no shortage of enthusiasm on the part of MPR's representatives, the Chief Engineer, Mr Jamtsai, was rapidly increasing his knowledge of the English language and actively encouraging his colleagues in the same direction.

At around the time that democratic rule began to open up in some eastern nations the MPR and UN requested a transfer of technology from Marlec in the form of a joint venture. This was greeted as a major forward move and an excellent opportunity to provide engineering expertise, training and local employment in the capital, Ulan Bator. This would break new ground in the MPR and also in Marlec who hosted a number of Mongolian trainees at their factory in Corby, UK.

The Rutland Windcharger utilises a special frictionless generator, allowing the windcharger to commence charging of batteries at very low wind speeds (5 mph). The generator comprises of a disc type encapsulated winding coil with a fixed shaft and two rotating moulded permanent magnets at either side of the coil. The whole unit is designed to be mounted on a 2" water pipe and also incorporates a slipring/brush assembly, enabling the generator to rotate through 360° to face winds from any direction. The control box also contains a control choke linked to a thermostat which protects the unit from overheating in prolonged gale force winds.

Although this was demonstrated to the first Mongolian trainees, it was only necessary to learn the generator final assembly on this first visit in 1988. Magnet moulding and coil winding were considered too complex at this stage and time was concentrated on teaching yaw bearing assembly, the axis where the whole unit pivots on its mounting pole. Other training work included rectifier, control choke and yaw brush contact assembly.

Before 100 units had been exported in components and assembled the MPR Government requested from UNDP that full manufacturing facilities be established in Ulan Bator. Mr. Fawkes, Marlec's managing director, expressed reservations to the MPR that insufficient experience had been gained both by the assembly workers and the managers of operating this type of industry. Previous visits to the MPR had shown that little was understood about the need for regular maintenance programmes and he was concerned that the specialist tools and jigs necessary would not be operated and maintained at an efficient level. The cultural gap between a western nation and one shrouded in communism for 50 years was evident.

Negotiations continued between Derek Lovejoy of the UN, John Fawkes and Jamtsai and it was agreed that whilst under the guidance and assistance of the UN the project would proceed to investment in the capital equipment required to manufacture the major components of the Rutland Windcharger whilst continuing to import less costly items that were less easily sourced in Mongolia. Various tools for moulding and aluminium castings, injection moulding equipment, magnetising, balancing, generator testing and also a small foundry unit was agreed upon and installed at the factory in Mongolia.

Training was once again undertaken at the Corby factory but on this occasion the intricacies of coil winding, encapsulation moulding and the very latest in static balancing were taught.

The UN involvement has ceased this year and in preparation of that Marlec has established a privately operating company, Monmar Ltd, with members of the MPR whose currency is not yet convertible. The solution to this was simple, Marlec now exports wind generator components and imports Mongolian sheep's wool used in quality carpet manufacture.

Teresa Auciello, Sales director
Marlec Eng Co Ltd
Unit K Cavendish Courtyard
Sallow Road, Corby
Northants., NN17 1DZ, United Kingdom

MONGOLIA HOLDS GOOD PROSPECTS FOR SMALL WIND TURBINES

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plans to manufacture 200-250 W units, that still will be portable. A market for 2-20 kW stationary units is expected to develop during the next years to cater for the increasing number of small permanent settlements, agro-processing units and radio/TV relay stations in the Gobi desert. The Danish International Development Agency, DANIDA, is at the moment considering to provide institutional strengthening to the Ministry of Energy in the field of wind mapping, wind turbines connected to local diesel grids and stand alone turbines for remote applications.

Rene Karottki/Folkecenter

TOOL/WOT ENQUIRY SERVICE ON WIND ENERGY

Background

The enquiry service on wind energy of TOOL/WOT was established in 1990. TOOL (Transfer of Technology for Development) and WOT (Working Group on Development Techniques) are Dutch organisations focusing on technology transfer. These organisations joined forces to create a specialised enquiry service on wind energy, to continue the work of the Dutch wind energy consultancy group CWD, that expired in July 1990.

The enquiry service of TOOL/WOT is free of charge and relies on a network of some 40 graduate students at Twente University, and is supported by various professional experts. The service is financed by Twente University.

The Enquiry Service on Wind Energy

The TOOL/WOT enquiry service on wind energy concentrates on windpumps and small wind generators, e.g. for battery charging. With respect to medium and large wind turbines, clients are referred to other institutions and manufacturers.

The different tasks within this enquiry service have been divided between TOOL and WOT as follows. The TOOL Reference Centre provides general information on wind energy and the TOOL Bookshop distributes publications on wind energy, including publications of the former CWD. The Wind Energy Group of WOT runs the question-answer service, supported by a TOOL wind energy expert.

In 1991 some 70 questions on wind energy have been handled. During the first half of 1992 up to 50 questions have been answered (note: very short or general questions have not been included). Questions are being received from a variety of groups and individuals, for example universities, development workers, small enterprises, NGOs and end-users. At the moment questions are usually answered within 2 months. If available, references on local institutions, projects and manufacturers in the field of wind energy are included in the answers.

WOT maintains an automated documentation centre, specialising on small scale applications of solar and wind energy. Literature on other renewable energy systems will be added in the near future. The documentation centre also has available an extensive selection of CWD-research material and publications.

Future Policy

Next year's challenge will be to extend the international contacts with organisations in the field of small scale wind energy systems. It is our aim to collect data on expertise and projects in as many countries as possible, so more references to regionally available experience can be included in our answers.

Addresses

For more information please contact the TOOL Reference Centre or WOT. Note that the quality of an answer mainly depends on the information supplied by the client. It is highly recommended to add as much relevant details as possible.

TOOL Reference Centre
Sarphatistraat 650
1018 AV Amsterdam
The Netherlands
Phone:+31 20 626 44 09
Fax: +31 20 627 74 89

WOT, Twente University
P.O. Box 217
7500 AE Enschede
The Netherlands
Phone: +31 53 89 28 45
Fax: +31 53 35 70 42

Jaap de Winter/TOOL-WOT

INTERNATIONAL STANDARD FOR SMALL WIND TURBINES

One of the earliest commercial applications of modern wind energy technology was the generation of electric power with small stand-alone wind turbines. Before 1950 thousands of these machines were in operation in farms and homesteads; however the widespread implementation and further improvement of this technology has been seriously delayed for a few decades by fossil fuel power generation and the arrival of the grid in rural areas. As a consequence of increased concern for the environment and increasing fuel prices wind energy has made a come back since the late 70s. Today a wind energy capacity of more than 2,000 MW has been installed worldwide; the corresponding number of wind turbines is larger than 20,000. The installed number of small wind turbines however is substantially larger. Exact figures are difficult to obtain but it is estimated that at least 150,000 machines are in operation. The market is growing but relies on a number of small manufacturers who have limited possibilities for research and product development.

The verification and certification of small machines according to adequate standards would contribute to safety and quality, and consequently to life and cost effectiveness. Standardization and certification would allow for objective product comparison, improving the confidence of users and resulting in higher sales volumes; inferior products would disappear from the market.

This standardization is now under way on an international level. Within the International Electrotechnical Commission (IEC) a technical committee TC88 was established in 1988 with the objective to develop standards for wind turbines. First the committee concentrated on grid connected machines and stand-alone systems larger than 40 m^2 rotor swept area. Later on a working group (IEC-TC88-WG4) was established to prepare a standard for stand-alone machines smaller than 40 m^2. Members of the working group are manufacturers of small wind turbines and researchers from Canada, China, Europe, Japan and the USA. The convener of the working group is Mr Frans van Hulle of ECN (Netherlands).

The standard will specify requirements for the safety of small wind turbines including design methods, manufacture, installation, maintenance and operation under specified external conditions. A working group draft will be ready at the end of 1992. After going through the lengthy formal IEC-procedures, the standard will be ready not before spring 1994.

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FAST PUMPS FOR FAST WINDPUMPS

There has been a strong debate within the windpump industry for many years about the merit of fast running windpumps. Advocates of low solidity wind rotors often argue strongly the benefits of improved aerodynamics and the lightness of rotors leading to economies of production. Those presenting the case for slow rotors often point to the pump as the 'boss' of the system. The reciprocating pump, they say, does not like to go 'fast' (defining 'fast' very much depends on momentum, changes in accelerations and other characteristics of the specific pump). They point to shock forces, resonances, the wide range of running speeds and pressure waves as reasons why one should not connect a piston pump to a 'fast' windpump.

Dr John Burton (University of Reading, UK) has effectively cut across the debate with a simple observation. He points out that small windpumps (less than 3 m diameter) run 'fast' even if you don't want them to. Even high solidity small rotors (80%+) run at over 100 rpm. So regardless of the 'rotor solidity' debate there is a need for further research on coupling piston pumps to 'fast' running rotors.

That is why the Universidad de Los Andes (Colombia), the Technical University of Eindhoven (Netherlands) and the University of Reading (UK) have joined forces for just such a study. Colombia is known in the windpump industry for the Gaviotas, a small diameter windpump, that has become very popular in the rural areas. Made in its thousands, it is designed for domestic supplies and small irrigation, and has found a willing market within Colombia. An improved 'fast' pump would benefit the small diameter windpumps already in production in Colombia and stimulate renewed interest in a number of other countries. The research will be divided between the different institutes, with design, laboratory testing and field testing all forming part of the process. The research is being funded by the EEC.

Simon Batchelor/Gamos

THE RIO CONFERENCE AND SMALL WIND TURBINES

Most interest for wind power at the Rio conference was for small plants for single households and local communities off the national or regional electricity grids.

Brasilia has many potential national sources of energy to be utilized for electricity, e.g. water power and dry biological material waste from production of ethanol. However, the potential wind resources are also great, especially in the north west region of the big country, the average wind speed is up to 8 m/s. The market demand concentrates on stand alone wind turbines in the range of 5 kW to 20 kW. Also hybrid plants operating in parallel with a diesel generator are demanded.

The wind power industry has until now been much influenced by the Californian market with unlimited sites for big wind farms using the biggest available types, so small scale turbines is a new challenge for the industry. The technique for 5 to 20 kW stand alone and hybrid system plants is available and has been tested successfully on prototypes. Within a short time the small turbines might be available in series in Brazil and on the world market.

Preben Maegaard/Folkecenter

STRUCTURAL ANALYSIS RESEARCH IN THE UK

A research project to predict and measure the forces involved in an operating windpump has been accepted and funded by the British Government through the SERC system. Starting this academic year and proposed by joint application from Dr Neil Bishop and Dr John Burton, the research will look at the dynamics and structural analysis of windpumps. Dr Bishop's team already has some simple finite element models of a windpump resulting from a contract to evaluate the CWD machines last year. The research programme will develop these models to consider the problem in more detail. The output model should generate the frequencies at which one might expect damaging harmonics. The research team will then validate its model by instrumenting and measuring an actual windpump.

The problems involved in this research are not to be underestimated. In 1984, IT Power, under the Windpump Completion contract from the British ODA, measured the forces and resonances of a 7.2 m diameter built in Kenya. Although useful and exciting results were obtained, the difficulties in instrumentation still send chills down the spines of those involved. Instrumenting the rotor requires an innovative slip ring arrangement and it is likely that a by-product of the Bishop/Burton work will be novel experimental techniques that might be useful to future programmes.

Dr Burton's team will look more closely at the pump end, and develop models to predict the shock forces being sent up the tower. The end result of the research should be some ideas on dampening the shock forces. At last year's EWEC conference, Dr Bishop spoke up about the need to cope with and design for shock forces in windpumps: 'If the shock absorbers were removed from a car before driving it down the bumpy road, it would not be surprising to have a structural failure within a few miles'. The combined team already has some ideas on changing the stiffness of components to act as shock absorbers, and there are strong possibilities that alternatives to an air chamber may arise from their work. Many in the industry will watch their work with great interest.

Simon Batchelor/Gamos

Citation is encouraged on the condition that the source is indicated.
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First Solar Thermal Power Plant in Asia

An experimental 50 kW solar thermal power generation system has been designed, developed and installed at the Solar Energy Centre of the Ministry of Non-Conventional Energy Sources, New Delhi, India. The system is being operated and monitored by a research team of the Solar Energy Centre. Experience and data gained from the operation of this thermal power plant will be advantageous for developing a bigger unit. Theoretical studies on sub-systems of solar thermal power generation systems using line focussing collector technology have also been taken up at the Centre with a view to optimizing the plant configuration for Indian conditions.

The Solar Energy Centre has been established by the Ministry of Non-Conventional Energy Sources, Government of India, to serve as an effective interface between the Government, R&D institutions, industry and user organisations for the balanced development and utilization of solar energy in the country.

Fig. 1. Solar thermal power plant.

Fig. 2. Solar passive building.

The Solar Energy Centre is located at Gwal Pahari village in Gurgaon district of Haryana State, bordering Delhi. The 200 acre campus is situated on a hilly terrain of the Aravallis. The buildings of the Centre have been designed and constructed using solar passive concepts. It is about 35 km from the offices of the

Cont. P. 2

INNERTAP

Incorporates news from the Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

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Supplement: Small Scale Wind Energy Systems

First Solar Thermal Power Plant in Asia

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Ministry of Non-Conventional Energy Sources in C.G.O. Complex, New Delhi.

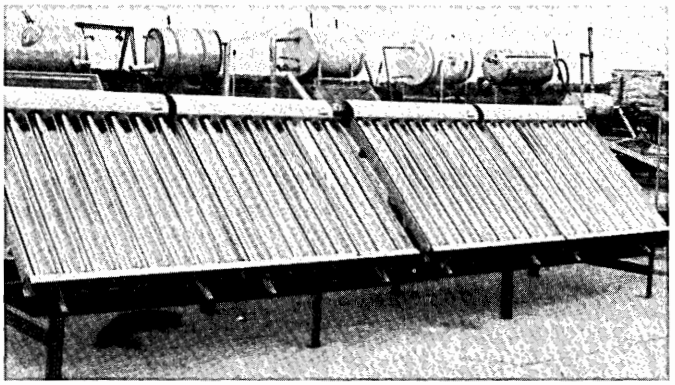

Fig. 3. Testing of solar water heating systems at Gwal Pahari.

The Centre has mainly been active in the areas of solar materials and low and medium temperature heat applications; preparation of specifications and test procedures for the standards on solar collectors and cookers; solar passive architecture and greenhouses; establishment of a 50 kW solar thermal power plant on the campus; and manpower development. A state-of-the-art Solar Simulator for indoor and outdoor testing of solar collectors and a Photovoltaic Test Facility are being added to the Centre. It is intended to be an International Centre for solar energy activities. The Solar Energy Centre has been designated as the focal point and will serve as the Secretariat for coordination of the G-15 project on solar energy applications.

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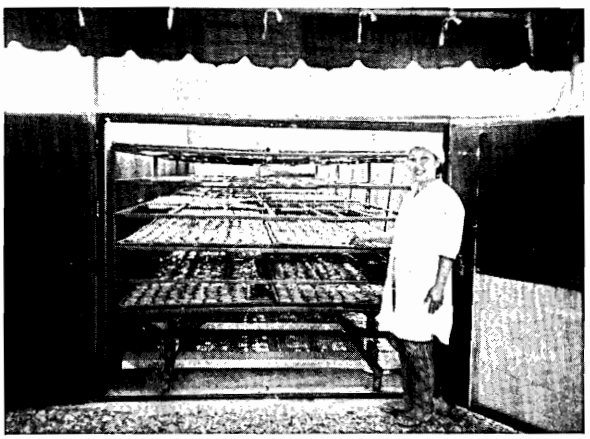
ASEAN–Canada Project on Solar Drying

The Canadian International Development Agency (CIDA), is sponsoring the "ASEAN-Canada Project on Solar Energy in Drying Processes", which commenced from April, 1992, and will have a duration of four years. The objectives of the project are to demonstrate the application of solar energy in drying processes (primarily agricultural and industrial), and to disseminate information about the application of appropriate solar energy technology throughout the ASEAN region, with the aim of commercializing efficient and economic solar systems. The project will be jointly managed and implemented by a Canadian Executing Agency (CEA) which will initiate Canadian technical assistance by providing expertise, experience and information transferring activities. The participating nations are Indonesia, Malaysia, Philippines, Singapore and Thailand and all countries will have two projects each. Each country will have a project leader and the projects guided by a "National Project Office" and overseen by the "ASEAN Project Office".

The traditional sun dried process.

In Thailand, Buriram and Phitsanulok have been selected as project sites. The solar dryer to be constructed at Phitsanulok will comprise of 200 m² of collector area and will have a capacity to dry 1,000 kilograms of fresh bananas per batch. Although an established banana drying industry which sun-dries its product does exist, the new cabinet drying system will be taken up under a community co-operation programme. The committee of the Phitsanulok project has done extensive research in recent years, to record positive progress with developing better systems to effectively dry bananas. These modern, small scale systems still utilize solar energy as the energy source, though the product is dried in an enclosed cabinet, thereby improving the banana quality remarkably.



The proposed solar drying cabinet.

The project will complete its first year in April, 1993 and completion of the detailed system design is also approaching. Regular workshops are alternately conducted in ASEAN countries to gather information, to hold discussions on the progress achieved so far, and to determine the future project schedule. In Thailand, the ASEAN-Canada project will install a large scale dryer to demonstrate the value of using solar energy for drying. At the same time the project will highlight the country's dried banana industry.

(Information provided by John O'Donoghue, Project Co-ordinator, Thai Project Office, Dept. of Physics, Naresuan University, Phitsanulok 65000, Thailand.)

Solar Energy for Sea Water Desalination – Israel

The demand for water in Israel has surpassed the supply from conventional water sources and as a result this shortage is placing a constraint on the development of the country. Import of all its fossil fuel requirements further puts a pressure on the economic condition of the country. Under such circumstances, development of low-cost and high-efficiency solar collectors and sea water desalination plants has always been accorded high priority among the national issues.

Continued R&D efforts have generated significant as well as world-known innovations. These include the low temperature sea water distillation processes, salinity gradient solar ponds, advanced high-temperature parabolic solar energy collectors, etc. The commercialization of these innovations by Israeli industry, and the successful installation and operation of numerous solar energy and desalination plants locally and overseas, have gained it high credits and a well earned international reputation.

With the deteriorating water supply situation in the entire Middle East, serious considerations have been given to large scale desalination processes. Sea water desalination, utilizing non-polluting solar energy, appears to be an ideal solution for the region. Climatic conditions in the Middle East are conducive to solar heat collection, and large water consuming population centers are located near the Mediterranean and Red Seas and the Persian-Arabian Gulf, which would supply the saline "raw material".

ADAN Technical and Economic Services Ltd. was commissioned by the Israeli Ministry of Energy and Infrastructure (MOEI) to review and study the technical potential and the resultant economics of solar desalination, on a regional scale. The study was guided by certain considerations like competitiveness with conventional sources, financial structure of the project, balanced approach between proven and advanced design concepts, technologies based on economics of scale, and space requirement for these projects.

Various solar desalination systems were studied and after a comparative study based upon a number of criteria, the LT-MED combination appeared to be the most economical. It requires the lowest overall investment and results in the lowest cost water. The system is completely solar operated and does not require fuel-fired heat back-up. LT-MED technology is developed and proven but design improvement for plant can still be significant. Strong institutional considerations like environmental cleanliness and safety also favor the solar desalination technology.

(Source: Extracted from "The Application of Solar Energy for Large Scale Sea Water Desalination" by Daniel Hoffman (ADAN Technical and Economic Services Ltd., Tel Aviv), *Israel Energy News*, Winter 1991/92, pp. 1-5.)

Innovation of Multiple-Wick Solar Still

A multiple-wick solar-distillation unit consisting of a fibre-reinforced plastic (FRP) frame has been invented by Dr. Gopal Nat Tiwari of the Indian Institute of Technology, New Delhi, India. This innovative technology was nominated for the International Inventors' Awards. The unit encloses a sheet of glass, covering several interspaced layers of jute and sheets of polythene. Both the jute wicks and the sheets are black colored in order to absorb solar radiation. Each pair of wick and sheet is shorter than the next lower pair, thus exposing the ends to the sunshine. The upper ends of the jute wicks dip into a reservoir of raw water. Desalinated and purified water is condensed on the sloping glass cover and collected at the lower end of the frame. According to the inventor, the design has an advantage in that the condensing glass cover and the evaporative black surfaces are parallel and the whole frame can be placed at any slope in relation to the horizontal plane, in order to optimize its angle towards the prevailing sun.

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(Source: Extracted from "Multiple-Wick Solar Still," *Appropriate Technology*, Vol. 19, No. 3, December 1992, p. 34.)

"Solar Pest Buster" Towards Commercialization

A solar-powered "pest buster" has been successfully tested by Nattavut Chayavanich, a senior lecturer at the King Mongkut's Institute of Technology in Thonburi, Bangkok, Thailand. The device can be used to get rid of pests such as grasshoppers and insects.

The device, called Solar Cell Power Supply for Insect Extinguisher System, operates on a 10-watt battery charged in the day by the sun's rays. The energy stored is then converted into black fluorescent light which, when shone at night, proves fatal to pests. According to Nattavut, the device's solar cells are guaranteed for 20 years, and the battery for three years. The cost per unit, calculated to be 7,000 baht (US$280), is expected to come down with commercialization.

(Source: Extracted from "Solar Pest Buster," *Asia Magazine*, Vol. 31, No. H-4, November 20-22, 1992, p. 8.)

Development of Solar Water Heater for Swimming Pools – Brazil

Sunpower Energia Solar, a Brazilian company specializing in solar energy has developed a solar water heating system for swimming pools. The system uses thin, translucent, plastic floaters whose black surface comes in contact with the water. The black surface attracts, concentrates, and transmits through conduction the sun's heat energy to the water mass. An air cushion, acting as a heat insulator, prevents the water from cooling down for several hours after the sun's heat energy is gone. The pool has to be completely covered with floaters (seven floaters/m^2) which can be interconnected using a net for easy removal at the time of pool usage. Although, the system does not provide a very high temperature, it is claimed to be cheaper compared with traditional heating systems which use fuel.

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(Source: Extracted from "Brazil: Solar Water Heater for Pools," *Tips-Energy*, ENE-B945/1, October 22, 1992.)

Solar Spotlight to Shine on Earth

Russian scientists will get into the act of using a giant mirror to shine a solar spotlight on Earth. An unmanned Russian spaceship will unfurl the cloth-like mirror designed to capture the sunrays and reflect them down to the night-time surface. The spot of light from a thin mirror, which will whirl over the surface of the globe in the sky, should appear as a flaring star to those in a two-and-a-half mile path it will illuminate. The dual-purpose experiment will also test the mirror's utility as a "solar sail" to allow spaceships to harness and ride the sun's gases like a sailboat catching the wind on the ocean.

If successful, the experiment could lead to the development of panels of space mirrors powerful enough to light up night-time work projects, rescue operations and sun-starved polar regions – something like a cosmic klieglight. Then, any city could be lighted using the mirror from midnight until 6 a.m. Although funding problems surround the issue and the practical uses of night light are still a decade away, the space experts are enthusiastic about the applications of the device. The main purpose of the experiment is to see whether the reflective sheet, called a "solar sail," can be used to maneuver spaceships.

The sail itself is made of Kevlar, an extremely thin but strong material, used in bulletproof vests. It is coated with a thin layer of aluminium and shaped like a parachute, 25 metres in diameter. While attached to the supply ship, Progress, the sail will be spun to open slowly, using centrifugal force. Scientists believe that it will take about one and a half hours to unfurl completely. Since the sail will be orbiting the globe, the spot will zip across the planet's surface. If the weather is clear, the beam is expected to hit somewhere in the Atlantic and move eastward across Europe toward Russia, fading as it meets the rising sun.

(Source: Extracted from "Solar Spotlight to Shine on Earth," *China Daily*, Thursday, February 4, 1993, p. 1.)

Modern Chips Raise Hopes for Efficient Photovoltaic Cells

The development of porous silicon chips that give off light instead of electrical impulses may one day be used in making efficient photovoltaic cells that convert sunlight to electricity, and in high-quality colour display screens for laptop computers, according to Michael Sailor, a chemist at the University of California, San Diego. Alcohol and other chemicals, when applied to the chips, cause them to emit less light. As a result, the chips hold promise to be used as sensors to test drunken drivers, measure air pollutants, detect deadly gas in mine shafts and measure sugar levels in a diabetic's blood. This light-emitting chip has been termed a "shining example of new science" and has been cited as a significant development in physics in the year 1991.

It may take decades for the chips to be applied in purely optical computers but their application in hybrid computers may be realised more immediately. This would greatly accelerate computation because light travels through-fibre-optic cables 10 times faster than electricity moves through wires.

A single optical fibre can also accommodate multiple light signals simultaneously, providing much more capacity than current computer components which can take only one electric signal at a time.

Thus a computer using light-emitting chips could increase the speed and volume of information much as a six-lane freeway can carry more cars at higher speeds than a single-lane road.

However, a porous silicon chip possess a drawback as regards its stability. It tends to break down and stop emitting light. So far, Sailor and others have extended the chip's lifespan to six months. The big breakthrough in chips came last year when British and French scientists showed that porous silicon emitted intense, visible orange-yellow light when stimulated with laser light or electricity.

(Source: Extracted from "Shining Example of Modern Chip," *The Nation*, Bangkok, December 1, 1992, p. B9.)

Solar Bizz in Malawi

A small enterprise in Malawi named Eco Systems Ltd. has shown exemplary skill and determination in utilizing the natural resources and reducing the dependance of developing countries upon the developed ones. These natural resources include earth, water, sun and people. The company which started about 15 years ago has set up a reputation not only locally but internationally. It not only manufactures solar water heaters, solar refrigerators, solar power systems but their associated systems as well.

The use of solar energy in Malawi goes back to the 1950s. Stiff competition from easily available firewood and high import costs to land-locked Malawi resulted in few sales of the poor-performance imported water heaters. There was a need for a simple, locally-made heater suited to local water, climate and raw materials. Models were developed in the late 1970s, and the company started production in 1984 with just five employees, initially supplying mostly rural mission stations. Today, the manufacturing process for solar water heaters is well-established and the company now reckons to offer the widest range of specialized solar water heaters in the world. Capacities range from 75 litres to more than 5000 litres, and models have been adapted for different roof types, water supplies and architectural requirements. Their six square metre single-pass collectors, which can work in banks of more than 10 units to supply a single tank, are unique.

Most of the solar water heaters make use of the thermosyphon effect in a closed circuit, which is heated on one side. The single pass heater is a new idea. It makes use of a thermostatic valve and mains water pressure. It is more sophisticated, but it has the advantage of higher early morning temperatures. Solar water heaters of this type can also be built to a very large scale, without the need for a circulation pump. The design of these water heaters has been shaped by

- ready availability of cheap labour;
- difficulty in obtaining materials and parts;
- locally available materials;
- local water and water supply conditions;
- local building traditions; and
- local climatic conditions.

These water heaters are relatively cheap and perform well. One of the first models built in 1979 is still working. They are made to different specifications to developed world equivalents and have been supplied mainly to different African countries. Having no moving parts, these heaters are virtually maintenance-free. They perform almost as well in the cool season as in the hot one.

In 1985, the Malawi government became the company's biggest customer. To date, some 950 solar heaters have been produced and installed in hospitals, schools, health centres, missions and private homes all over Malawi. A further 60 have been exported to other Central African countries. Production is now running at 20 units per month.

The company is expanding. Its workforce now numbers more than 100, and it has set up a daughter company, Ecoelectric Ltd. Working with a bore hole drilling company, they can now provide a complete solar-powered water supply system with bore hole, water pump, piping, plumbing and storage tank. Solar-powered versions of centrifugal, piston and spindle water pumps have been developed, and some 20 have been installed in Malawi, and 5 in Zambia.

The company developed a polyhedral shape for storage tanks, in order to distribute the stresses evenly on the metal shell, so that much thinner gauge metal can be used in construction, further reducing raw material import costs. Although more skilled labour and a longer time is taken to construct the new design than the conventional one, the company can make the stainless steel tank for the same cost as a conventional galvanized one.

A wide range of solar-powered lights is produced using small transverters to change the 12 volts direct current supplied by the solar panels to 220 volts alternating current. At present, these transverters are imported, but the company has plans to manufacture its own. The company is also adapting and installing solar-powered refrigerators for domestic use and its solar-power generating equipment is now good enough to run medical refrigerators. The company has now provided some 50 such solar-powered medical refrigerators to rural hospitals and health centres in Zambia, and about 15 in Malawi.

Recently, the company supplied a complete system of water pumping, plumbing, storage, heating, lighting and refrigeration to the health centre at Lisungu refugee camp. Water pumping systems have also been installed at the government health centre in Phalombe and for the isolated community of Likoma Island.

All the company's products can be made with hand tools. A few small machines are currently used in the factory in order to speed up production to meet ever-increasing demand. However, this type of production operation could be carried out in rural areas in this and other countries. Supply of the company's products to schools, hospitals, health centres and missions helps to develop the infrastructure that is essential for development. Environmentally sustainable energy sources, especially those with low maintenance costs and demands, will become increasingly popular as aid projects, because aid agencies find it easier to provide capital than ongoing finance for running costs and maintenance.

The future of this enterprise is quite promising as can be traced from its historic performance and the continuously increasing demand for its varied products. Demand for its products in Malawi and Zambia is outstripping supply, and its ideas are finding favour in Zimbabwe and Mozambique. So far, the greatest obstacles faced by the business have not been economic or technological, but conventional thinking and red tape. An open minded approach should see the company prospering more rapidly and impressively.

(Source: Extracted from "Solar Bizz in Malawi," by Jennie Swann, *Our Planet*, Vol. 4, No. 6, 1992, pp. 16-18.)

Alternative Energy Holds a Big Potential in Asia

Small-scale solar photovoltaic (PV) power generation is a viable option for rural electrification in Asia, was the message of a speech given by Loretta Schaeffer, Programme Manager of the World Bank's Asia Alternative Energy Unit. Lack or failure of application so far has been largely the result of market distortions by governments, lack of information and lack of interest by utilities. In the present context, the World Bank is increasingly willing to help promote alternative energies in Asia. The right technology at the right price, according to Schaeffer, is still the key to applying alternative energies, as is domestic availability, but other factors are equally constraining.

One of the major obstacles to expanding the PV market is current energy pricing policy, with its customary emphasis on subsidised tariffs for rural electricity. This represents a market distortion which alternative energy suppliers would find hard to beat. Realistic pricing of current rural schemes, on the other hand, would result in an estimated high kWh cost of around 20¢, and would open new opportunities for photovoltaic (PV) use.

A second major financial constraint is the different cost structure of PV power, which concentrates expenditure in capital rather than the more usual running costs. If cost analysis is based on life-cycle costing, PV can be competitive, says Schaeffer, even without consideration of saved environmental expenditure. But translating this into practical use of PV would require alterations to traditional accounting and financing procedures. Devising innovative long-term credit or leasing schemes for the small users can prove to be far more effective.

Another fundamental for market expansion is the involvement of the private sector. This is firstly because the public sector tends to concern itself with large-scale generation projects, utilizing official or donor support, and secondly because effective decentralised use of PV power depends on "responsive service capability", which is less likely from larger, more bureaucratic organisations. Accessing private sector support will mean new incentives and financing.

Until 1989, the Bank had been providing indirect help only in the form of laying emphasis on the establishment of a competitive energy environment and reduction of tariff barriers, providing advice on regulatory and institutional frameworks and assistance for privatization to help boost rural PV power development. Direct Bank actions began in 1989 with the establishment of the FINESSE (Financing Energy Services for Small-Scale Energy Users) project in co-operation with other donors. This was designed to study and identify a portfolio of energy-efficient and renewable energy options in Indonesia, Malaysia, Philippines and Thailand, and led to the creation this January of the Asia Alternative Energy Unit.

The Unit is intended to incorporate conservation and renewable energy options into Bank-assisted energy strategies and lending operations. The Unit will concentrate mainly on identifying alternative energy investments and following up FINESSE project recommendations. Under consideration is a US$ 430 million Indian renewable resources project which will include solar PV programme, mini-hydro and wind farms. Other projects include a non-grid based renewable energy component costing perhaps as much as $20m in a Bank-funded rural electrification programme in Indonesia, a study of the solar PV market in China under a Global Environment Facility (GEF) funded study into greenhouse gases in the country, and smaller PV projects within World Bank health and education projects for the region. (Source: Extracted from "Asia's Solar PV Option," *Power in Asia*, December 14, 1992, Issue No. 116, p. 17.)

EC – Thailand Biomass Energy Demonstration Programme

The Demonstration Programme is jointly organized by the European Community (EC), the Asian Institute of Technology (AIT), and the Energy Conservation Center of Thailand (ECCT).

The aim of the Demonstration Programme is to accelerate the implementation of proven technologies generating heat and/or power from wood and agro-industrial residues. Some of the technically and economically viable technologies are either not popular or have not been tested in Thailand. The Programme can bring technical and financial assistance to implement Full Scale Demonstration Projects (FSDP).

FSDP can be defined as the implementation of a proven technology on a full scale basis in order to demonstrate its technical reliability and economic viability. It constitutes a shop window in Thailand, aiming to convince other potential end users to select the technology. The impact of the Programme, besides opening of the market, can be energy cost savings as well as the protection of the environment.

Project criteria are as follows: the technology must be proven elsewhere and should use biomass (wood or agro-residues) as a fuel, it should not have a negative impact on the environment, and should be replicable.

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Mud Brick Chimneys, A Success

The improved stove component of the Nepal-Australia Community Forestry Project has successfully devised a simple and sustainable process for promoting the use of improved stoves by village people in Nepal. The new improved stoves with brick chimneys are cheap and can be constructed locally with ease. The new stove, can also significantly contribute to the conservation of forest resources.

Traditionally, most Nepali houses contain one or more simple chulos. These can be just three stones, a metal tripod or a simple mud and stone stove. There is no practice of constructing chimneys and hence at cooking time Nepali houses are filled with smoke. Initially, the project purchased and freely distributed about 2,000 ready-made improved ceramic stoves to the villagers. But this campaign proved to be costly and unsustainable and the users faced difficulty in maintaining the fragile stove.

In 1989, the project reviewed its stove programme and planned to implement training programmes in order to teach the villagers how to build improved stoves using locally available material. No problems were faced in the construction of the firebox, pot seats and baffles but chimney construction proved cumbersome. Ceramic flue pipes and chimneys constructed from stone and mud mortar were tried but either a high breakage rate during transportation or the requirement of considerable craftmanship hindered their dissemination. Flue pipes made from old tin containers also proved expensive and non-durable.

After trying different methods, chimney construction was given a new approach. A wooden mould was constructed to enable the production of flue bricks using locally available materials such as mud, sand and ash. Using this type of mould, flue bricks can be easily made by villagers and then dried in the sun for 4 or 5 days. The dried bricks then can be stacked up and joined with a mud mortar to produce a chimney of the desired height. Angles or elbows, to allow the chimney to pass outside the house, can be made easily by breaking a hole in one side of the flue brick. A stone is lightly mortared with mud and placed into the hole in the top flue brick inside the house. It can then be easily taken out again to allow for frequent cleaning of the chimney.

The stoves can thus be constructed easily for little or no cost using local skill and materials. These long-lasting improved stoves have helped in drastically reducing the smoke from filling inside the cooking room. Like most successful technologies, it is relatively simple, can be developed from existing skills and does not cause family or social problems. It should be easy to 'transfer' and to adopt for similar conditions without expensive research or advisors.

(Source: Extracted from "Successful Mud Brick Chimneys" by Sharada Kharel and Tony Bartlett, *Boiling Point*, No. 28, August 1992, pp. 18-20.)

US Order Boosts Tyre Pyrolysis Industry

A joint venture between AEA Technology and Herbert Beven Ltd of Colchester (AEA-Beven), UK has sold a Multi-Purpose Disposer (MPD) to North American Tyre Recycling Ltd (NATRL). The MPD has been specifically designed for the recycling of tyres using a pyrolysis process. The order, which is the first for the British machine, coincides with an exclusive licensing agreement for the whole of North America. This entitles NATRL to manufacture and market the design in the United States and Canada, where sales of around 90 units are anticipated over the next five years.

Pyrolysers offer an environmentally attractive method of reducing the world's tyre backlog, which stands at around three billion in the US alone. The machines use high temperatures and an oxygen-free environment to decompose tyres chemically, producing lower emissions of nitrogen-oxide and sulphur-oxide than incinerators – the conventional technology.

By recycling rather than burning the tyres, pyrolysers also allow valuable materials to be recovered. The oil and gas, for example, can be used as fuels within the pyrolysis system, or for an adjacent plant such as a combined heat and power system. Char and steel are also recovered from the process. The char, which operates in a similar manner to activated carbon, but at a much lower cost per tonne, is an efficient treatment for liquid effluents.

(Source: Extracted from "US Order Gives Boost to Tyre Pyrolyser," *Waste Management*, November 1992, p. 16.)

Conversion of Wood Residues into Fuel Sources

A simple reactor, Carbonizing Gasifying Chamber (CGC), which converts wood residues and agro-waste into charcoal and gas has been developed by Carbotechnica S.A. of Portugal. The fine charcoal can be made into briquettes for domestic use and industrial heating while the gas produced during the process can generate heat for various purposes. The reactor is based on an inclined static body concept for which mechanical means are not required to move the residues inside the reactor.

In the CGC reactor, wood residues are fed through the upper part of the reactor. The residues then slide down the reactor and form a layer of solid material. This layer moves down when the charcoal extractor, located at the lower end of the reactor, is switched on. In the process of carbonization, the hot gases flow slowly upwards to maintain the pyrolysis process. Unlike horizontal or vertical reactors, this inclined

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Converting Piggery Wastes for a Productive System – Australia

A two-stage anaerobic digester constructed for the total management of piggery wastes has been installed at Berrybank Farm in Victoria, Australia. It is the first of its type installed in Australia and processes the output of 12,000 pigs housed on the farm. The daily output averages up to 210,000 litres of slurry having an organic solid content of around 1.7 per cent. This volatile slurry may be compared to the sewage output of a town with a population between 30,000 and 40,000 people.

The unmetabolised part of the feed which passes in the animal manure is not only a wasted resource but also a pollutant. Although the most common way to dispose of the waste is to spread it directly on cropland or pastureland, the harsh Australian conditions are not always conducive to the natural decay of animal manures and lead to greenhouse gas emissions. With reference to environmental issues and impacts on soil fertility, it becomes imperative to follow intensive animal husbandry practices.

Anaerobic digestion is a biological process similar to that occurring naturally in swamps where bacteria breaks down the rotting vegetation to produce marsh gas. A digester provides the ideal conditions for the process to proceed at a faster, more controlled rate, by excluding air, thoroughly mixing the contents and keeping the temperature at a preset level. The farmer can benefit from digester use by reducing energy costs, reducing waste disposal costs and have full utilization of farm resources.

The anaerobic digestion system developed by SPI in Italy was adapted for Australian conditions and uses a two stage digestion process with a recirculation of biomass to ensure complete digestion of the solids. Organic material is pumped into the primary digester where it is maintained at a constant 37°C. This is achieved by hot water from the cogeneration system. Gas is produced continually and is extracted and stored in the gas holder above the secondary cold digester. Material pumped from the primary to the secondary digester receives a thermal shock. This causes the digested slurry to flocculate and settle to the bottom of the tank from where it is discharged. The undigested slurry, which is lighter, is then recirculated to the primary digester. Biogas (70% methane, 30% CO_2), concentrated sludge and water containing minerals are the final products of the process.

As regards the benefits, the digester should be planned as part of an integrated farm development – from livestock production to energy and by-products for aquaculture, hydroponics or fertilizer. It is more accurate to consider these plants as a complete treatment and recycling system with energy being only one of the by-products.

On a daily basis the plant at Berrybank Farm recovers 20,000 litres of organic liquid fertilizer containing 10% dry matter, 10,000 litres of mineralized water and 3,500 kWh of electricity and 27,000 MJ of heat. The organic liquid fertilizer is being used instead of chemicals to fertilize 365 hectares. It is anticipated that this will allow continuous cropping of the land which otherwise is not possible with the usage of chemical fertilizers. The mineralized water can be used to improve pasture for stock. With an initial investment of about A$2 million there is a simple payback period of 6-7 years. There is the potential for improving the return through producing and marketing dry organic fertilizer and by using the heat that is available. The system possesses additional advantages like reduction of smell, utilization of more land and reduction of diseases, and insects. Moreover, building permits are usually easier to obtain in the future.

(Source: Extracted from "Energy from Piggery Wastes" by P. Andreoli, S. Charles, F. Darby and R. Mendelsohn, *Solar Progress*, Vol. 13, No. 2, Spring 1992, pp. 30-31.)

Conversion of Wood Residues into Fuel Sources

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reactor allows a smoother flow of the gas.

In a typical reactor fed with 1 ton of wood residues and 0.3 ton of air per hour, it is claimed that the reactor can generate 1.0 ton/hour of gas (equivalent to 2.4 MW) and 0.2 ton/hour of charcoal. Based on an annual working time of 8000 hours, it can generate 1,600 tons of charcoal and an amount of gas which can substitute an equivalent of 1,600 tons of fuel oil.

The CGC plant, excluding boiler and dryer for the charcoal briquettes, currently costs about US$400,000.

(Source: Extracted from "Converting Wood Residues into Charcoal and Gas," *The ASEAN Timberlink*, Vol. 5, No. 11, November 1992, p. 11.)

Biomass Energy and Combustion Technology

The biomass industry in USA is experiencing a transition state and new processes and technologies are becoming part of several new biomass projects. Companies in the industry have succeeded in identifying specific market niches which can use biomass energy technology, and they are beginning to capitalize on these target audiences. In the present context of increasing environmental awareness, new advances in biomass technology can make the related industry prosper, and especially in areas with limited supply of fossil fuels and an abundance of biomass resources. Broad public support for the use of renewable energy technologies is equally important. With various development efforts, the industry is working to implement projects using technological solutions to meet market needs.

The Whole-Tree System

In many communities in the United States, the use or installation of wood stoves and fireplaces has been limited or forbidden because of their high emissions. Nevertheless, the properties of wood are not at fault; rather, problems related to the combustion process in a typical wood stove cause high pollution. A new patented process developed by Energy Performance Systems, Inc. of Minneapolis, Minn., is an advance in large-scale biomass projects. The technology, called whole tree energy (WTE), is a complete system for harvesting, transporting, drying and burning whole hard-wood trees to produce low-cost electricity with low levels of pollution. The technology is ready to move to the marketplace and a recent contract funded by the Electric Power Research Institute (EPRI) allowed the company to test the final design details of its system.

WTE technology uses waste heat from the power plant to dry whole trees and remove about 70 per cent of the initial water content. The dried wood is burned in a high-efficiency boiler at 2,700°F under optimal combustion conditions. This type of combustion process can achieve the high heat release rates needed for efficient power production and whole trees can be used to cleanly produce electrical power. A recent heat release test of WTE produced 3.15 million Btu/square foot/hour compared to 0.5 and 1.85 similar units respectively from standard wood and coal.

Energy Performance Systems is working to identify applications of its technology and to determine its prospects. The company plans to use the WTE system in two different ways to produce electricity. The first is to retrofit fossil-fuel plants that are mothballed or used infrequently because of high-pollution levels or high operating costs. These can be repowered to use the WTE technology. The second direction is to build new WTE power plants – facilities with lower capital and operating costs than conventional coal-fired plants. According to the company president, David Ostlie, WTE plants are less expensive to build and have lower operating costs than other wood-fired plants. By using whole trees, costs are saved in pre-treatment – for example, chipping and grinding the feedstock. One key to the lower capital and operating costs is reducing the size of the coal pulverizing systems, SO_2 scrubbers, particulate and ash collection devices and other components of coal-fired plants. Many components can be eliminated altogether. Compared to a coal plant, the WTE system produces one-hundredth of the sulfur, less than one-fourth the nitrogen oxide (NO_x), less than one-tenth the ash and no net addition of carbon dioxide (CO_2) to the atmosphere.

Retrofitting

According to Leonard Theran, President of G&S Mill in Northborough, Massachusetts, USA, many companies are turning to modern biomass and other renewable technologies because of air quality requirements. G&S Mill specialize in replacing the combustion systems in the boilers associated with smoke, inefficiency and other energy problems, to make them efficient and environmentally friendly. The company retrofits aging wood and coal boilers with improved new combustion systems. Wood energy usually has a pay-back on investment of two years or less because of the tremendous savings of wood fuel compared to oil, according to Theran.

Similarly, American Tractebel, Corp., the New York-based subsidiary of a Belgian industrial and energy group is becoming successful with its wood burning plants in northeast United States. The plants are clean and efficient and are easy to operate. One of the company's plants has been designed to burn 300,000 tons of whole-tree chips per year to produce 19 megawatt (MW) power. The system's wood ash by-product, a natural lime substitute, is valuable as a soil additive.

Hepple Energy Project, Inc. of Costa Mesa, California, has taken a step to solve the wood refuse problem, besides the provision of electricity to the public utilities in Alberta, Canada. The new station, to be developed by 1994, will make a valuable and environmentally sound use of waste material by producing 21.5 MW and significantly reducing the amount of CO_2 released. The generating station for the project will be designed and constructed by Outokumpu EcoEnergy Inc., using its fluidized bed combustion technology. The combustion unit for this project uses fluidizing air to suspend a bed of wood fuel and sand during combustion. Hot gases and light particulates from the process are raised in the furnace and channeled to superheaters, the evaporator and the economizer sections of the boiler. The gas then passes through the mechanical dust collector, induced draft fan and the baghouse, where fine particle loading is collected before discharge of gas to the atmosphere. Ash and sand material will be removed from the bottom of the unit and taken to the town landfill. The super-heated steam generated in the boiler is directed to the steam turbine and to the generator to produce electricity. By directing the steam exhaust into a condenser, the efficiency of the unit is improved because cooling water produces a vacuum and thus a greater differential in pressure from the inlet to the outlet of the turbine.

(Source: Extracted from "The Growth of Biomass" by Kenneth Sheinkopf, *Independent Energy*, Vol. 22, No. 9, November 1992, pp. 66-68.)

Metallurgical Process Coupled with COREX Cogeneration

Metallurgical processes for the production of iron and steel not only require enormous amounts of energy but also produce energy, side by side. With the new COREX technology, the surplus gas is produced in the form of export gas and as compared with the blast furnace, this technology produces 2.5 times more medium-calorie gas. The new ecology-friendly COREX technology produces power during the production process of hot metal using conventional steam coal.

The COREX technology was jointly developed by Voest-Alpine Industrieanlagenbau Ges. M.B.H., Linz/Austria, and Deutsche Voest-Alpine Industrieanlagenbau GMBH, Dusseldorf/Germany. The first large-scale smelting reduction plant of the world was put on stream in the metallurgical works ISCOR, Pretoria, South Africa. Compared with the conventional blast furnace/coking plant route, the COREX process includes benefits like:

- elimination of coking plant through use of non-coking coal;
- elimination of agglomeration plants through the input of 100% lump ore (or pellets and/or sinter);
- minimization of environmental loads;
- high operational flexibility with respect to production capacity, raw material changes and stopping times;
- production of hot metal of at least blast furnace quality.

The high quality COREX gas, on account of its composition and heat content, can serve as basic material for the chemical industry or as reducing agent for metallurgical purposes or as fuel gas for various combustion processes.

The COREX export gas is exceptionally important for cogeneration. Depending on the composition of the coal employed, the amount as well as the composition of the COREX export gas vary within definite calculable limits. The volatile matter content is of particular importance because it increases both the coal consumption as well as the amount and caloric power of the export gas. For a typical steam coal with 63.7 % C_{fix}, 7.75 % ash, and 28.5 % volatile matter the analysis is approximately:

45%	CO
32%	CO_2
16%	H_2
2%	H_2O
2%	CH_4
3%	residuals (mainly N_2)
10 - 70 ppm	H_2S (depending on the burden)
net cal. value	7500 kJ/m³n.

The adiabatic flame temperature of this gas is 1780°C which is close to natural gas which computes at 1940°C and distinctly higher than blast furnace gas at 1450°C. The specific properties of this gas demonstrates the compatibility of the COREX export gas to replace natural gas for the majority of in-plant uses including power generation by combined cycle technology. With an unchanged metal production, the gas produced in the COREX process can be very flexible:

- by modifying the coal mix (increase or reduction of volatile matters)
- by increasing the coal rates to above the demand of the melting reduction process.

In combination with a diminished hot metal production also very low amounts of export gas with less than 60 % of the normal rate can be achieved. In the case of electric power generation, this flexible gas production allows for an adaption of operating conditions in the cold and hot seasons. This results in optimized energy prices and/or in a replacement of other energy sources within the metallurgical works.

When generation of electric power is not needed, the COREX gas may be alternatively used for DRI-production. After CO_2 removal the export gas allows for a sponge iron production of some 60 % of the hot metal production tonnage. A standard C-2000 plant would thus be capable of producing additionally 1200 tons of DRI on a daily basis within a completely energy independent COREX system, where also the oxygen requirements and electrical needs are covered by the produced COREX gas. In such a case the C_{fix} consumption per ton of iron produced amounts to barely 360 kg which is even less than reported for most successful blast furnace results with coal injection rates of 165 kg at coke consumptions of 319 kg per ton of hot metal.

With COREX gas serving as a basis, the production of synthesis gas can be an attractive application for the chemical industry. Because of its value (transportation fuel) the production of methanol seems to be one of the most interesting synthesis materials proceeding from COREX export gas. Good storage facilities of methanol in combination with excellent burning properties are best prerequisites for a methanol plant integration into a power generating COREX plant, where the partition on electricity and methanol generation can be done according to the requirements.

The replacement of conventional coke oven – blast furnace work by COREX is accompanied by significant environmental improvements. All the air, water and solid waste discharges originating from coke making are eliminated with COREX. As an example, a combined system of COREX – combined cycle power generation will yield environmental savings of 65% dust, 97 % SO_2 and 57 % NO_2 in comparison to the conventional plant which is assumed to be furnished with all necessary gas cleaning equipment to meet today's legal requirements. Similarly, an appreciable reduction in CO_2 emission has been observed for systems employing the COREX process.

(Source: Extracted from "Co-Generation with COREX" by Dieter Siuka and Michael Lemperle, *Urja*, Vol. 32, No. 5, November 1992, pp. 47-51.)

Performance Research on the Built Environment – PROBE

PROBE is an associated research centre of the Department of Building and Environmental Engineering at the University of Ulster. Its activities are based at the University's Jordanstown campus and the technology unit at Carrickfergus.

PROBE carries out:

i) Building thermophysics research
ii) Full design support services
iii) Long and short-term monitoring and analysis of buildings and their sub-systems in the UK and overseas
iv) Computer-based simulations of annual and daily, thermal and lighting performance
v) Research and development of active and passive solar components
vi) Economic assessment and market research.

PROBE's research work encompasses:

i) Validated prediction of the holistic performance of a built environment and building components.
ii) Integrating appropriate performance prediction into building design, construction and operation processes to produce "optimal" integrated systems comprising the building's form, fabric, services and controls to meet its function for a particular occupancy and location.
iii) Monitoring, analysis interpretation and reporting on the performance of specific buildings.
iv) Studies on particular aspects of buildings and their sub-systems, where an improved understanding is a pre-requisite for holistic performance analysis.

Though the initial focus is on thermal, lighting and associated environmental performance, it is envisaged that compatible protocols for including the evaluation of the acoustic, economic (i.e., life-cycle trade-off between initial and running costs) and structural performance of buildings will be developed, in order that their mutual interactions may be explored.

The centre has extensive experimental facilities including specialist laboratories for window performance rating, solar energy simulation, heating and ventilating component appraisal and timber technology. There is also a full range of associated instrumentation, data acquisition and visualization facilities.

PROBE has been awarded a major new contract by the Commission of the European Communities (CEC) to develop solar energy collectors for rural applications in India. The project, part of the CEC's "International Scientific Co-operation" programme will last for three years and will involve advanced computer-based simulation techniques with practical testing in India. The centre released its first newsletter named "PROBE" in January 1993.

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Setting an Example in Wastes Management and Energy Recovery – Sweden

Sweden has been, for many years, been following the practice of ecologically-sensitive disposal of domestic and industrial wastes. The government has set up aggressive targets for reduction in waste volume and promotion of recycling. Every municipality must establish a solid waste plan for the handling of all wastes produced in the area under its authority. This includes waste from domestic, industrial and hospital premises and those deemed to be hazardous. An inventory of the amount of different wastes and their origin is also required. By 1994 Sweden's goal is that incineration and landfilling of unseparated wastes will cease.

Thermal treatment has become the preferred method of refuse disposal in Sweden and in some cities the heat produced in this process provides more than 40 per cent of the district heating requirements. Sweden now has 21 modern incineration plants, the biggest with an annual capacity of 400,000 tonnes. In future, increasing amounts of waste are estimated to be incinerated – generating over 10 TWh per annum by the turn of the century. In this respect, paper and paperboard, which forms up to 45 per cent of domestic waste, has become a valuable source of biomass fuel.

Sweden has enforced strict standards in the emissions of pollutants such as hydrochloric acid, carbon monoxide, sulphur dioxide, mercury and dioxins. Emissions of all pollutants have been heavily reduced since 1985 and will further decline as increasingly sophisticated flue gas cleaning techniques are introduced. The by-products of the combustion process are also planned to be either utilized or disposed of effectively. The inert slag is planned to be used in construction industries whereas the fly ash is considered for safe disposal in impervious landfills.

(Source: Extracted from "Sweden Sets the Pace in Energy Recovery," *Wastes Management*, July 1992, p. 19.)

Sponsoring Wind Energy Programme – USA

The US Department of Energy (DOE) and the Electric Power Research Institute (EPRI) will jointly help US utilities evaluate a new generation of wind turbines over the next five years. The $40 million joint initiative is designed to make wind power in many states broadly competitive with electricity derived from fossil fuels. The DOE and EPRI will assist up to four host utilities in construction (installation, site operation, testing) of wind power test plants with about 20 turbines at each site. Selection of the vendor and turbine technology will be carried out by the host utility. An information base for manufacturers will be established to improve their technology and allow potential users to judge the value of deploying wind power plants.

The goal of the programme is to, through commercialization of world-class power systems, bring down the cost of electricity generation to 5¢/kWh by 1998 in areas with 21 km/h winds from the present cost of 7-9¢/kWh with 26 km/h winds.

A second phase of the programme, still under consideration, would evaluate another generation of technology expected to be available by about the year 2000. Spearheaded by DOE's advanced turbine programme, this technology is designed to cut costs by another 20 per cent, to 4¢/kWh with 21 km/h winds.

(Source: Extracted from "DOE and EPRI Sponsor Wind Programme," *Modern Power Systems*, Vol. 12, Issue 12, December 1992, p. 3.)

Western Australia Opted for More Wind Power

Nine, 225 kW Vestas wind turbines from Denmark are to be installed for the State Energy Commission of Western Australia (SECWA) by Australian Defence Industries Ltd (ADI). The AUS $5.2 million project will supply up to 14 per cent of the electricity needs of the town of Esperance. The 2 megawatt (MW) wind farm, expected to be completed by August 1993, will be sited close to Australia's only wind farm of Westwind turbines at Salmon Beach, also operated by SECWA. It is believed the wind farm will make Western Australia the leading wind power generator in the southern hemisphere.

SECWA has an extensive wind monitoring programme throughout the state. Wind monitoring stations are located at ten towns, from Onslow to Albany to Mount Magnet and Lake Lefroy, near Kambalda. In order to avoid environmental deterioration, SECWA has also been required to submit an environment management programme before permission was granted by the Environmental Protection Authority.

A tender of AUS $ 4.2 million was accepted from ADI to design, construct, supply, install and commission the wind farm. The remaining AUS $ 1 million of the total cost will be for project infrastructure, including a 14 kilometre power line, access roads and new equipment at the Esperance power station. One of the most interesting aspects of the project is its high penetration on the 14 MW grid and the grid penetration will be in the region of 30 per cent.

(Source: Extracted from "Second Group of Turbines for Western Australia" by Lyn Harrison, *Windpower Monthly*, Vol. 8, No. 12, December 1992, p. 10.)

Huge Wind Power Target Set –Spain

Spain's biggest public electric utility, Endesa, has agreed to an installation target of 750 MW of wind power generating capacity by the year 2000. Endesa's commitment is part of an agreement for the joint promotion of wind power signed with the country's two largest trade unions and the environmental group Aedenat. The target equals the amount of wind power installed in California's Altamont Pass, the largest concentration of wind turbines in the world.

Currently Spain has about 45 MW of wind power and future power generation from wind is seen as an alternative to environmental hazards and as source of industry creation and employment. The Worldwatch Institute's State of the World report explains clearly that nuclear energy produces fewest jobs per kW generated and that wind produces the most. A working committee has now been set up to examine ways in which wind power could be developed in Spain as quickly as possible. The unions can also help reach the achievable target in the minimum possible time. Endesa is also researching the best sites for wind farms, sites where there will be the least ecological impact. The move serves as a basis for the future and an ecological transition. Many related organizations are doubtful about Endesa's plans, but with the available infrastructure and Endesa's determination, the target can be fulfilled.

(Source: Extracted from "Spanish Utility Sets Huge Wind Power Target" by Nick Inman, *Wind Power Monthly*, Vol. 9, No. 2, February 1993, pp. 10-11.)

Durable Electricity Fuses

Overloading of the system is a common problem, both in national grid electricity supply as well as in micro-hydro schemes. The task of limiting the amount of power consumed by each consumer from a small system assumes great importance. Since voluntary limits to power consumption is not a workable solution, some sort of device is necessary to prevent overloading of the system. Positive Temperature Coefficient (PTC) thyristors and Electronic Current Cut-out (ECC) have proved to be reliable devices to control the amount of power consumed, but the latter has more numerous advantages, besides having a very long lifespan.

Around four years ago, the micro-hydro manufacturers in Nepal became interested in using PTC thyristors as fuses. These small electronic components can be installed like ordinary fuses and shut off, when necessary. PTCs automatically reset themselves once the demand returns to normal. Additionally, these devices simplify tariffs and the collection of bills. Instead of charging households for the power actually consumed, current limiting devices make it possible to employ a "flat tariff" system where consumers are charged a fixed amount of money each month regardless of the amount of power taken. As well as dispensing with expensive electricity meters, a flat tariff provides consumers with a strong personal incentive to make the best possible use of their electricity which helps to improve the cost-effectiveness of the micro-hydro scheme.

However, drawbacks are associated with PTC and these become prominent, particularly in the context of Nepal. These problems include a change in performance with changes of the ambient temperature, irregular availability of the PTCs (as they are imported) and shorting of the control mechanism by overloading the PTC, thereby giving access to an unlimited amount of power.

The ECC is an electronic switching device, which cuts off the power supply to the consumer when the load current exceeds a certain limit. Resetting the ECC is done manually by switching the main supply off, reducing the load to normal and switching the supply back again. As current is measured, the supply voltage needs to be relatively constant throughout the system. Large voltage variations will lead to unequal power consumption at the same ECC setting.

Main features of the ECC are:

- Low cost (1991 price: US$ 19)
- Simple design
- Local manufacture possible
- Rugged and reliable due to the absence of moving parts
- Setting not dependant on ambient temperature
- Fast acting, but trip time can be set
- Wide range: from 25 to 600 watts
- Protected against lightning spikes and consumer shorts
- Repairable, any defective electronic component can be simply replaced.

The ECC does have a drawback in that it measures the average value of load current and not the root mean square (rms) current. Thus non-linear loads like tube lights, TV, video and radios should constitute only a minor part of the total load or a serious measurement error of up to 80% may occur. The resistor in an ECC is so small that it gives a voltage drop of only one volt. Since, no transformer for power supply is needed, this results in simplicity and low cost of the system. ECCs are available in two types: from 0-250 watts (W) and from 251-600 W.

(Source: Extracted from "Everlasting Fuses – The ECC" by Raj K. Thapa, *Hydronet*, Issue 2, 1992, pp. 13-14.)

Plans to Accelerate Power Supplies from Bongkot Fields – Thailand

The oil group led by France's Total plans to expedite the development of Bongkot gas field in the southern Gulf in order to produce more gas as early as possible to meet the Kingdom's demand for power generation. The accelerated plan is in response to a call by the Petroleum Authority of Thailand (PTT) which is locating additional sources of gas supply, both at home and in the neighbouring countries. The gas produced will be used to fuel a new power plant in Thailand. The combined-cycle plant, initially with 700 megawatt (MW) capacity, is supplanting the country's first coal-fired power plant at Ao Phai which the government decided to delay, pending further environmental impact studies.

According to the general manager of Total Exploration and Production Thailand, there is a potential to bring forward the planned gas production rate of 350 MMcfd in 1998 to 1996. That possibility is further enhanced by the fact that PTT has decided to proceed with the laying of a second gas pipeline running parallel to the existing 425-km trunk line laid from the Erawan field in the central Gulf to the eastern coast at Mab Ta Phud. That pipeline, scheduled to be completed in 1996, will double the delivery capacity from various gas fields, including Bongkot, to 1,600 MMcfd from the current limit of some 800 MMcfd and, therefore, removes the bottleneck hindering PTT's effort to get more gas. However, early gas production targets from Bongkot gas fields remain unchanged – 150 MMcfd in the first six-months of production start-up which commences in mid-1993 rising to 200 MMcfd in 1994 and 250 MMcfd in 1995. In the meantime, Total and its three partners in the Bongkot development – PTTEP (40%), British Gas (20%) and Statoil (10%) – are looking at how the development could be hastened to achieve higher production earlier than originally planned.

(Source: Extracted from "Total to Push Bongkot Fields to Boost Power Supplies," *Power in Asia*, Issue No. 113, November 2, 1992, p. 12.)

A Leading Edge in Incinerator Tube – Sweden

Sandvik Steel of Halesowen, Sweden is developing and testing a new grade of composite tube for use in incineration plants. The new composite tubes have a super austenitic, high nickel, corrosion resistant Sandvik alloy outer and a carbon steel inner. They have been developed to provide greater resistance to chlorine attack and to have a high resistance to caustic chemicals.

Incineration has become an important means of eliminating municipal waste and it is becoming increasingly common, particularly in Scandinavia and other parts of Europe, to use the derived heat to supply steam or hot water in district heating systems or for power generation. The corrosive acidic components formed during the incineration process include hydrogen chloride, sulphur dioxide and plastic derivatives. As a result, severe demands are placed on the processing plants particularly in such areas as furnace walls where the temperature reaches as high as 250°C (480°F).

Composite tubes were developed in the 1960s to overcome corrosion problems in black liquor recovery boilers used by the pulp and paper industry.

The traditional product consisted of a 18Cr 8Ni stainless steel outer component and a carbon inner component which were bonded metallurgically to achieve perfect mechanical integrity of the tube. The bond also guarantees good heat transfer. So successful have composite tubes been in the past in prolonging the service life of furnace walls, that in addition to water wall applications, the new grade has now also been selected for use in superheater elements. A first order for the new Sandvik composite tube grade has been placed by the Hogdalen incineration plant in Stockholm, Sweden which has three boilers with an output of 94 megawatts (MW).

(Source: Extracted from "Sweden Takes the Lead with Incinerator Tube," *Wastes Management*, August 1992, p. 55.)

Increased Investment for Fusion Programme

The United Nations (UN) will soon assemble an enormous global engineering research programme to design a prototype nuclear fusion reactor at a cost of $1.2 billion. The fusion process takes place continuously in the stars, releasing energy in the form of light and heat. Simulating that process on earth would require exacting conditions, including the heating of fuel to temperatures in excess of 100m °C, which is about 10 times as hot as the centre of the sun. The process creates energy by fusing atoms at high temperatures and the system aims at releasing more energy from the fusion reaction process than it consumes by heating the fuels. Power output depends on the density of the reactor gas and its volume; and power losses must be kept to a minimum by insulating the reactor from its surroundings. The energy released is in the form of high-speed neutrons, which can be utilized in electricity generation through conventional heat exchange.

Participants in the scheme to design and eventually construct the projected International Thermonuclear Experimental Reactor (ITER) include the European Community (EC), the United States, Japan and Russia. The programme will proceed under the auspices of the UN's International Atomic Energy Agency (IAEA). The extended ITER programme follows three years of conceptual design activities which put the construction costs of a reactor at $5 billion. The work will be overseen by a director from the EC and administered by a Moscow-based council comprising representatives of each participating country. The technological complexity, the elaborate global-scale administrative infrastructure of the project, participation of a large number of industrialized nations, and the multi-billion dollar resources required, all present a formidable challenge.

Deuterium, which is a heavy isotope of hydrogen in plentiful supply, would be the main fuel used for nuclear fusion. Unlike fossil fuels, nuclear fusion harnessed to power generation would not produce greenhouse gases or acid rain. According to the fusion enthusiasts, the system is inherently safe because any malfunction results in rapid shutdown and no long-lived radioactive wastes are generated by the system. The engineering design activities planned for the project will extend over six years. The work will involve industrial research and development institutions in all the participating countries. The project will lead to the construction of a test facility to demonstrate the technological and scientific feasibility of harvesting fusion energy. The participants are to decide, on completion of the engineering design work, whether to proceed with the construction of the reactor.

(Source: Extracted from "More Money for Fusion," *Petroleum Economist*, Vol. 59, No. 9, September 1992, p. 38.)

AEEMTRC: A Profile

ASEAN-EC Energy Management Training and Research Centre (AEEMTRC), ASEAN region's energy institution, was founded in November 1988, in cooperation with the Commission of the European Communities (CEC). Hosted for ASEAN by the Government of the Republic of Indonesia through the Ministry of Mines and Energy – Directorate General for Electricity and New Energy, AEEMTRC is located at the premises of the "LEMIGAS" Oil and Gas Technology Research and Development Centre in Jakarta.

The other member states of ASEAN support AEEMTRC by providing facilities and local costs for seminar-workshops, training courses, secondment of staff and by providing guidance, technical cooperation and back-up for research studies. The CEC provides cash funding to carry out part of the programme of AEEMTRC. It also provides a resident Senior Adviser and short term consultants on a need basis.

AEEMTRC's activities are laid out in a work-programme agreed by a Project Steering Committee (PSC) composed of the ASEAN Senior Officials on Energy Cooperation (ASEAN SOEC) and a CEC Representative from Brussels.

The main missions of AEEMTRC are:

- to strengthen cooperation in the energy sector among the ASEAN countries and between ASEAN and the European Community (EC) in the field of energy;
- to contribute to the ASEAN-EC dialogue on energy issues of mutual interest;
- to provide a focus for joint energy activities.

AEEMTRC is primarily engaged in energy management and policy research. It does in-house research and it also acts as a focus and a channel for ASEAN guidance in joint research activities with third parties. There are six distinct in-house research projects:

i) ASEAN Energy Database – ASEAN Energy Database has been prepared to enable a regular analysis of the regional energy activities and to act as a databank for the studies undertaken by AEEMTRC. It includes primary energy supply, energy transformation and energy final use. The yearly analysis of the data received from the member countries are regularly published in *AEEMTRC's ASEAN ENERGY REVIEW*. This publication aims to give a quick overview of the energy production, consumption and other energy developments in the region starting from 1973.

ii) ASEAN 2020 – This project aims to provide a comprehensive assessment of the energy situation in ASEAN and to identify opportunities for regional action. It is a long-term energy supply-demand study for ASEAN member states up to the year 2010 at the first stage. Also, the study is to help identify common problems and find opportunities where a cooperative effort in the region or between ASEAN and the European Community could be rewarding.

iii) Integrated Urban Energy Planning (IUEP) – This research programme aims to investigate the energy related problems in ASEAN urban areas, particularly their relationship with the social, economic and environmental aspects of ASEAN cities and urban communities, and to demonstrate the application of an integrated energy planning approach in their developmental planning processes.

iv) Valorisation of Energy Technology (VALENTE) – To assist ASEAN companies and institutions in their searches for advanced energy technology, AEEMTRC has launched the VALENTE Programme to promote a database on European energy technology. This programme aims to contribute to ASEAN's endeavours in developing energy conservation, utilizing advanced energy technology and fuel substitution.

v) Energy Pricing, Consumer Behaviour, Load Management – A preliminary study on this programme has been undertaken, i.e. on Price Behaviour in Electricity Demand which initially aims to determine the influence of various techno-economic determinants (especially price) on electricity demand in the ASEAN countries.

vi) Energy in Buildings – In this new programme, building codes and standards are related to energy saving and energy efficiency suitable for the region. This programme is intended to support the vigorous building programmes in the region.

Besides, AEEMTRC has a role to play, in working with third parties on matters of importance to ASEAN in order to facilitate transmitting of the guidance and decisions of the ASEAN Senior Officials Meeting on Energy Cooperation. AEEMTRC is currently carrying out projects of this character such as the Dissemination and Development on Technology for Energy Efficiency in Industry (DITECH) in cooperation with the Asian Institute of Technology (AIT). AEEMTRC is also involved in other ASEAN-EC joint programmes such as COGEN (Cogeneration).

AEEMTRC holds seminar-workshops on a regular basis to initiate research programmes, to transfer the results of its research programmes, to define research topics in emerging new areas of concern or simply to facilitate exchange of experience and opinions among experts from ASEAN and the European Community. Likewise, AEEMTRC together with the CEC conducts training courses. These training courses are also part of a wider EC programme on energy management for Asia including China and India. Aside from the aforesaid programmes, AEEMTRC also carries out specific programme assigned by "ASEAN Senior Officials on Energy Cooperation/ASEAN Economic Ministers on Energy Cooperation" and concurred by PSC, such as: Common Energy Reporting Format, Programmes of Action for Enhanced ASEAN Cooperation on Energy (PAECE).

For further information contact:
AEEMTRC
c/o PPPTMGB "LEMIGAS"
Jl. Ciledug Raya, Cipulir
Kebayoran Lama
Jakarta Selatan 12230

Postal Address:
P.O. Box 1089, Jakarta 10010
INDONESIA

Tel: 62 (021) 7398279
62 (021) 7394422
Fax: 62 (021) 7398279
62 (021) 716150

Training Courses/Conferences

International Conference on Energy Systems and Ecology

July 5 - 9, 1993, Cracow, Poland

Topics include the following:
- Thermodynamic and Thermoeconomic Analysis of Thermal Systems and Energy-Intensive Chemical Processes
- Environmental Impact of Thermal, Chemical and Nuclear Processes
- Mathematical Modeling and Optimization of Thermal Energy Systems
- Renewable Energy Systems and their Environmental Impact
- Economic Evaluation of Ecological Effects
- Improvement of Energy Utilization

For details contact:
Conference Secretariat
Institute of Thermal Technology
Technical University of Silesia
Konarskiego 22
44-101 Gliwice
POLAND
Fax: 48-32-372872

or

George Tsatsaronis
Tennessee Technological University
Center for Electric Power
P.O. Box 5032
Cookeville, TN 38505
USA
Tel: 615 372-3681
Fax: 615 372-3898

International Symposium on Heat and Mass Transfer in Energy Systems and Their Environmental Effects

August 22 - 25, 1993, Cancun, Mexico

The purpose of the Symposium is to provide an opportunity for engineers and scientists to present the state of the art, discuss new developments and exchange ideas in the area of heat and mass transfer in energy systems and their environmental effects. Invited lectures and contributing papers will be presented by researchers and practicing engineers from around the world.

Most of the renewable energy sources (solar, wind, biomass), energy conservation and environment will be extensively discussed. Topics to be included in the symposium are as follows:
- Improvement of energy utilization
- Thermodynamic analysis of cogeneration
- Energy intensive chemical processes
- Metallurgical processes
- Environmental impact of energy systems
- Mathematical modeling and optimization
- Thermoeconomical analyses of energy systems
- Air pollution
- New and advanced thermodynamic cycles
- Heat pumps
- Energy conservation
- Biomass energy
- Solar energy
- Wind energy
- Nuclear energy
- Waste heat
- Thermal pollution
- Combustion
- Turbomachinery

For details contact:
Professor Jaime Cervantes-de Gortari
Faculty of Engineering, UNAM
Mexico, D.F. 04510
MEXICO
Tel: 52 (5) 622-0882
Fax: 52 (5) 548-3044

The Taejon International Exposition

August 7 - November 7, 1993, Taejon City, South Korea

The International Exposition based on the theme "The Challenge of a New Road to Development" is organized by The Taejon International Exposition Organizing Committee. Sub-themes of the exposition include traditional and modern technologies for the developing world, and the way towards improved use and recycling of resources. Korea, as a developing country, is hosting the international exposition in which a more harmonious and balanced development in the coming 21st century will be eagerly sought and vividly envisioned.

The objectives of the exposition include:
- Sharing the experiences of Korea's development process and the technologies acquired during that process, thereby encouraging the desire for and the possibilities of future progress in developing countries.
- Seeking harmony between the high technologies of developed countries and the traditional cultures of developing countries by promoting understanding and exchanges between the North and the South.
- Offering opportunities to recognize and make public the crucial importance of the preservation of the earth's environment and efficient use of natural resources.
- Promoting development in science and technology, the main engine for economic development by providing today's youth with a vision toward the 21st century.

For details contact:
The Taejon International Exposition Organizing Committee
Taedok Science Town, Taejon City
SOUTH KOREA

Fifth Australasian Heat and Mass Transfer Conference

December 6 - 9, 1993, Brisbane, Australia

The Australasian Heat and Mass Transfer Conference provides a forum for the presentation and discussion of research and applied work. It is held

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1st AIT Training Course on Solar Photovoltaic Pumping Systems for Rural Development

15-26 November, 1993

Asian Institute of Technology, Bangkok, Thailand

The 1st AIT Training Course on Solar Photovoltaic Pumping Systems for Rural Development will be organized by the Division of Energy Technology, Asian Institute of Technology (AIT).

Course Design

This two week course is designed to provide participants with a technical understanding of pumping systems powered by solar photovoltaics. It is intended principally for persons who have responsibility for the selection and installation of small and medium sized rural water supply systems.

For most of the ten days of actual course work, mornings will be spent in lecture and demonstration sessions while afternoons will be used for practical work. Practical work sessions will be done in groups no larger than five persons per instructor. Practical work will utilize equipment commonly in use for solar pumping and the experiments are designed to show component operation and failure modes, installation requirements and troubleshooting and maintenance procedures.

By limiting the number of course participants, attention can be paid to each individual participant's needs. Each day, participants will be evaluated and examined regarding that day's work and additional study material and assistance provide participants where understanding of the course material is inadequate.

Instructors in the course include internationally recognized experts in photovoltaics as well as AIT technical staff, all which have long, practical experience with PV systems and pumping.

Pre-Requisites

Candidates should have an understanding of basic DC electricity and should have job responsibilities relating to the purchasing, specification, design, supervision, installation, repair or maintenance of solar PV systems.

Language

The course will be given in English language and participants need to have the ability to understand, speak and write in English.

Application

The number of participants is limited to 20. Applications using pre-registration form should reach AIT **not later than 1 October, 1993.** Acceptance will be on a **first come first served** basis, hence, applicants should submit applications as soon as possible.

Date and Venue

The course will be held from 15 to 26 November 1993 at the Division of Energy Technology of AIT.

Requests for additional information or Application forms should be mailed or faxed to:

The Secretary
Division of Energy Technology
Asian Institute of Technology
G.P.O. Box 2754, Bangkok 10501
Thailand
Fax: (662) 524-5439
or (662) 516-2126
Tel: (662) 516 0110–29
Telex: 84276 AIT TH
Cable: AIT Bangkok

Training Courses/Conferences

From P. 16

at approximately four year intervals and is organised by a host institution which has volunteered for the honour. The Fourth Conference was held at the University of Canterbury, Christchurch, New Zealand in 1989.

The Fifth Conference aims to stimulate participants to greater achievements by presenting keynote speakers with international reputations. Current research work will be discussed to keep up with the latest developments. Young authors are particularly encouraged to participate so that they can gain experience of debating their work in open company.

Possible topics include:

Processes
- Non-interacting heat and mass transfer *(conduction, convection, radiation, diffusion).*
- Interacting heat and mass transfer *(evaporation, boiling, condensation, ablation).*
- Reaction heat and mass transfer *(combustion).*

Environmental systems
- Meteorology
- Atmospheric effects *(dispersion of sprays, chimney plumes, greenhouse warming)*
- Oceanography *(thermal pollution)*
- Waste disposal *(pyrolysis, incineration, effluents)*

Biological systems
- Thermal comfort
- Horticulture
- Aquaculture

Modelling
- Instrumentation, measurement, control.

Engineering systems
- Refrigeration and air conditioning
- Mineral processing
- Drying
- Space vehicles

For details contact:

HMT Conference Secretariat,
Continuing Professional Education
The University of Queensland
AUSTRALIA 4072
Tel: 61-7-365-4069, 61-7-365-7100
Fax: 61-7-365-7099

Book Review

Economic Load Dispatch and Load Management Technology in the Asian Context

Economic and Social Commission for Asia and the Pacific
United Nations
New York
1992, v+145 p.

The demand for electricity in developing countries of the ESCAP region has been growing at a high rate. To meet this growing demand, utilities in these countries need an enormous amount of financial resources, technology, management capabilities and technical skills. Over the years the electric power industry has become a complex capital-intensive sector of the economy. Power system technology has evolved into a sophisticated system of engineering. Many developing country power systems have grown at a faster rate than their supporting capability. This has resulted in a sub-optimal system with several financial, managerial and technical problems. In many instances, information on the latest technologies do not flow freely to all the utilities. The latest thinking in this area goes beyond the load-shaping objective to demand side management, a total energy savings approach to reducing peak as well as base loads to create a long-term structural energy efficiency improvement in the economy.

Managing the demand side or demand side management is a relatively new concept for the utilities of the developing countries of the ESCAP region. To know more about demand side management and the techniques, methods and technology available in that area, a Regional Workshop on Economic Load Dispatching and Demand (Load) Management in Electric Power System Management was conducted in Malaysia from July 29 to August 2, 1991. The Workshop was jointly organized by ESCAP and the Government of Malaysia, within the framework set up by the Regional Energy Development Programme (REDP).

Part one of "Economic Load Dispatch and Load Management Technology in the Asian Context" contains a summary of the key presentations and the panel discussion of the Regional Workshop; part two contains the papers presented by the resource persons; part three contains abridged versions of country papers presented at the Workshop.

Resource persons providing inputs to the Workshop came from Electricité de France (EDF) and Schlumberger Industries of France, Monenco of Canada, International Institute of Energy Conservation (IIEC) of the United States of America, the Energy Conservation Centre of Thailand (ECCT), the National Institute for Development Administration (NIDA) of Thailand, and the Tenaga Nasional Berhad (TNB) of Malaysia. For the benefit of the large number of interested professionals and officials who could not attend the Workshop, these informative and high quality rated papers, together with selected abridged country papers, are included in this publication for wider dissemination.

Publications Received

ENERGY

* *Integrated Systems and Farm Energy Requirements*, by G. Pellizzi, F. Mazzetto and B. Biet, REUR Technical Series 22, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy, 1991, iii + 43 p.

* *Technical Information Directory: An International Directory of Organizations That Provide Information on High-Efficiency Energy Technologies* (2nd Edition), Compiled by Matthew Grund and Christopher Gronbeck, The International Institute for Energy Conservation, Washington, D.C., USA, October 1992, 129 p.

WIND ENERGY

* *Phase One Feasibility Study of A 20MW Wind Electric Power Plant in Costa Rica* (with Annexes), Prepared by International Development and Energy Associates, Inc., A Report of the Office of Energy and Infrastructure, Bureau for Research and Development, United States Agency for International Development and Instituto Costarricense de Electricidad, Costa Rica, Report No. 92-08, Bureau for Research and Development, United States Agency for International Development, Washington, D.C., USA, December 1992, v+110p.+Ann.

Diary of Events

- **3 – 5 June, 1993, Birmingham, United Kingdom**

6th International Meeting on Transparent Insulation Technology

With many successful transparent insulation technology projects now in place, the first day of this market-oriented event will focus attention on full-scale applications and will provide an introduction to the subject to potential users. The full programme will also include a technical tour as well as poster and oral presentations on research and development issues.

For details contact:
The Franklin Co. Consultants Ltd.
192 Franklin Rd.
Birmingham B30 2HE
United Kingdom
Tel: +44 21 459 4826
Fax: +44 21 459 8206

- **3 – 8 June, 1993, Beijing, China**

ELECTRO'93 (Second International Exhibition on Electrical Equipment & Technology for China)

For details contact:
Business & Industrial Trade Fairs Ltd.
18/F First Pacific Bank Centre
51 Gloucester Road
Wanchai
Hong Kong
Tel: (852) 865 2633
Fax: (852) 865 5513, 866 1770

- **8 – 11 June, 1993, Paris, France**

BIO EXPO 93

An international exhibition of biotechnology applied to research, industry and agriculture.

For details contact:
BIOEXPO/SEPFI-TECHNOEXPO
8 rue de la Michodiere
75002 Paris
France
Tel: (33) 1.47.42.92.56
Fax: (33) 1.42.66.14.28

- **13 – 17 June, 1993, Florence, Italy**

6th European Congress on Biotechnology

For details contact:
Department of General Physiology and Biochemistry
Via Celoria 26
1 20133 Milan
Italy

- **14 – 16 June, 1993, Borlange, Sweden**

The Third International Symposium on Renewable Energy Education

Organised by the ISES Working Group on Education.

For details contact:
Annette Henning
Conference Secretary SERC
Box 10044
S-781 10 Borlange
Sweden
Fax: 46 2437 3750

- **27 – 30 June, 1993, Pacific Convention Plaza, Yokohama, Japan**

International Conference on New Energy Systems and Conversions

For details contact:
Shigeharu Tanisho
NESC, Yokohama National University
Hodogaya-Ku
Yokohama 240
Japan
Tel: 045-335-1451
Fax: 81-331-1704

- **9 – 13 July, 1993, Quebec, PQ, Canada**

Solar in Action

19th Annual Conference of the Solar Energy Society of Canada.

For details contact:
Lynda Harris
Conference Co-ordinator
c/o SESCI
420-301 Moodie Drive
Nepean, Ontario K2H 9C4
Canada
Tel: 613 596-1067
Fax: 613 596-1120

- **12 – 16 July, 1993, San Francisco, CA, USA**

American Wind Energy Association Annual Conference and Exposition

For details contact:
American Wind Energy Association
777 N Capitol Street, NE
Suite 805
Washington D.C. 20002
USA
Tel: +(202) 408-8988
Fax: +(202) 408-8536

- **21 – 24 July, 1993, Edinburgh, United Kingdom**

1993 European Wave Energy Symposium

For details contact:
Mrs Elspeth Gibson
National Engineering Laboratory
East Kilbridge
Glasgow G75 0QU
United Kingdom

- **27 – 29 July, 1993, Bali, Indonesia**

16th International Conference of the IAEE with the Theme Energy, Environment and Sustainable Development: Challenges for the 21st Century.

For details contact:
Artono Arismunandar
Chairman of the Programme Committee
c/o REDECON
Gedung Patra Lt. 1
Jl. Gatot Subroto 32-34
Jakarta 12950
Indonesia
Fax: +62 21 515 133

- **10 – 13 August, 1993, Nashville, TN, USA**

Waterpower'93 – Hydropower: Its Role in World Energy

For details contact:
American Society of Civil

Engineers
345 East 47th Street
New York, NY 10017
USA

- **23 – 27 August, 1993, Budapest, Hungary**

Harmony with Nature: ISES Solar World Congress 1993

The biennial congress of ISES, the most significant event in the calendar for all those working in the field of renewable energies, is held this year in Budapest, hosted by ISES Hungary: the first time ISES has held one of their prestigous conferences in Central Europe.

For details contact:
ISES Solar World Congress
c/o Malev Air Tours Budapest
1367 P.O.B. 122
Hungary
Tel: +36 1 118 7836
Fax: +36 1 118 7359

- **26 – 27 August, 1993, Muronran, Japan**

International Symposium on Ocean Energy Development for Overcoming Energy and Environmental Crises

For details contact:
Prof. Hideo Kondo
Muroran Institute of Technology
Dept. of Civil Engineering and Architecture
27-1 Mizumoto-cho, Muroran
Japan 050

* **5 – 8 October, 1993, York University, York, United Kingdom**

British Wind Energy Association 15th Annual Conference

Organized by Yorkshire Water.
For details contact:
Keith Pitcher
Yorkshire Water
Western House
Halifax Road
Bradford BD6 2LZ
United Kingdom
Tel: +44 (0) 602 483838
Fax: +44 (0) 602 472977

- **18 – 22 October, 1993, Seoul, South Korea**

ENERGEX'93, 5th International Energy Conference

For details contact:
Secretariat
c/o KIER
P.O. Box 77
Taedok Science Town
Taejon 305-343
Korea
Tel: 042-861-6230
Fax: 042-861-6231
Tlx: KIEREL K45507

- **16 – 18 November, 1993, Guilin, China**

An International Symposium on Medium and Small Sized Hydropower Stations

For details contact:
Ms. Liu Zhonggui
Bureau of Water and Hydropower
Guangxi
Jianzheng Road 12
Nanning, Guangxi
China

- **23 – 25 November, 1993, London, United Kingdom**

3rd International Conference on Power Cables and Accessories – 10 kV–500 kV

For details contact:
Ms. Louise Bousfield
Conference Organizer
IEE Conference Services
IEE
Savoy Place
London WC2R 0BL
United Kingdom

- **1 – 5 December, 1993, Perth, Australia**

Solar'93: Bridging the Gaps Between Research, Development and the Markets

For details contact:
Bev Jolly
Solar'93 Conference
Debrett's, PO Box 445
South Perth WA 6151
Australia
Tel: (09) 474 1556
Fax: (09) 474 2030

- **13 – 15 December, 1993, Florence, Italy**

Uprating and Refurbishing Hydro Powerplants–IV: Conference and Exhibition

For details contact:
Lindsey Maskell
Conference Co-ordinator
Water Power & Dam Construction
Quadrant House
The Quadrant
Sutton, Surrey SM2 5AS
United Kingdom

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Library and Regional Documentation Center, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The "RERIC News" is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership along with the other four regular publications namely: RERIC International Energy Journal (formerly: Renewable Energy Review Journal); RERIC Holdings List; Abstracts of AIT Reports and Publications on Energy; and RERIC Membership Directory. For further details contact:

Regional Energy Resources Information Center
Asian Institute of Technology
G.P.O. Box 2754
Bangkok 10501, Thailand
Telex: 84276 TH
Tel: 5245866
Fax (66-2) 5245870

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SMALL SCALE WIND ENERGY SYSTEMS

Published with financial support from the Netherlands Minister for Development Cooperation
Editors: Goezinne & Veldkamp, Renewable Energy Consultants

EDITORIAL

I must be brief as there is a lot of news.

Frank Goezinne/G&V, The Netherlands

SAFETY OF WINDMILLS – The Danish Approach

Throughout the last 15 years, the safety of windmills has been a matter of great concern in Denmark with special regard to avoidance of third party injury in case of failure.

Basically, this concern has been part of a responsible approach.

As a result, according to public opinion in Denmark, windmills are considered safe.

Obviously, general acceptance of windmills as an integral part of everyday life implies a very high degree of third party safety. Just a few fatal accidents caused by the operation of windmills might cause a serious setback in the development and spread of wind power.

The experience gained throughout these 15 years has confirmed the general consensus of opinion, that safety is ultimately a question of controlling the driving torque. Consequently, an aerodynamic effect reducing device is considered indispensable. This requirement is embodied in the Danish code of practice for windmills as well as in the Danish certification system.

The fundamental reason for the superiority of an aerodynamic effect reducing device over any kind of shaft brake is, that an aerodynamic device counteracts the driving torque at the very source regardless of failure in other parts of the windmill. Any shaft brake implies the integrity of the main shaft and possibly the transmission.

As compared to a friction brake, the aerodynamic device has the further decisive advantage, that it reduces the very driving torque or produces a counter torque increasing linearly with the rotational speed as does the driving torque. A friction brake produces a constant torque regardless of the rotational speed. Thus, at increasing rotational speed any friction brake may get overpowered.

Finally, an aerodynamic device requires ordinary maintenance only. In contrast a friction brake may fail, unless parts subject to wear are replaced regularly.

A safety device reacting to high winds only is inadequate. The device must secure the windmill against runaway in any case of operation or failure regardless of wind speed.

With regard to horizontal axis windmills, yawing off may apply to slow runners. Fast runners require air brakes, possibly in the form of turnable blades, as yawing off implies severe additional gyroscopic loads. In the absence of a safe aerodynamical yawing system, the air brakes must be fully operative even in case of adverse winds. Similarly vertical axis windmills require air brakes.

Jacob Bugge, Folkecenter for Renewable Energy, Denmark

SUBSIDY FOR NEW DEVELOPMENT IN DENMARK

Three Danish manufacturers of small windturbines have received subsidy for technical development of their plants. The subsidy is granted by Danish Energy Agency's technical committee for renewable energy as a consequence of the recommendations in the report: "Statement of Small Windturbines".

"DK-Milieu" develops the Kolibri, a two bladed downwind turbine with 6 meters diameter and 4 kW installed power to be grid connected in the household. The target group of the market is single houses in the countryside. The subsidy will be used to improve the pitch regulation, yaw system and the brake system in cooperation with Folkecenter for Renewable Energy.

"Windflower" develops a multi-bladed turbine with 12 narrow aerodynamic blades and a rotordiameter of 6 m. The installed power is 11 kW. The subsidy is for all purpose development of the plant. The target group of the market is single houses, domestic and developing areas abroad without access to electricity today.

"BJ Steel" develops a multi-bladed turbine with 8 blades and a rotordiameter of 6 m. The synchronous generator has 10.7 kW nominal power and the power is used for stand-alone purposes. The subsidy is to finance the improvement from a mechanical pump turbine to an electrical unit.

Peter Rasmussen, Folkecenter for Renewable Energy, Denmark

STATEMENT OF SMALL WIND TURBINES

The Danish Energy Agency's technical committee for renewable energy has in December 1992 published a report with the title "Statement of small wind turbines".

The report describes the products, the development potential, the operation costs of the turbines and the sales potential of the Danish industry for small wind turbines.

The report identifies 14 different types of wind turbines distributed on 9 different manufacturers/developers. The size of the wind turbines are from 1.5 to 22 kW being stand-alone as well as grid connected wind turbines. The best economy is obtained by grid connected wind turbines of 10-20 kW. By these wind turbines, at a location of roughness class 1.5 and without subsidies, an economy can be obtained which is at least even as good as the economy for a solar heating plant which is subsidized by 30%.

In Denmark there are about 135,000 freely situated houses of which about 30,000 have wind conditions which are better than roughness class 2.3 and 10,000 having a roughness class better than 1.5.

In Denmark in 1920 about 30,000 farm mills were installed for water pumping and for operation of agricultural machines. Today about 180 small wind turbines are in operation for production of heat and most of them are not grid connected. In addition to this there are 4 different makes which are in the prototype phase and 5 in the design phase.

The statement work concerning small wind turbines has been followed by a steering group, appointed by the Danish Energy Agency. A majority of this group recommends the Danish Energy Agency to make the small wind turbines (household wind turbines) to a special area of effort for research and development for the years to come.

The report which is in Danish has been published by BTM Consult, Fax. No. +45 9736 9293.

Lars Yde, Folkecenter for Renewable Energy, Denmark

COLOMBIA GETS THERE BEFORE EUROPE

Great minds think alike. Dr John Burton recently reported that he had found a Colombian artisan who had built a windpump with a long stroke gear. A large elliptical gear is employed to give a long steady stroke, thus avoiding the dynamic forces that are common with short stroke pumps on direct drive small windpumps. This type of gearhead for a windpump was first used by a system manufactured in Canada at the turn of the century. In the 1904 Royal Agricultural Society tests, the wind machine pumped twice as much water as its commercial rivals. Part of its apparent success may well have been the way the test was conducted, however whatever the limitations of the comparison, the windpump with the elliptical gearhead sold well and was a popular model.

Recently, as reported previously, IT Power (UK) have picked up on the concept of an elliptical gear and with modern materials have proposed a new small diameter version. This project has been funded by the EEC and the industry eagerly awaits the outcome.

But while the weight of European expertise continues, a Colombian artisan has already explored the same idea. Dr Burton reported that he saw a small diameter windpump, with a long stroke created by an elliptical gear. Some people in the industry have voiced concern about the IT Power project, over whether such a complex gear system can be locally made. Perhaps the fact that the Colombian artisan has one already operating shows that such a gear can be made in a light engineering workshop. The one caveat might be that without the use of modern materials, Dr Burton comments that the system already showed signs of wear (although the age of the system was not known).

Simon Batchelor/Gamos Ltd (UK)

A MODERN OLD WINDMILL

Imperial College have for some time been researching the possibilities of a small wind generator for the Isle of Crete. The Lassithi plane on Crete has an interesting and famous history in windpower and the new developments seek to build upon that history. The farmers on the Island have used sail cloth wind turbines for pumping water for many years. So many years in fact and in such large numbers that the wind turbines have become part of the "culture" of Crete. The association is so close that tourists of Crete look for and expect sail cloth windpumps, and European wind technicians tend to speak of all sail cloth wind turbines as "Cretan wind turbines". With this in mind the proposal to place a wind generator on the Island met with an interesting condition from the authorities there. They decided that the blades of the wind generator should have a similar appearance to the old systems, and thus be in harmony with the landscape of the Island. This has given Imperial College an opportunity to look again at small scale generation of electricity from wind power. Even with few "sail cloth" blades the main shaft rotation is relatively slow when compared to other low solidity rotors of the same diameter. Prof Leon Ferris with his post graduate students have considered a new low speed generator. This new generator may hold the key to a workable design. Regarding the rotor, at one point the team considered wind surfing sails as possible ready made blades. A prototype has been built and Mr Nigel Scott has taken up the project to develop the full working system. The design constraint of "cloth sails" may cause the Imperial College team to do some hard thinking but perhaps with such a challenge there may be interesting innovations for wider use in the industry.

Simon Batchelor/Gamos Ltd (UK)

THE POWER GUIDE

The price or reliability of petroleum supplies, the increasing biomass scarcity, and pressures to reduce environmental pollution are increasing the interest in renewable energy sources as an alternative to fossil fuels. Wind, solar, hydro and biomass are particularly suited for use with small scale decentralised energy systems. The common but basic questions facing those responsible for energy supply, be they government energy planners, development project managers or small business entrepreneurs, are: which energy source and its conversion technology are appropriate for their specific situation and where can they obtain such equipment?

The Technology and Development Group (TDG), at the University of Twente in the Netherlands, have been well aware of these questions through their training courses in Rural Energy Planning and Energy Management in Small and Medium Scale Industries. For more than 10 years, they have provided, as part of their course material, a directory of renewable energy equipment to help course participants with the selection of the most appropriate equipment. TDG felt it was time to pass this information and their experience on to a wider audience and have joined forces with IT Publications, Intermediate Technology Development Group and Densi Tech to produce "The Power Guide: An International Catalogue of Small Scale Energy Equipment". The aim has been to publish a book which is more than a list of addresses, but instead is a manual with guidelines for the selection of the most appropriate renewable energy source as well as providing information on more than 350 commercially available items of conversion equipment.

The information is broken down into chapters on PV, wind, micro-hydro and biomass. Each chapter has an introduction with guidelines on equipment selection and the possibilities and constraints of using that energy form. This is followed by manufacturers data which contain key information on the equipment, presented in a systematic way to enable the reader to compare the options available. Selection guidelines are also included on solar thermal systems and small gasoline and diesel engines.

Considerable effort was made to ensure South manufacturers are well represented (more than half of the entries). Data was collected by counterparts spread across 15 countries in Latin America, Africa and Asia. (RERIC was one of the contributors).

The Power Guide (ISBN 1 85339 192 1) is to be published in the second half of 1993 and will be available by post from IT Publications at 103-105 Southampton Row, London WC1B 4HH, UK.

The project has been financially supported by the Dutch Minister for Development Co-operation.

Further information can be obtained from: Dr J Clancy, Technology and Development Group, University of Twente, PO Box 225, 7500 AE Enschede, The Netherlands. Fax +31 53 340822. Telex 44200 thtes nl.

Joy Clancy,
project coordinator

PRESENT STATE OF SMALL SCALE WIND ENERGY IN MOÇAMBIQUE

The utilization of wind energy for water pumping purposes is not an entirely new phenomenon in Moçambique: as early as the 1930's the Portuguese settlers, in majority small farmers, and often only a little above subsistence level, introduced windmills from South-Africa and (then) Rhodesia for irrigating their fields.

Around the Moçambican Independence in 1975, almost all of these windmills were abandoned, if not destroyed by the departing Portuguese, as they did to many of the machines, equipment and other parts of the infrastructure that could not be shipped back to Portugal. But even the windmills that remained in working conditions, were no longer being used, since the Moçambican farmers never had been trained, neither in the practice of irrigation, nor in the utilization of a windmill. In the years to come most of the existing windmills would deteriorate beyond repair. Also the fact that many of these small areas of approximately 5 to 10 ha were joined together into large scale state-controlled agricultural enterprises, did not make things easier nor improved production.

Only in the mid-80's arose an increasing awareness of the importance of the small private and family sector farming for the agricultural production and many of the 2,000 to 10,000 ha schemes were divided to be cultivated by small-

Cont. P. 4

PRESENT STATE OF SMALL SCALE WIND ENERGY IN MOÇAMBIQUE

From P. 3

scale farmers. Old irrigation schemes were being recuperated, new schemes developed. This too was the era that some of these farmers were looking for alternatives for diesel and electric pumps for irrigation purposes. With the aid of donor organizations abroad, windmills were being purchased in South-Africa and Zimbabwe. One Dutch development organization, NOVIB, set up a metal processing factory in Chicumbane (Gaza province), where windmills of the Dutch CWD 2740 type were being manufactured. Of the about 120 windpumps manufactured, some 90 have been installed, but due to the situation of an internal war (from 1980 to 1992) not much is known about the state or condition of most of those that have been placed in rural areas.

Exceptions are the windmills that have been placed in an area around the city of Xai-Xai in Gaza province and those in the Green Belts around the provincial capital Beira in Sofala. The project of the windmills around Xai-Xai unfortunately was ill-conceived: donated to the farmers along the Colector do Lumane by the provincial government, without prior consultation of, or information to them, the farmers did not really know what to do with the windpumps. Worse even, when they were told that the windmills were a gift but when being used the farmer had to pay for the water pumped, most of them preferred to continue drawing water from the Colector by hand and uncharged.

The Swiss trade union-related development organization SAH initiated a project of installing 12 CWD 2740 windmills from Chicumbane in the Green Belts around Beira. In the beginning also this project suffered from basic problems, such as lack of training and duly informing the owners. Because of targeting small, family sector farmers which previously only practised rain-fed agriculture, this implied that these had to be educated well about the operation and maintenance of the windmills, as well as about the practice of irrigation. After some initial failures, the set-up of the project was improved and presently there are now some 7 windmills in full operation. Especially during the latest years of a severe and persevering drought in the region, the windmill-irrigated plots proved to be exceptions, yielding a good agricultural production.

Recently SAH approved a 4-year project to install some more 10 windmills of the same type in the Beira area, while plans are being developed to install another 10 windmills around Maputo and to recuperate some of the Xai-Xai windmills.

Studies of (a.o. by the Dutch windmill specialist consultants of Goezinne & Veldkamp Consultants) and experience with above mentioned projects show that in Moçambique windmills turn out to be a useful alternative for diesel pumps (which are too expensive for small farmers, while many times diesel is not available) and electric pumps (too expensive; too far away from the grid). Provided that a great deal of attention is being paid to particular problems with the introduction of this technology for this target group of farmers.

A serious problem is that – when a windmill has to be imported or manufactured locally from imported materials – the price is not competitive with e.g. a diesel pump. But a diesel pump is not only also too expensive for this kind of farmer (both in purchase as well as in operation), but also of too large a capacity for their small area. Organizing farmers to jointly operate an irrigation devise often is very difficult or even impossible.

Research is now being started to find out whether there are possibilities to introduce either materials or technology from other, more similar, countries (e.g. India; Sri Lanka), hoping that this may lead to a more accessible price for a locally to be assembled or produced windmill.

Even with a very low (subsidized) price for the windpump, this proves to be beyond the reach of the target group: the small-scale, family sector farmer – subsistence and with often no more than 0.5 to 1 ha. So the projects recognized the need for a credit system (these farmers have also no access to bank credits) and set up a loan system. In several cases this showed to be a success and the increased production enables these farmers to pay back regularly the loans into the Revolving Fund, from which other windmills can be pre-financed.

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Citation is encouraged on the condition that the source is indicated.
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Energy Efficiency in ASEAN Countries: A Survey

An unprecedented survey of the industrial sector's perceptions of and attitudes towards energy efficiency was launched in ASEAN countries by ASEAN-EC Cooperation in Dissemination of Energy Technology (DITECH) at the end of November 1992.

DITECH aims at expanding and strengthening the capabilities of ASEAN countries in the field of efficient energy use.

One thousand copies of the questionnaire were sent to firms in Thailand, Singapore, Malaysia, Indonesia, the Philippines and Brunei, through national institutions, such as ECCT, KONEBA, etc.

Firms responded well to the survey and 191 completed questionnaires were received by the DITECH Project Office at AIT, Bangkok.

The results of the survey are extremely interesting as they reveal ASEAN countries' perceptions of energy related matters, while allowing us to identify the specific concerns of each country.

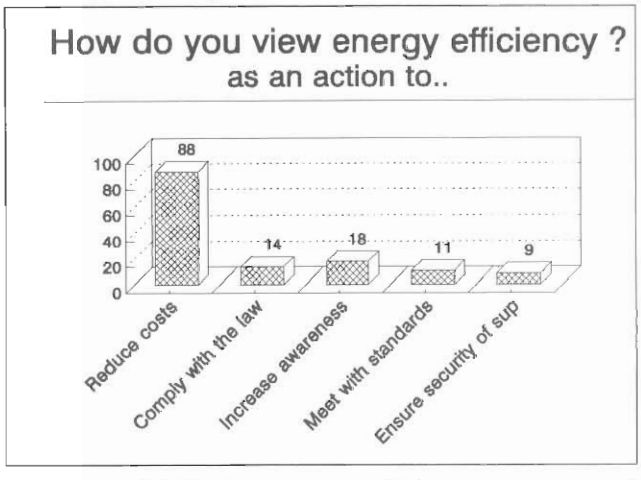
What is the Perception of Energy Efficiency in ASEAN Countries ?

98 % of the firms which responded believe that energy efficiency can play an important role in managing production costs.

88 % view energy efficiency as a way to reduce costs.

These high figures reveal a general concern about costs in ASEAN countries.

1. How do you view energy efficiency ?



88 % view energy efficiency as a way to reduce production costs. Energy efficiency is considered first in its economic dimension, and we can assume that firms are primarily interested because of its economic impact.

The second view, in terms of percentage and ranking, is of energy efficiency as an action to create more awareness for a better environment. Even though this concern lags far behind the predominant perception, firms do see energy efficiency as a way of improving the environment; being energy efficient will not only reduce costs, but will also protect the environment.

15 % perceive energy efficiency more as a legal constraint, than as a voluntary action to improve the firm's efficiency.

It is well known that an appropriate legal infrastructure for energy related matters will produce greater and faster changes in the industrial sector.

Setting energy standards for all the different activities could be a satisfactory solution.

Already **10** % of the firms believe that energy efficiency is a way to meet international standards.

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INNERTAP

Incorporates news from the Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

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Supplement: Small Scale Wind Energy Systems

Energy Efficiency in ASEAN Countries

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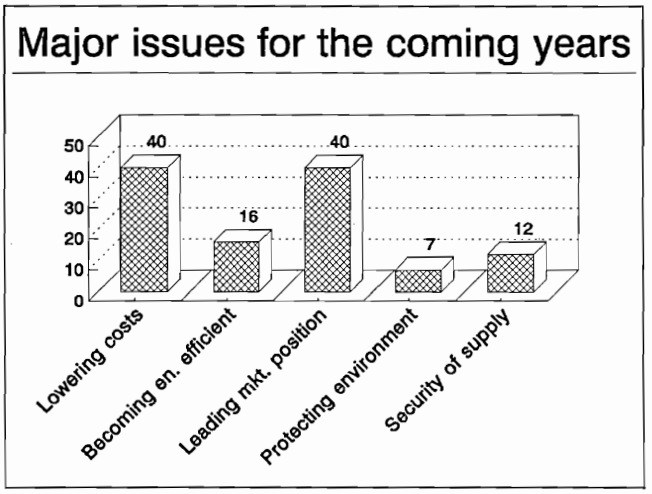
No major differences emerged among the different countries' perceptions: cost control was the dominant concern.

2. Major issues for the coming years



40 % of the firms which responded think that lowering overall production costs will be the main problem in the coming years.

40 % believe ensuring a dominant presence on the market will be the critical issue.

16 % feel that becoming energy efficient will be the most crucial.

Evidently, energy efficiency will play a major role in the overall management of firms, not only because 16 % named it as their chief concern in the coming years, but also because energy efficiency plays a direct role in the other issues selected by the firms.

First, energy efficiency is directly linked to reducing production costs as acknowledged by 98 % of the firms, and cost reduction is all firms' major objective in the coming years.

Second, energy efficiency is connected to other issues also selected by the firms, such as security of supply, protecting the environment and modernizing equipment.

Whatever their size, type or country of origin, all the firms considered cost control as the biggest challenge of the future.

Most firms feel concerned by the environment and energy situations of their countries :

89 % of the firms which responded think that their country's energy situation and environmental problems are of direct concern to businesses, and as they are part of the economic momentum, they share a common responsibility to improve it.

It is only in Brunei, that 67 % of the firms which responded think that the country's energy situation is not directly related to business, and that these issues should be treated at government level only.

The industrial sector in ASEAN Countries appears to have quite a homogeneous perception of energy efficiency.

Energy efficiency is perceived mainly in the light of its economic impact, rather than in view of its environmental benefits.

How do Firms in ASEAN Countries Perceive Their Own Energy Consumption ?

93 % of the firms which responded believe they can reduce their energy consumption.

This means that only 7 % of the firms view their factory as being energy efficient.

3. How can you reduce your firm's energy consumption ?

By improving existing fittings through repairs and better maintenance: **33%** / by informing and training the employees to reduce energy losses: **40%** / by replacing old machines with modern, energy efficient equipment: **23%**

To lower their energy consumption, industrialists think they should first inform and train employees to reduce energy losses; second they should improve existing fittings through repairs and better maintenance, and third, replace old machines with modern, energy efficient equipment.

This shows that the simplest and least expensive improvements are considered before the more expensive ones, such as changing the equipment.

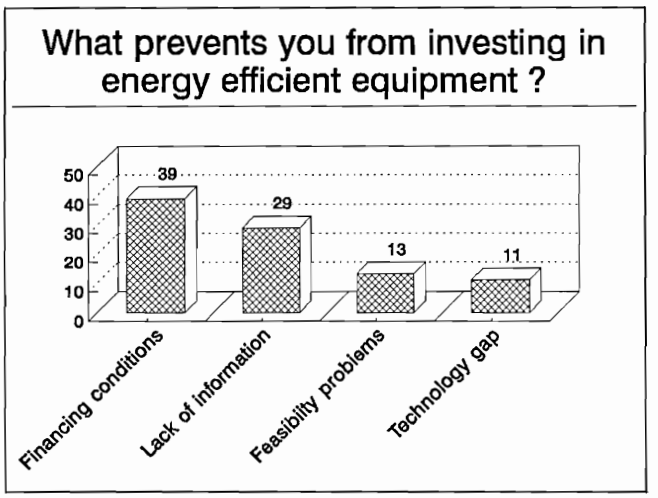
Previous studies have shown that the less costly improvements can considerably decrease the amount of energy consumed as is mostly recommended by experts in energy audits.

The more expensive investments should be made only after ensuring good maintenance in the factory of existing equipment, and employing a fully aware and trained staff.

While the majority of the firms think that they can reduce their energy consumption, and have some ideas about how to do it, many do not implement these projects.

What are the Barriers to Energy Efficiency in ASEAN Countries ?

4. What prevents you from investing in energy efficient equipment ?



The principal barrier for the industrial sector in all ASEAN countries is financing conditions.

Many firms which responded suggested that there are no financial in-

centives to invest in energy efficient equipment. Import duties and interest rates are too high, pay back periods are inadequate and there are no tax rebates on the cost of new equipment purchased to comply with the government's regulation on energy efficiency; these are some of the many examples given by the firms.

The second barrier is the lack of information.

Dissemination of information is the first step towards improving the energy efficiency of firms in ASEAN countries.

The information must be precise, accurate, and often, should be backed by demonstrations and technical assistance.

Once the information is easily and regularly accessible to the firms, the technology gap will rapidly vanish.

The third barriers are the feasibility problems, and the technology gap.

5. What do you expect from the government on this issue ?

To provide more information on the subject: **48%** / to provide technical assistance: **31 %**/ to improve financing conditions: **29 %**

Surprisingly, although financing conditions constitute the most chief obstacle, firms would like more information from their governments first, followed by technical assistance and then an improvement in financing conditions.

This is easily explained, since information is a prerequisite for the successful transfer of technology.

Efforts by public institutions should concentrate on the dissemination of information concerning the widest range possible, the organization of seminars, conferences, demonstration projects, the mailing of documents, etc.

6. What do you expect from international cooperation ?

To give more information on the subject: **61%**/ to provide technical assistance: **36%** / to increase its financial support: **19%**

Firms feel an even greater need for information from international cooperation.

They expect more information from industrialized countries.

The industrial sector clearly wants to benefit from international cooperation.

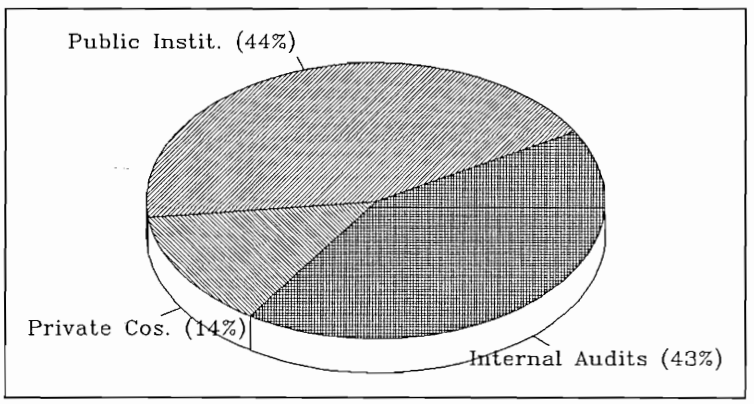
What Concrete Actions Have Firms in ASEAN Countries Taken to Improve Their Energy Efficiency ?

58 % of the firms which responded say they have an energy management program.

52 % have had an energy audit.

It is interesting to note that among the small firms, only 3 % have been audited; whereas 56 % of the medium-sized ones and 40 % of the large firms have been audited.

The energy audits were conducted by :



85 % of the audited firms were given recommendations to increase their energy efficiency.

Of those 85 % :

59 % say they have or will implement all the recommendations.

32 % say only a few of them have been or will be implemented.

9 % admit that none of them have been, or will be implemented.

The fact that often firms will not implement recommendations is a difficult problem, and a source of concern.

It reveals that there are the concrete reasons for not improving energy performance. Some firms explained that financial constraints, management crises, having other more urgent priorities, and difficult business market conditions prevented them from implementing the recommendations.

Firms have extremely positive attitudes about energy related matters.

In **91 %**, the manager of the firm encourages the efficient use of energy.

Examples given were :

* Replacing old machines with energy efficient equipment.
* Supporting energy conservation programs.
* Circulating guidelines on how to reduce energy use.
* Monitoring all operating energy parameters.
* Publishing energy conservation projects in the newsletter.

All firms think that individual employees can encourage the efficient use of energy in their work. However, they concede that if there is no support from top management, employees cannot individually improve a process or substantially modify something in the firm.

51 % of the firms which responded say that they have provided basic information and training to their employees to increase their awareness of energy related matters.

Although quite satisfactory, this percentage should increase because information is the fundamental key to increasing efficiency.

7. Important criteria when buying new equipment

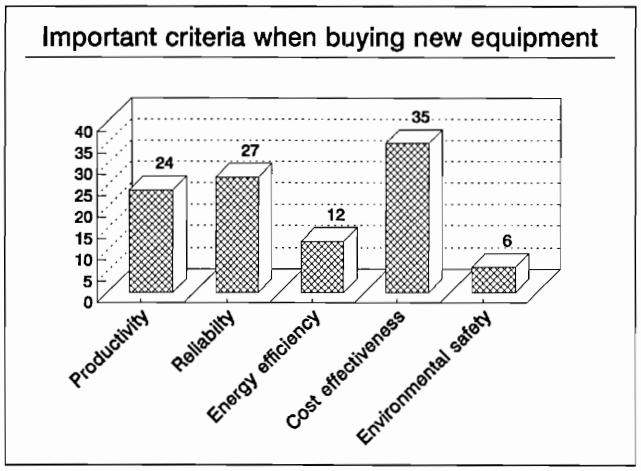
Energy efficiency is not yet one of the fundamental criteria when selecting new equipment.

Is the Industrial Sector Aware of EC-ASEAN Cooperation in Energy ?

Cont. P. 4

Energy Efficiency in ASEAN Countries

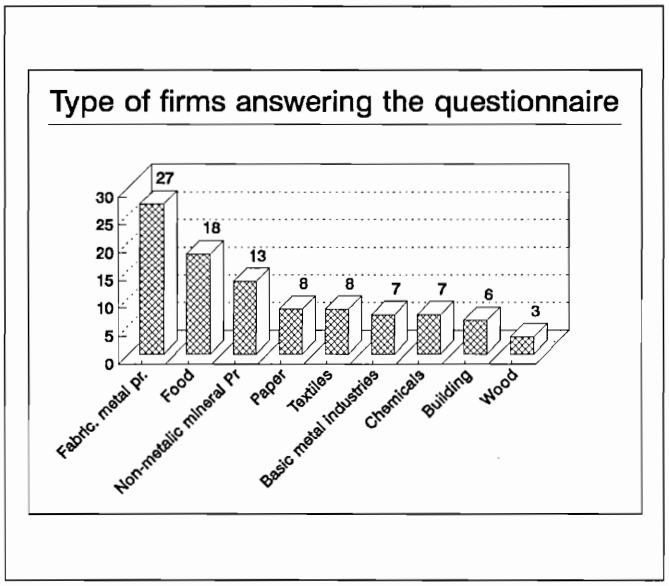
From P. 3



15 % are aware of recent EC-ASEAN cooperation in energy (DITECH, COGEN, VALENTE).

2 % are familiar with the EC Investment Partner.

16 % know of tax incentives, soft loans and grants provided by their countries to promote energy conservation.



10 % are aware of the Energy Conservation Fund.

Still, **77 %** are not aware of specific financing conditions for energy conservation.

1 % have heard of THERMIE, the latest European Program for the promotion of European energy technology.

5 % have participated in European cooperation programs.

87 % want more information on this matter.

Source: Extracted from "Industrial Sector's Perception of and Attitude Towards Energy Conservation Efficiency and Cooperation" by Aude de Margerie and Giap Van Dang, ASEAN-EC Cooperation in Dissemination of Energy Technology (DITECH), 1993.

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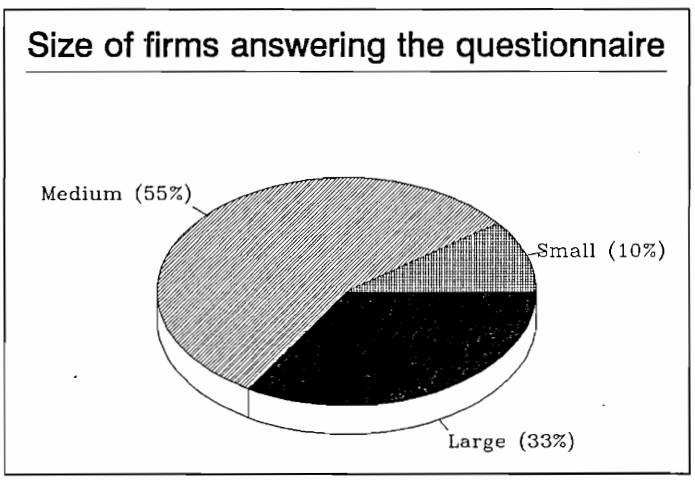
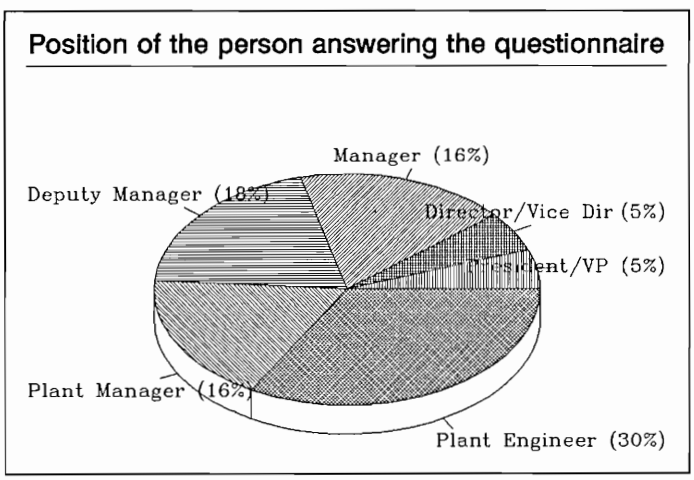
Fax: (66-2) 516 2126

Number of questionnaires sent : 1000
Number returned : 191

Country	Number of Questionnaires Sent	Number of Completed Questionnaires Received	Size of Firm
Thailand	250	45	11% small 66% medium-sized 29% large
Singapore	100	35	19% small 60% medium-sized 16% large
Malaysia	200	30	13% small 53% medium-sized 29% large
Philippines	200	45	48% medium-sized 52% large
Indonesia	200	33	9% small 42% medium-sized 47% large
Brunei	50	3	2 small 1 large

The results never amount to 100, either because the firms could choose more than one answer, or because not all the firms filled out the entire questionnaire.





Some Facts about Solar Energy in Israel

Solar energy, at present, accounts for over 3% of the total energy consumption in Israel, and is used mainly by Solar Domestic Hot Water Heater (SDHWHs) applications. It makes Israel the world's largest solar energy user per capita. The share of solar power in the energy market is expected to rise to 4.5% by the year 2000. The components for SDHWHs and other applications of solar energy are provided by local industry. Although, the majority of SDHWHs utilize natural circulation systems for hot water supply, especially in residential units, forced flow installations are also used in the commercial and industrial sectors. About 65% of all households in the country have SDHWHs supplied with a guarantee of up to 8 years. Israeli legislation requires that every new apartment building up to 9 stories will employ a SDHWH.

While Israel does not yet have a commercial solar power plant, the Jerusalem-based Luz Company has manufactured concentrating trough collectors for the construction of thermal power plants in the USA. The company has installed a number of electricity generation units with overall capacity of more than 350 MW; these comprise about 95% of the world's electricity supply produced by solar energy. The Negev Desert is the region best fitted for solar power stations in Israel due to abundant sunshine and extensive undeveloped space. A solar radiation and land survey is being carried out there to choose the best location for future solar power stations.

Two types of solar ponds have been investigated in Israel. The first is the salt-gradient solar pond. Large-scale efforts to utilize solar energy trapped in salt-gradient solar ponds, by means of organic Rankine cycle turbines and applications to solar desalination have been made. The other is a thermal diode solar pond based on the use of fresh water.

Various solar thermal units with novel solar collectors (Paz/Pimat), selective coatings and cooling systems have been constructed. The technology of solar space heating and absorption air-conditioning (Paz-Gal) has also been developed, demonstrating technological feasibility in various applications.

Solar energy is extensively utilized on a large scale for industrial evaporation at the Dead Sea Works and in sophisticated greenhouses all over the country. The use of photovoltaic systems is rapidly increasing, mainly in small-scale systems. The applications include an experimental project for the supply of electricity to single houses in a small community, spot illumination and emergency communication. Passive climate control principles were developed and are being increasingly considered in designing new buildings. At present, advanced R&D is being carried out by research institutes, universities and industry, encouraged by the Ministry of Energy and Infrastructure. Some of the projects are close to commercialization. Two large facilities for solar R&D, the Sde Boqer Test Center and the Weizmann Institute Solar Tower, are in operation – investigating various methods of electricity production and thermal utilization.

Israel was the first country to utilize solar energy on a commercial basis. Israel is among the world's leaders in the application and development of solar energy. A strong capability exists to supply a variety of solar energy technologies. About $38 million have been invested between 1979-1990 in a number of industrial scale solar demonstration facilities throughout the country. Most of them are still in operation. Different projects are at various stages of development, including some at or near commercialization.

(Source: Extracted from "Solar Energy in Israel – Utilization and Research," a paper presented at Israel - USSR Energy Conference, May 13-15, 1991, by Professor Y. Zvirin (Israel Institute of Technology, Haifa) and S. Zamkow (Israel Ministry of Energy and Infrastructure, Jerusalem), Israel.)

PV Panel from BP Gets Bigger

A new solar module capable of producing up to 75 watts using the latest monocrystalline wafer technology is now being marketed by BP Solar Australia Pty Ltd. The new High Power Solar Module BP275 is the most powerful single module to be manufactured in Australia, according to the company sources. The new module uses 36 high efficiency (14%) monocrystalline packed into 1188 x 530 mm (0.63 m^2 area) cells to produce an average peak power of 75 watts in 1000 W/m^2 irradiation and 25°C air temperature. These large area cells are made from high purity silicon wafers using the latest integrated circuit wafer technology. The modules deliver an open circuit voltage of 21 V at peak power and 17.5 V at maximum power when charging 12 V battery arrays.

The module is housed in an anodised, high strength aluminium alloy frame and is highly resistant to water, hail abrasion and impact. Each unit weighs only 8kg and uses low iron, high transmission self-cleaning glass manufactured to comply with both Australian and international standards. A weatherproof junction box is fitted to the rear of the panel which contains glanded screw terminals for connecting cables. A bypass and blocking diode option is available.

The new module can be used for a wide range of applications including telecommunications, navigational aids, telemetry, cathodic protection, radio networks, rural electrification, domestic utilities and for remote area applications.

(Source: Extracted from "Bigger PV Panel from BP," *Solar Progress*, Vol. 13, No. 4, Summer 1992-93, p. 21.)

A Timber-drying System Fuelled by Sawdust

A 16 m^3 capacity (equivalent to approximately 7,000 board feet of timber) timber-drying system heated by a suspension burner capable of burning sawdust and other particulate wood waste typically produced from sawmills and wood workshops has been developed by the Natural Resources Institute (NRI), Chatham, United Kingdom.

The Natural Resources Institute (NRI) is an internationally recognized centre of expertise on the natural resources sector in developing countries. It forms an integral part of the British government's overseas aid programme. Its principal aim is to alleviate poverty and hardship in developing countries by increasing the productivity of their renewable natural resources. NRI's main fields of expertise are resource assessment and farming systems, integrated pest management, food science and crop utilization.

NRI carries out research and surveys; develops pilot-scale plants, machinery and processes; identifies, prepares, manages and executes projects; provides advice and training; and publishes scientific and development material.

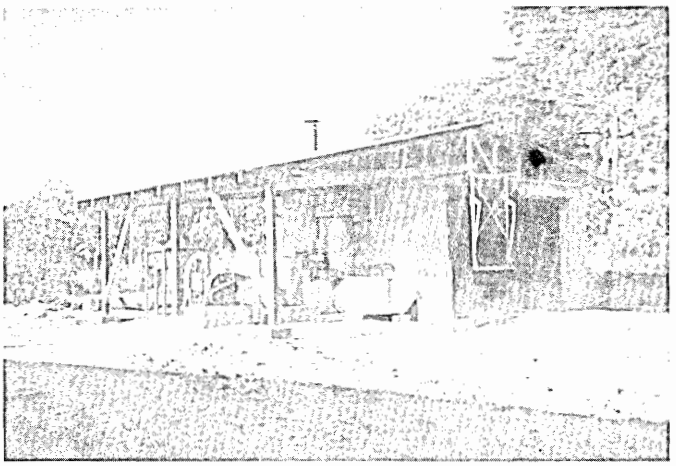


Fig. 1. Suspension burner/timber-drying system in Belize.

The timber-drying system fuelled by sawdust was tested in Belize under commercial operating conditions. It dried timber for an adjacent wood workshop, which processed wood for furniture, sidings and mouldings. These processing operations generated significant quantities of sawdust and wood chips which were used to fuel the burner for the drying operations. Field trials of timber drying were conducted with mahogany (*Swietenia macrophylla*), Santa Maria (*Calophyllum brasiliense*) and pine (*Pinus caribaea*).

Solar Modified Fuels

Years of research has made practicable, the use of solar energy to modify hydrocarbon-based fuels to allow more-benign utilization and to produce new hydrocarbon-based fuels. Fossil fuels can be modified by processes driven by high temperature solar heat and/or photon flux from recently developed concentrating collectors – allowing more energy to be available when using coal, natural gas, bagasse and biomass in general, with less overall pollution.

The approach to modify fuels with solar energy is attractive because it:

- Provides energy for the process without the generation of greenhouse gases.
- Increases the energy content of the original fuels with less overall pollution as a result of chemically storing a large fraction of the applied solar energy in the product gas or liquid.
- Provides fuels in gas or liquid form, allowing ready storage and/or transport and utilization.
- Reduces the potential polluting effects after modification has been achieved.
- In the case of natural gas modification, the product gases ($CO+H_2$) are far less greenhouse influential than the original natural gas in the event of leakage into the atmosphere.
- Provides syngas ($CO+H_2$) from a range of hydrocarbon-based feedstocks.
- Can provide fuels for burning as in town gas, process heat, gas turbines, etc.
- Can provide a means of producing methanol for transportation.
- Provides a means for utilizing solar energy on a continuous basis – the solar modified fuels being used to supplement the solar energy when required; much of this supplementary energy is stored solar energy.
- Relies on the use of already largely-available technology and can be implemented with relatively small R&D effort; can therefore take effect rapidly.
- Is now practicable due to the development of suitable large cost effective high temperature concentrating solar collectors by the Energy Research Centre of the Australian National University and related developments by Power Kinetics Inc (of Troy, NY, USA); as well as the progress in central receiver solar technology in USA and Europe.
- Solar gasification of fossil fuels and biomass provides the greatest long term potential for storing solar energy indefinitely.

(Source: Extracted from "Production of Solar Modified Fuels" by Stephen Kaneff, *Solar Progress*, Vol. 13, No. 4, Summer 1992-93, p. 8.)

The main potential market for this suspension burner/timber-drying system is considered to be the small- to medium-scale sawmilling and woodworking industries which process about 500-700 m^3 (200,000-300,000 board feet) of timber per year. The unit will be of particular interest to woodworking enterprises in timber-producing countries that are short of fuel resources.

Capability of the System

The suspension burner/timber-drying system, similar to any conventional timber-drying kiln, provides good control over the temperature and humidity conditions, within the range of operation. This allows the use of the full range of recommended kiln drying schedules so that optimal drying times can be achieved.

The system also enables the application of special conditioning treatments to the timber. These include:

- high temperature and humidity relief treatments for (a) degrade, such as collapse and case hardening, that may result from drying; (b) to prevent fungal attack; and (c) to halt insect infestation;
- conditioning treatments to establish final moisture contents; after drying is complete the temperature and humidity conditions can be set to establish a particular equilibrium moisture content, to which the timber will equalize.

Results of Field Trials

Drying times varied according to species, thickness and initial moisture content of timber. It took 90-120 h to dry 25-50 mm thicknesses of air-dried mahogany boards from a 25-30% moisture content to a 8-10% moisture content. The quality of dried boards was assessed on the amount of commonly observed degrade experienced during drying and was generally good.

The heat balance shows that the system is very energy efficient in terms of the transfer of heat generated from the burner to the kiln, and actual losses from the burner are small in comparison to the rest of the system.

The system's optimal design feed rate of 28 kg/h with a heat output of 500 MJ/h, although easily obtained, was not required during normal operation of the system. The maximum heat required was about 385 MJ/h. This was obtained with a feed rate of 23-24 kg/h. Average performance, taking into account periods when the burner was off, gave an output of 300 MJ/h at feed rates of about 17 to 19 kg/h. Furnace temperatures during operation were generally in the range 500-900°C.

Burner 'shut down' was automatically activated when the kiln temperatures reached the set schedule dry-bulb temperature. Shut-down periods generally lasted for 5-20 minutes. During these periods the temperature of the furnace chamber would drop by a maximum of 200°C at the higher operating temperatures and about 100°C at the lower. There were no difficulties with re-igniting the cooled furnace chamber; smokeless operation was achieved almost instantaneously. It was found that the burner would re-light easily at temperature levels as low as 200°C.

Large amounts of smoke were sometimes produced at high feed rates and with particularly damp wood waste. This was caused by incomplete combustion, and rarely persisted. With experience, the operator was able to choose the feed rate best suited to kiln conditions and burner temperatures which circumvented the problem.

Overall the field trials demonstrated that the suspension burner could successfully be linked to a conventional timber-drying kiln thus proving the technical viability of the system. The performance of the system was very encouraging in terms of its steady controllable process heat output, efficient energy recovery and the production of high quality dried timber. The system operates smoothly with the minimum requirement of operator attention and demands only routine maintenance for continued satisfactory performance.

Environmental benefits are to be gained through the introduction of a timber-drying system which combusts particulate wood wastes. Benefits include:

- the use of an alternative fuel to fuelwood, gas, oil and electricity;
- the productive disposal of a waste product;
- minimized smoke emissions through controlled and efficient combustion; and
- reduced indiscriminate dumping of particulate wood wastes which provide sites for rodent infestation and constitute a fire risk.

(Source: Extracted from: A.P. Robinson, R.C. Marder, and H.O. Coote (1993), *A Timber-drying System Fuelled by Sawdust*. Chatham, UK: Natural Resources Institute.

Published with permission from the Natural Resources Institute, Central Avenue, Chatham Maritime, Kent, ME4 4TB, United Kingdom.)

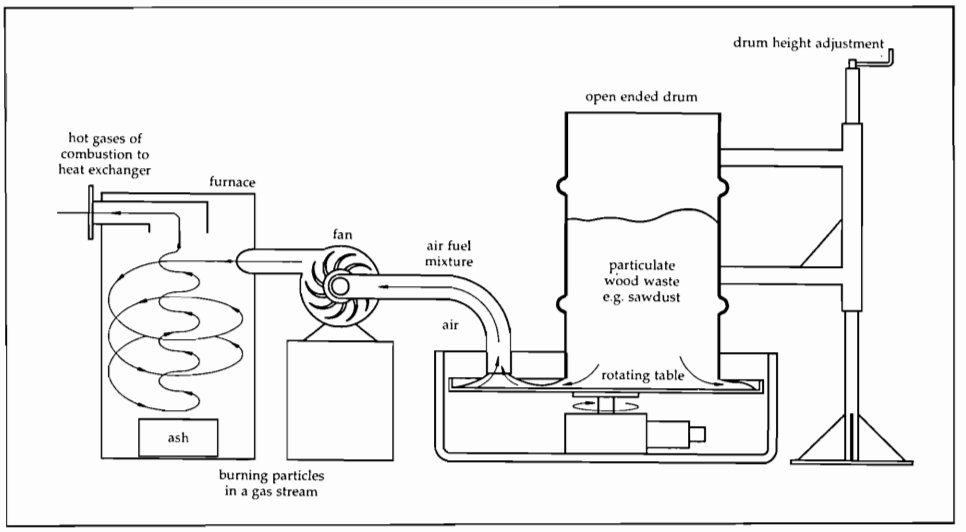


Fig. 2. Suspension burner.

Turning to Biomass for IGCC Demonstration – Sweden

Swedish energy company Vattenfall plans to build a demonstration pressurized wood gasification power plant in the city of Eskilstuna. The Integrated Gasification Combined Cycle (IGCC) Plant is planned to begin operating in 1996. The decision was taken after pre-studies for a project whose primary objective was to investigate and estimate the potential for environmentally acceptable biomass based energy systems. The project, supported by a Swedish parliamentary resolution on energy policy, covers three main areas: the fuel supply, market and environment; conversion of biotechnology to power and heat with plans for a large scale demonstration; system and market issues. Another technology based on indirect fire combined cycle was also chosen for demonstration. These technologies were judged to show reasonable performance and feasibility in cogeneration applications in the target size range 30 to 100 MJ/s district heating capacity.

A feasibility study, performed to evaluate the potential for biomass technologies, concluded that during the next 25 years the total Swedish power generating potential for new biomass plants is 5 TWh each year in the municipal cogeneration sector and 1-2 TWh in the industrial cogeneration sector. According to the survey, 10 to 15 municipal cogenerating plants can be built in Sweden during this period, of which several could be IGCC installations.

The IGCC process is a very efficient way of converting bio-energy into electricity and heat. The high rates of power and heat generation are due to the combined cycle configuration of the process, the optimized integration of the gasification plant into the gas/steam process and the optimized integration of the fuel dryer into the system.

This process has been developed by IGT since 1974 and Tampella purchased the world-wide licence in 1989. In the U-gas gasification system, biomass will be gasified using air with a small addition of steam. The biomass has to be dried to 15 - 20 per cent moisture content to generate a gas of reasonably high heating value. When applying steam drying, an efficient integration of the drying and steam process can be realized.

The dried fuel is fed through lock-hoppers into the fluidized bed containing bed material such as sand or dolomite. The gasifier operates at 950°C and generates a low calorific value gas of about 4 - 6 MJ/kg lower heating value. The gasifier pressure is in the range 20 - 25 bar, determined by the gas turbine requirements. The product gas leaving the gasifier is cooled in a special type of gas cooler to 400 - 550°C which is a tolerable temperature for gas turbine control and shut off valves and other downstream equipment.

One of the key parameters of a simplified IGCC process is hot gas clean-up. Tar formation, destruction and removal during biomass gasification are the main issues. Hot gas clean-up occurs at an intermediate temperature, between 400 and 600°C. At this temperature heavy tar compounds, vapour phase alkaline metals and dusts can be removed from the biomass derived gas while the ammonia in the gas is not affected. The ammonia to NO_x conversion is controlled in the gas turbine combustion chamber. In Tampella's IGCC design, tar destruction occurs mainly in the gasifier at high temperature, using dolomite as the catalyst. Dolomite also helps maintain efficient circulation in the bed and recirculation of entrained fines. After cooling the gas, the contaminants condense on the particle surface in the gas cooler and will be removed from the gas stream. The gas cooler is a self-cleaning circulating fluidized bed boiler where dolomite circulates in order to crack tars and keep the heat surfaces clean. The heaviest hydrocarbons are absorbed by dolomite in the gas cooler. Also, a small portion of dolomite fines is mixed with the gas stream in the gas cooler to form a porous filtering cake together with the fuel ashes on the filter surface in the following filter unit.

Commercializing Multi-Fuel Stove, Philippines

A Philippine firm, Darmo Metal Industries, is offering a multi-fuel stove which can be fuelled by wood, charcoal, sawdust, ricehull, corn cobs, coconut husks and shells, twigs, and other agricultural wastes, as well as newspapers and cardboard. Known locally as "Superkalan," the stove is claimed to be portable and soot-free. It has a cast aluminum body which is rust proof, lightweight and unbreakable.

The stove consists of the following parts:

- cone-shaped bottom with small opening for ventilation
- heat regulator for high, medium and low fire
- ash tray for non-messy cooking
- fuel feeder with cover for smokeless operation
- cylindrical body combustion chamber
- cone-shaped heat intensifier which forces flames and heat radiation to converge upward for fast heating
- chimney and chimney extension for smokeless operation
- three adjustable ring plates for non-soot cooking utensils of different sizes and for conserving heat
- ring plate cover to conserve heat for reuse
- grill for barbecue and fish.

For further information, please contact:

NARCISO MOSUELA
Darmo Metal Industries
Tepaurel Compound
Barangay Putatan, Muntinlupa
Metro Manila
Philippines
Tel: (632) 8423112, 8422903

(Source: Extracted from "Philippines: Multi-Fuel Stove," *Tips-Energy*, ENE-B877/2.)

The final gas clean-up step before the gas turbine is a high temperature, high pressure filter where the dust loading is reduced to a negligible amount. The filter can be a ceramic or metal candle design. A commercial gas turbine requires modification to burn low calorific gas. It must be equipped with modified combustor chambers burning the biomass derived gas efficiently and with low emissions in a dry low-NO_x burner. Air is extracted from the gas turbine after the compressor for the gasification process. The pressure and temperature of gasification air is adjusted in the booster compressor and heat exchanger system.

A second IGCC demonstration plant of 140 MJ/s, part of a project called VEGA, is planned for the city of Eskilstuna, 100 km west of Stockholm. Investment cost is estimated to be $210 - 250 million. It will be built in cooperation with the local utility. The annual biomass consumption is 350,000 m^3 and a new cogeneration plant of 50-75 MJ/s heating capacity is planned for the city. Thus the town was a natural choice for the VEGA demonstration plant. Forest residue reserves in the area and future biomass plantations will provide sufficient fuel for the new biomass plant. The VEGA demonstration is designed to be a cogeneration utility. The demonstration plant will be optimized to reach the highest total net thermal efficiency.

The fuel input to the plant is 140 MJ/s, corresponding to 180 m^3/h of 50 per cent wet biomass (60 t/h). In cogeneration the plant gives 60 MW net power and 65 MJ/s district heat and a total efficiency of about 90 per cent. The net efficiency for power generation is above 40 per cent (LHV).

The IGCC process incorporates advanced environmental control systems that will significantly reduce the level of gaseous emissions. Furthermore the facility's greater efficiency as compared to conventional and competing technologies will also reduce emissions due to the resultant reduction in feedback requirements.

The biomass has to be dried from around 50 per cent to 15 per cent moisture before gasification. There are two alternatives, steam and flue gas drying. Steam drying is an indirect system using bleed steam from the turbine. Flue gas drying uses exhaust from the heat recovery steam generator, but is complicated and expensive in the case of biomass fuel because of the high oxygen content, about 12 per cent of the flue gas. Efforts are being made to optimize the system and make the technology viable on a commercial scale.

(Source: Extracted from "Sweden Turns to Biomass for IGCC Demonstration" by Nils Lindman, C-G Andersson, Leif Liinanki, Andras Horvath, Kari Salo, *Modern Power Systems*, Vol. 12, Issue 5, May 1992, pp. 19-23.)

Natural Gas Vehicles – Getting a Foothold in the US

Recent studies have demonstrated the high potential for natural gas as an alternative vehicle fuel and the convergence of economic and environmental forces may well mark natural gas as "the fuel of the future". Natural gas is highly suitable for light trucks, vans and buses that travel less than 200 miles per hour, that are centrally garaged and that can allow for time-fill refueling. But, natural gas will realize its potential as a transportation fuel only when, and if, an infrastructure is built that will support refueling, manufacturing, maintaining, and reselling natural gas vehicles (NGVs).

An excellent alternative transportation fuel, natural gas combines high octane and clean-burning characteristics with abundant domestic supply sources. Well-established basic distribution networks are already in place throughout USA. Also, compared with gasoline, natural gas enjoys price and environmental advantages. Natural gas costs between 40 and 90 cents an equivalent gallon and it is clean not only outside the vehicle but reduces normal wear and tear of engine because of no carbon build-up. These advantages come hand in hand with challenges, however. The primary disadvantage of natural gas as a transportation fuel lies in its low energy density. Currently available technologies address this issue through compression and high-pressure storage, but these processes increase costs by requiring expensive fueling stations and on-board storage tanks.

Recent legislation in USA has opened the way for the development of the NGV market. At the Federal level, the Clean Air Act Amendments of 1990 mandates the use of alternative fuel vehicles (AFVs) beginning in the late 1990s in the 24 U.S. metropolitan areas identified by the Environmental Protection Agency (EPA) as "non-attainment" areas (those with serious to extreme pollution problems). The National Energy Security Act (NES), now in Congress, will provide tax incentives for alternative fuel vehicles and for development of fueling facilities. If passed, the NES will also expand the list of non-attainment areas to 125. Alternative fuels have been categorized as those fuels that do not include reformulated gasoline or clean diesel. California for example, has set up a program that will, in effect, move up the dates for AFV use by two years as compared with the Clean Air Act.

The American Gas Association estimates that 2.4 million NGVs could be on the road by the year 2000 as a result of the Clean Air Act amendments. SoCalGas has received approval from state regulators for the nation's largest NGV program to date. Now in progress, the NGV program includes installation of 51 fueling stations through 1993, and is helping fleet operators defray the added costs of buying early models of dedicated NGVs. On the technology front, car, truck, van and bus manufacturers have developed vehicles that will run only on natural gas. Because natural gas is currently about 30 per cent less expensive than gasoline, fleet operators have found that NGV fuel savings pay back the $3,000 to $5,000 "extra" cost of dedicated natural gas vans and light trucks within a relatively short time period.

Conversion of diesel vehicles to NGVs is not practical as spark plugs are not utilised in diesel engines. Use of a mixed fuel (80 per cent natural gas, 20 per cent diesel) would overcome this problem, but would not improve emissions enough to meet new environmental standards. NGV

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Natural Gas Vehicle - Getting a Foothold in the US

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manufacturers are also starting to provide normal full warranties on their vehicles.

According to a study sponsored by New England Gas Association (NEGA) the operators of large fleets appeared to be more positively inclined toward natural gas than operators of smaller fleets, and were almost twice as likely to choose natural gas as their first-choice alternative fuel than colleagues with smaller operations. The study also categorized several NGV market segments, each identified by one or more operating characteristics. Of these market segments, the most promising for NGVs was defined as fleet vehicles for which: (1) central refueling is appropriate, (2) time-fill is appropriate, (3) limited-milage range is appropriate, and (4) natural gas is accessible.

The NEGA study identified five significant market barriers to the adoption of NGVs by fleet operators – safety, vehicle cost, fuel costs, lack of infrastructure, and fuel supply. But some of these barriers represented perceptions rather than actual problems. For example, fuel cost is actually lower for natural gas than for gasoline or diesel, but fleet operators believed that alternative fuels, including natural gas, were likely to cost more than gasoline. In the NEGA study, fleet operators rated future fuel availability as the most important decision factor in considering alternative fuels.

Many NGV demonstration programs are already planned or underway around the country, including several within the NEGA service area and other programs are making headway all across the country. Natural gas vehicles are becoming a reality, with about 30,000 traveling on U.S. roads today. The industry is promoting the fuel as economic, clean burning, safe, and domestic. Natural gas vehicles are capable of standing on their own merits, and natural gas can gain more widespread popularity as a superior fuel for cars, trucks, and even boats and trains. (Source: Extracted from "Natural Gas Vehicles: The Race for Profits" by Alan S. Hirshberg and Richard W. Scullary, *Public Utilities Fortnightly*, Vol. 130, No. 7, October 1, 1992, pp. 34-38.)

Energy-Saving Measures in a Steel Mill – Thailand

An electric-arc-furnace based steel mill in Bangkok, Thailand, has applied, progressively, various energy-saving measures over a number of years. An electrical energy reduction of 211 kWh/t-steel and an increase in productivity, measured by reduction in scrap melting time of 80 minutes, have been achieved. These major successes have been attributed to the use of high melting power and improved scrap handling.

In 1990, the iron and steel production sector of the Thai industry consumed over 643,000,000 kWh of energy with a power demand of 158 MW. The consumption is 8.7% of the entire industrial sector and is second only to the textile sector. The iron and steel production industry is dominated by the long products sector which produces steel round bars, deformed bars and wire rods. Currently there are eight scrap based electric arc furnace (EAF) steelmaking facilities equipped with billet continuous casting machines and rolling mills with a total licensed steelmaking capacity of about 1,328,000 tonnes per annum. All the facilities are generally smaller than their European, Japanese and American counterparts with nominal EAF capacities in the range of 6 to 30 tonnes.

Although numerous energy-saving measures for steelmaking have been reported in the literature, their application among the Thai steel makers is still not widespread. Since the mid-80's, one of the largest steel mills in Bangkok has initiated, progressively, a number of energy saving and productivity improvement programs. The plant produces wire rod measuring 5.5-8.0 mm and rebars measuring 6.0-34.0 mm in diameter with a nominal annual production output of 180,000 tonnes. Its main facilities comprise two 25-tonne EAF's with 15 MVA transformers, and a three-strand continuous casting machine. The bar and wire rod mills are located in a separate plant nearby, which necessitates reheating of the billets before rolling.

An EAF based steel plant's main energy requirements are melting energy, driving energy for fans, pumps (for water and oil-hydraulics) and cranes, oxygen, fuel oil, coke and graphite electrodes, the most significant component being that for melting.

The application of energy saving measures has resulted in a reduction of the specific electrical energy consumption for melting of 211 kWh/t-liquid steel over the period between 1987 and early 1992, and a reduction in the tap-to-tap time of about 80 minutes from 1990 to early 1992 (Fig. 1).

Up to 1989, reduction in the specific electrical energy of 74 kWh/t had been achieved through a variety of measures, among them were the installation of water-cooled furnace wall and roof systems, foaming slag practice during meltdown, use of hot-tundishes for casting, better scrap handling, use of high-performance continuous casting machines, and improved coordination of process operations.

The most significant achievements to date are the results of increasing the melting power by upgrading the furnace transformer rating from 9 MVA, and of improved scrap handling by the use of a press-and-shear unit.

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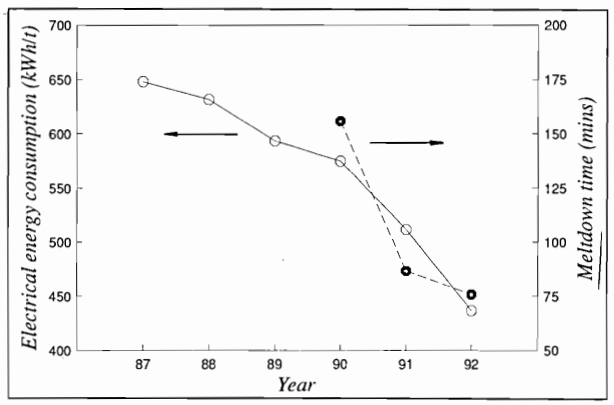

Fig. 1. Evolution of specific electrical consumption and scrap meltdown cycle time.

SMALL SCALE WIND ENERGY SYSTEMS

Published with financial support from the Netherlands Minister for Development Cooperation
Editors: Goezinne & Veldkamp, Renewable Energy Consultants

EDITORIAL

Another batch of wind energy news, the fifth already. This proves that it is not too hard too find enough news: this is not surprising since a lot is going on in the field. It is a bit strange however (and slightly disappointing too) that the total number of reactions on articles until now is only one. Well, at least in this issue there are some reactions of people from the field commenting on wind energy information, in this case not on wind energy news, but on a wind energy course recently held. Dear readers, follow this example and let us also know what you think!

Dick Veldkamp/G&V

JOURNALS ON WIND ENERGY

This article provides some clues on where to find specific information on wind energy, by listing some important literature sources. To voice the author's opinion: if you are interested in the news, Wind Power Monthly is your first choice; if your interest lies in scientific information, your best bet are the conference proceedings and 'Wind Engineering'. However, this does certainly not mean that there is no valuable information to be found in the other publications listed.

WindPower Monthly News Magazine

If you want to keep abreast of what's going on in the world of the large machines this is the journal you should read. It covers any event related to the application of wind energy 'from five continents' as they put it. Articles are of a general nature (i.e. not technical); WP Monthly is really a sort of newspaper. The emphasis is on large scale applications of wind energy, and most news is from the countries where the majority of all wind turbines is installed: Denmark, Germany, the USA, the United Kingdom, and the Netherlands. Because many manufacturers advertise in WP Monthly it is a useful source of addresses (not only manufacturers of big machines, but also producers of small wind turbines, brakes, blades, measuring equipment etc. It also contains statistics on wind turbine failures (covered more extensively in its sisters Journal WindStats Newsletter).

Appears monthly, subscriptions US$65. Contact: WindPower Monthly News Magazine, Vrinners Hoved, 8420 Knebel, DENMARK; or: WindPower Monthly News Magazine, P.O. Box 496007, Ste. 217, Redding CA 96099, USA.

Wind Engineering

The scientific wind energy journal. Articles of a technical nature on all sorts of wind turbines, from water pumping windmills to large electrical systems. To give a few examples of articles: on maximising long-term efficiency of water pumping windmills, on centrifugal pumps, on hybrid systems, on stability of wind turbines in yaw, on shaft vibrations.

Appears 6 times a year, subscriptions UK£132. Published by Multi-Science Publishing Co Ltd, 107 High Street, Brentwood, Essex CM14 4RX, United Kingdom (ISSN 0309-524X).

Windirections

Official journal of the EWEA and the BWEA. Sort of mixture between 'Wind Engineering' and 'WindPower Monthly'. The contents are mainly news, although occasionally there is a technical article. Emphasis on Europe and United Kingdom.

Appears 4 times a year. Contact: BWEA, 4 Hamilton Place, London, W1V 0BQ, United Kingdom (ISSN 0950-0642).

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SECOND INTERNATIONAL WIND ENERGY COURSE IN THE NETHERLANDS

From 29 March to 10 April, at ECN, the Netherlands Energy Foundation ECN, the second International Course on the Implementation on Wind Energy was held. There were 12 participants from India, Morocco, Israel, Sudan and Turkey. The two week course is meant in the first place for project managers and decision makers in countries where wind energy recently has been introduced or where plans for the first implementation exist.

Formally, the course is set up on a commercial basis, so that the participants have to pay the course fee. In order to create the opportunity for participation for as many applicants as possible, ECN has sponsored some participants. The course itself was also sponsored by the Dutch Ministry for Development Cooperation, by Renewable Energy Development, in Eindhoven, Netherlands and by the Dutch Metal Employers Association FME. Because of the vivid interest that exists for the course, it has been decided to organize such an event every

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Journals on Wind Energy

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Windkraftjournal

The contents may be compared to 'Windirections', but with emphasis on the German windturbine market, contains statistics on performance of wind turbines in Germany (in GERMAN!).

Appears 4 times a year, subscription DM50 excluding mailing cost. Published by Verlag Natürliche Energie, Grevensberg, 2372 Brekendorf, tel: +49 43 53 5 51 (ISSN 0720-8073).

Abstracts

There are two journals with abstracts of wind energy publications:

Wind Energy Abstracts

Appears 6 times a year, subscriptions US$201. Published by Windbooks Inc., St. Johnsbury, USA (ISSN:0277-2140).

Wind Engineering Abstracts

Appears 4 times a year, subscriptions UK£95. Published by: Multi-Science Publishing Co Ltd, 107 High Street, Brentwood, Essex CM14 4RX, United Kingdom (ISSN:0263-0915).

Conference Proceedings

If you are interested in in-depth articles on wind energy you should get hold of the proceedings of the European Wind Energy Conference (EWEC) and the European Community Wind Energy Conference (ECWEC). Although most papers are aimed at grid connected large scale wind turbines for electricity generation, you may find articles on any subject related to wind energy (e.g. resource analysis, power control and safety, aerodynamics, wind-diesel systems, fatigue, public acceptance of wind turbines, water pumping windmills) and looking through these proceedings is certainly worth it.

For proceedings of EWEC contact: EWEA, Via Bormida 2, 00198 Rome RM, ITALY, fax: +39 68 41 19 33

For proceedings of ECWEC contact: H.S. Stephens & Associates, Agriculture House, 55 Goldington Road, Bedford MK40 3LS, United Kingdom.

Other journals

Of course there must be other journals which are devoted to or publish on the subject of wind energy. We are particularly interested to hear from such journals in non-English languages (e.g. Spanish, French, Portuguese). A list of all journals (well probably not all but a lot anyway) on the subject of energy can be obtained from Swets Subscription Service. They can also do subscriptions for you (NOT free of charge).

Contact: Swets Subscription Service, P.O. Box 830, 2160 SZ Lisse, Netherlands.

Second International Wind Energy Course in The Netherlands

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year. However, a problem is that presently ECN has no more funds available to sponsor participants in the future. Therefore, ECN hopes that candidates for the 1994 course will apply as early as possible, so that funding from the appropriate sources can be organized in time. The course will be held every year in about the same period. The objective of the course is to help building up a human resource infrastructure for countries considering or starting with wind energy implementation. In the Netherlands in general and at ECN in particular, considerable experience and know how has been built up. One of the key issues for countries that are in the process of developing their economy is the availability of energy. Many developing countries are aware of the environmental dangers of a fast expansion of the energy consumption. Apart from that, the development of renewable sources makes developing countries less dependent on the expensive import of fossil fuels. By transfer of know how, a contribution can be made to an effective implementation of renewable energy in developing countries.

Practice

The course is based on the principle that decision makers, project managers, industrialists, scientists and consultants from countries where wind energy is making a start, are confronted with practical problems in a range of disciplines. Therefore, the course aims in the very first place at providing practical tools to people who are dealing with energy planning, estimation techniques of wind resources, planning of wind energy systems, pre-investment studies, implementation strategies, technology assessment, certification, manufacturing & installation, project management and operations. The course is divided in four modules: Planning Phase, Pre-Investment Phase, Implementation Phase and Operational Phase. The course program also contained excursions to a windfarm and a wind turbine manufacturer.

"We think the set up of the course is very practical", says P.U. Kulkarin, from the Non Conventional Energy Development Agency of the Indian state of Uttar Pradesh. "In Uttar Pradesh, we have many not very densely populated areas in mountain districts, where a very favourable wind regime exists. Apart from the contribution that wind energy can make to clean energy generation, it also offers advantages for isolated areas in our state, where the nearest grid in some cases is hundreds of kilometres away. With regard to the future energy demand in India, the federal government also is very interested in the industrial possibilities renewable energy can create in the future. One of the important items of the course is, that the lectures about technology assessment and manufacturing give information about our future industrial possibilities." Dr. Tanay S. Uyar from Turkey adds: "The course is very useful for countries who are not in the stage of implementation yet, but where wind energy is considered as an important possible future energy source and where the first inventories have to be made. As the organizers of the course emphasize, wind energy in Western Europe very much has been a matter of trial and error. What we learn here is how to avoid the failures that have occurred in Europe in the past." Jos Beurskens, head of the Renewable Energy Department of ECN, is very pleased with the course. "We have of course developed technologies in Europe, that are becoming mature now," he says. "It is spoiling energy if elsewhere in the world people start doing again what has been done in this part of the world already. On the other hand, occasions like this course teach us not to become arrogant. We learn so much about different conditions in countries outside Europe from our visitors, that we increasingly become aware that the bulk of the work in the field of renewable energy still has to be done."

F.R. Janse/Netherlands

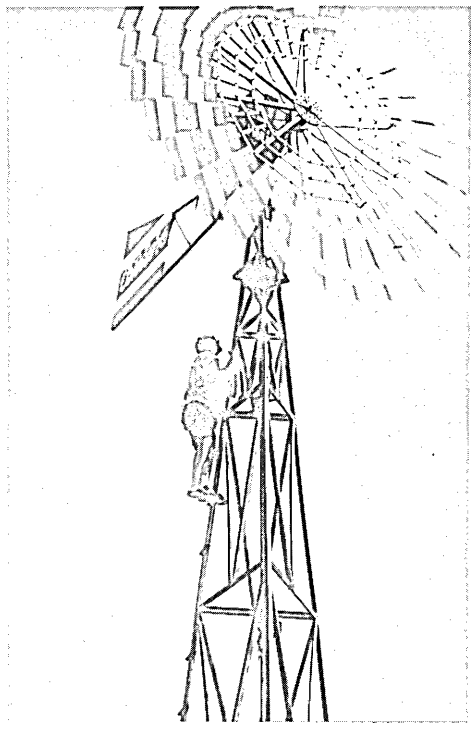
USA SERVICES THE SERVICE INDUSTRY

Usa windpumps are manufactured and installed in Thailand. A factory of 30 workers combines the manufacture of agricultural machinery with children's playgrounds and the production of a home grown windpump. Brightly painted with automotive lacquer, these windpumps stand out as one travels in Southern Thailand. They range in size from 3.2 m to 6 m, and are used for domestic supply, livestock and irrigation. But perhaps the most surprising of all the applications is Usa's recent coup in selling a number of systems to the petrol service stations on the main highway.

Right in the compound of the sale outlet of fossil fuel, renewable energy makes its mark. The windpump supplies water for the station, washroom, toilets, cafes and staff housing. And in a country which constantly talks about the environment, and how we must be more careful in its use, the rotating flower challenges both Thai and tourist alike.

The Usa set of windpumps are high solidity and from a distance could be mistaken as copies of the traditional Australian or American multiblade. However the history of Usa is based on its owner and entrepreneur who considered other designs but took his own route. The rotor construction is high solidity and therefore comparatively slow running, and only the details reveal it is not a copy of another design. However, the transmission is not a cast gear box and it is here that the real innovation of the designer shows. The crank and rocker mechanism is similar to those produced in Kenya and by the Dutch, but again the details reveal the uniqueness of the Usa design. Some of the larger machines (6 m) do still experience some technical problems with fatigue of principle components, however despite these few setbacks the Usa is well accepted in Thailand. Standing on a 15 m tower, the red, white and green rotor proudly displays the bright thoughts of an alternative to fossil fuel consumption.

Simon Batchelor/Gamos Ltd (UK)



New tourist sites in Thailand.

DGIS–STUDY ON WINDPUMP MARKET NEARLY COMPLETED

When Dutch government (DGIS) support of the CWD-project on windpump development and dissemination ended in July 1990, it was realised that better insight in the windpump market in developing countries was necessary. After the WERA-workshop (Wind Energy for Rural Areas) at Bergen (Netherlands) in October 1991, a market study was commissioned to Halcrow Gilbert Associates (UK). Subcontractors were Renewable Energy Development (RED, NL), the Netherlands Economic Institute (NEI) and Gamos Ltd (UK). An important source of information are local manufacturers. Some of them were already interviewed at the WERA. Later about 200 questionnaires were sent to manufacturers in developing countries; 30 manufacturers responded. Questions regarded company profile, types of windpump produced and sales figures. Manufacturers could also give their opinion on marketing strategy and expectations for the near future. In agreement with DGIS in-depth studies were carried out in Kenya, India and Colombia. Mr Rod Hacker (HGA) and Mr Jan de Jongh (RED) visited manufacturers, the government and people of NGOs in these countries, while local contractors approached the end users with assistance of Mr Ruud Fontijn (NEI). The main question was why a potential user decides to purchase a windpump. It was also attempted to obtain information to calculate life-cycle costs.

In India there is a huge market for small scale water supply. Some wealthy farmers purchased copies of 3 m first generation windpumps but were not satisfied about the water output. Another market are the innovating users. They opt for a windpump because it uses renewable energy and is not polluting. The Auroville project (India) shows that reclamation of degraded land is possible using only windpumps for water supply. Probably a large market exists among marginal farmers in India. For them a low cost pumping system is essential to increase their income. The unsuccessful Ghazipur 12PU500 project aimed at this group. In spite of the failure, people reported that a number of 12PU500 windpumps are still operating at sites with favourable conditions, as in Bihar. It seems that besides the market for proven first and second generation windpumps there is also a market for low cost windpumps. In Kenya Kijito and Pwani agree that finance is the main problem in selling their windpumps. Also maintenance service and owner involvement are crucial for success. Both complain about the lack of financial support to improve their service and production methods. They also stress the importance of having access to existing technical knowledge. In arid regions remote stand-alone systems often create new settlements around them. During the latest droughts in Kenya windpumps often were the only source of water in a region, even elephants were seen to drink there. Only few users and manufacturers can give reliable information about the water delivery of a windpump in situ. Many users are disappointed about the water output of their windpump. Accurate monitoring is necessary to know the causes of unsatisfactory water supply and to calculate life-cycle costs of any water supply system. In August 1993 the final report is to be submitted to DGIS. Hopefully the findings

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COMMUNITY WIND GENERATORS IN UK

Small scale wind generators may yet have a large role in the development of the UK wind generation industry. Only in the last three years has the UK seen the introduction of large scale commercial electricity generation from the wind. This can be largely attributed to changes in legislation, and the provision of the Non Fossil Fuel Obligation (NoFFO) which guarantees higher than normal prices to suppliers who do not use fossil fuel. These artificially high prices provide an opportunity for making a relatively quick profit from installing wind generators. Consequently there has been a rush of planning applications to erect large wind farms (5-10 MW) submitted by a rapidly growing number of commercial developers.

Each planning application has caused much local debate, and often leaves communities split over the issues, debating the contribution to national development against the cost of local visual impact and noise. Most of the windiest sites in the UK are areas designated as Areas of Outstanding Natural Beauty, or Sites of Special Scientific Interest, and are therefore subject to tight planning restrictions. The otherwise cool and calm British public have been getting very heated and agitated at recent planning meetings. To avoid confrontation, developers must compete for those few sites that have both wind and are likely to be approved for large scale wind farms with sizable generators.

Some supporters in the UK are now looking to the experience of Denmark and Holland, to compare and contrast the evolution of a wind generator industry. In these two countries, the industry started with small wind turbines. Once the small generator market was developed the manufacturers included larger machines into their product range. Local town or village cooperatives were formed to purchase and operate only one or two machines, which were then erected in the environs of the community. Electricity was exported to the grid, and the utility company paid for the energy by means of rebates on electricity bills made to individuals investing in the scheme. The lesson from this approach was that, in order to promote long term development of wind derived electricity, communities must be involved in ownership and planning, and they must be able to perceive the benefits of the project. (This sounds very familiar to those working in Third World Development – where community ownership is often a key to unlock the use of new technology).

Community Windpower Systems (CWS) is one of the first companies in the UK set up specifically to promote this approach to wind generator ownership. They expect the multiplication of single small to medium scale wind generators to be an alternative to large scale wind farms built by developers. Under CWS's first proposal, a 100 kW turbine will be financed by both shareholders and a bank loan, secured by individual guarantors. They have already shown that planning approval for single machines can be obtained cheaply, easily and without public enquiries. Not only does this approach open opportunities to extend wind power penetration, but more importantly, it may serve to sway public opinion in favour of wind power generation in the future.

Nigel Scott/Gamos Ltd (UK)

DGIS–STUDY ON WINDPUMP MARKET NEARLY COMPLETED

From P. 3

will contribute to a positive decision by the Dutch government to continue its support, which may contribute to an increased supply of clean water by means of an environmentally sound technology in those areas where it is one of the best options.

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THOUSAND WATTS FOR MARLEC

Marlec UK recently announced their 1 kW stand alone wind generator. Building upon the popularity of their 250 W system, they have produced a three blade 1 kW version. The neat aluminium housing, sharp electronics and sleek injected glass fibre blades maintain the Marlec tradition of simple effective functionality.

The system uses as a capstone the research of Mike Ackerman who investigated the complex response of the system under extreme conditions. Working with Reading University and Rutherford Appleton Laboratories, Mike modelled the system on a computer and then validated that model with an instrumented prototype. He looked at what happens to the tail within the rotor wake, he considered the gyroscopic effects during the yaw of the rotor, blade fluttering from tower shadow, stress analysis of the system in high winds and of course the output of the wind generator. With this comprehensive study as background, the Marlec designers have been able to refine their design parameters and produced an elegant machine that should sit well in the market for small systems.

Simon Batchelor/Gamos Ltd (UK)

Citation is encouraged on the condition that the source is indicated.
Reactions or other contributions are welcomed. Please write to:
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An Environmental Friendly Thermo-acoustic Refrigerator

Steven Garrett, an American university physics professor, has received the Rolex Award for Enterprise 1993 for the development of an environmental friendly thermo-acoustic refrigerator. He is developing a revolutionary system of refrigeration that does not use the chlorofluorocarbons (CFCs) that are to be found in conventional refrigerators and that are currently threatening the world's ozone layer. His objective is now to finalize the development and testing of his thermo-acoustic refrigerator, in which cold is generated by sound waves from a loudspeaker, so that it can be mass-produced in time for the ban on CFCs that will come into force in many countries in 1995.

The Need for CFC Substitutes in Refrigeration Systems

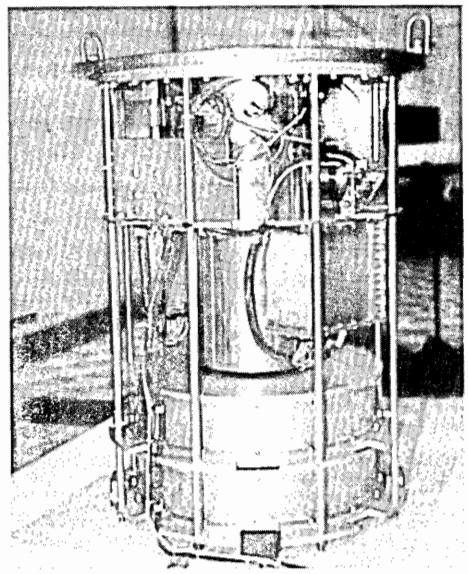
Starting in 1974, reports began to appear claiming that the widespread use of the highly stable CFCs would lead to depletion of the stratospheric ozone layer. An accumulation of alarming scientific evidence during the years, including the discovery of a hole in the Earth's ozone layer over Antarctica, has confirmed the severity of the problem.

Since they are cheap and highly stable, chlorofluorocarbons have been used in a wide range of applications (as spray propellants, plastics foaming agents, etc.) but in nearly all cases, with the exception of refrigerants, suitable substitutes have been introduced. There has been intense activity in developing alternatives to CFCs, reconsidering the substances which CFCs originally displaced, and looking at other refrigeration cycles which do not involve creating phase changes in fluids. It was this need to replace CFCs in the highly problematic area of refrigeration that motivated the research and the development of Garrett's Thermo-Acoustic Refrigeration project. This introduces an entirely new approach to refrigeration, based on a discovery made in the early 1980s, which uses high-intensity sound waves to pump heat, and in which inert gases are used as the working fluid.

Using Sound to Reduce the Temperature

The interaction between acoustics and thermodynamics has long been recognized, and the fact that a change in the temperature of a gas can cause a sound vibration in the gas itself is easily demonstrated. However, the reverse process – Thermo-Acoustic heat pumping – of extracting heat from a gas by producing a sound wave within the gas, is far less well known and was the first demonstration of a new class of intrinsically irreversible heat engines which are characterized by the virtual absence of moving parts and very good efficiency.

In 1986, Garrett's research group attempted to design and test a refrigerator based on this newly discovered "natural" heat engine cycle. At that time, prior to the discovery of the ozone hole and the ratification of the Montreal Protocols, it seemed that the most appropriate application of this new technology would be the production of a space-based cryocooler for surveillance satellites. Financial support was obtained from the Office of Naval Technology (Physics Division), the Naval Postgraduate School, and the Naval Research Laboratory (Naval Centre for Space Technology), and the Space Thermo-Acoustic Refrigerator (STAR) was produced and was placed in space as an autonomous refrigerator on the Space Shuttle Discovery on 22-29 January, 1991.



Steven Garrett's Space Thermo-Acoustic Refrigerator prior to installation on the Space Shuttle Discovery. The refrigerator is in the cylindrical vacuum vessel at the centre of the structure. It is surrounded by the electronics enclosures which support the measurement and control functions. The two cylindrical boxes at the bottom contain the batteries.

The refrigerator that went into space operated from batteries without human intervention and produced a temperature span of 80°C, whereas the improved ground version later produced a span of 118°C, i.e. enough to turn boiling water into ice! What made this accomplishment all the more

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Energy-Saving Measures in a Steel Mill - Thailand

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The former, implemented towards the end of 1990, yielded a specific electrical energy reduction of 65 kWh/t and a reduction in tap-to-tap time of 70 minutes. The latter, installed early this year, resulted in an electrical energy saving of 72 kWh/t and a reduction in tap-to-tap time of 10 minutes.

Currently a program to use ladle furnace, whereby the alloying and refining period at the final phase of a heat is transfered from the high-power furnace to the low-power ladle furnace to produce specialty steel, is being tried.

In the rolling mill, an exhaust gas recuperator has been installed to preheat combustion air for the fuel-oil-fired billet reheat furnace, resulting in a fuel saving of about 5 kg/t-billet or 14%.

(Source: Extracted from "Application of Energy-saving Measures in a Steel Mill", by B. Fungtammasan and P. Chongchitpaisarn, in 3rd ASEAN Science Technology Week, Volume IV: Non-Conventional Energy Proceedings, 21-23 September, 1992, Singapore. ASEAN Subcommittee on Non-Conventional Energy Research (ASCNCER), Bangkok, 1992, pp.68-72.)

Energy Efficiency for a Better Environment

The first international conference of the Watt Committee on Energy recommended improvement of energy efficiency as a key weapon to solve the problem on environmental pollution arising from energy supply. Although, the technology to increase energy efficiency and reduce energy consumption is available, adopting it on a global scale will be necessary to achieve the desired results.

The Conference entitled "The Rational Use of Energy and the Environmental Benefits" was attended by some 200 people across 17 countries. According to the Conference President Bernard Giovannini, of the many long-term solutions to meet the world's energy requirements, efficient energy is the most penetrative. Moreover, it is unlikely that new renewable energy sources will become viable on a large scale for 30-40 years. Half of the energy currently consumed could be saved quite easily through a mix of measures which include improving the performance of electric appliances and heating systems, using more energy-efficient light bulbs, insulation and intelligent control systems.

(Source: Extracted from "Energy Efficiency Solution for the Environment." *Energy Digest*, Vol. 21, No. 3, p. 24.)

New Hydroelectric Power Plants in Southern Vietnam

Two new hydroelectric power plants in southern Vietnam, financed through loans from Japan's Overseas Economic Cooperation Fund, are scheduled to go into construction by the end of 1994.

Two dams will be constructed 150 km northeast of Ho Chi Minh City. The dams will generate an additional 470 MW per year and the power will be delivered to the southern grid by 1999.

According to engineer Le Quang Huyen, director of Company No.2 which conducted the feasibility study, both projects will bring water downstream from the La Nga and Da Mi river basins to the main plants, displacing some villagers. Situated near the town of Bao Loc, along the North-South Unification Railway and the National Highway #1, the project hopes to minimise displacement and control relocation costs by taking over the least densely populated areas. The dam projects are to be located at Ham Thuan and Da Mi, on the border of Lam Dong and Binh Thuan provinces.

The Ham Thuan Project will inundate about 3,000 hectares of land. Water fed through tunnels on the right bank of Da Bo rivulet is estimated to produce about 300 MW per year from a 270 metre downfall.

The Da Mi Project, some 8 to 10 kilometres from the Ham Thuan hydroelectric plant, will tunnel water to another facility generating 170 MW per year from a 150 metre water column.

(Source: Extracted from "Hydro Plants to Start," *Vietnam Investment Review*, 3-9 May, 1993, p.3.)

An Environmental Friendly Thermo-acoustic Refrigerator

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amazing is the fact that it was achieved with a modified commercial loudspeaker and a stack consisting of 3 metres of 76 micrometres thick polyester film with lengths of monofilament fishing line glued across it as spacers. The successor to STAR, a second-generation, two-stage thermo-acoustic refrigerator, designated the TAR-3, designed to achieve super-conductor temperatures, is planned for testing on board Spacelab 2 in October 1993.

Applying Space Technology to the Domestic Refrigerator

Steven Garrett intends to start work on transferring this technology to devices to replace CFC-based refrigerators and air conditioners in domestic, automobile and industrial uses. The next project will be another refrigerator for use on the Space Shuttle, which will allow the work on the STAR to be applied to the development of a thermo-acoustic engine for commercial applications. The new project, the Thermo-Acoustic Life Sciences Refrigerator (TALSR) will have a much higher performance than the STAR and its heat pumping requirements are not unlike those of a small home refrigerator/freezer. Both TALSR and STAR operate from direct current (28V d.c.) and have a control system which varies the driving frequency of the loudspeaker to accommodate the temperature changes in the refrigerator.

It is expected that the TALSR will demonstrate the applicability of thermo-acoustic refrigeration to domestic appliances; once this has been achieved, the research necessary to make a TALSR-like unit commercially feasible will be started. This would require a new control system which would allow the device to operate at constant frequency, which makes thermo-acoustic refrigeration more efficient and reduces the cost of the loudspeaker (linear motor). The next step would be to improve the overall efficiency of the system and reduce the cost and complexity of the components.

According to Garrett, although this may sound an ambitious agenda, it is no more so than placing the first autonomous thermo-acoustic cryocooler in low Earth orbit, and it would also ensure that we are able to abandon the CFC-filled refrigerator and replace it with an appliance that has no harmful environmental impact.

(Published with permission from Montres Rolex S.A., Geneve. Extracted from: "An Environmental Friendly Thermo-Acoustic Refrigerator" in Spirit of Enterprise – The 1993 Rolex Awards, edited by David W. Reed, published by Buri International for Rolex, Bern, 1993, pp.356-359.)

Development of SHP Data Bank – China

China is very rich in hydropower resources. The total theoretical hydro power potential is 680 GW, of which 380 GW is developable and only 4.3% has been exploited. Small hydro power (SHP) is an important energy source in rural China. The total SHP potential in China is estimated to be 150 GW of which 70 GW is technically exploitable. By the end of 1991, about 54,660 small hydro plants with a total capacity of about 13.85 GW and an annual generated energy of about 40 TWh were completed. Of these, there are about 4,300 small hydro plants with an installed capacity of more than 500 kW and a total generated energy of 27 TWh.

The number of established SHP plants has already reached a huge figure and many more will be coming up in future in China. The variety of plants along with their numbers creates a necessity to maintain a data bank thereby, stressing on uniformity and timeliness in extracting the relevant information about different plants. Entrusted by the Department of Rural Electrification, Ministry of Water Resources of China, a numerical data bank on small hydro power plants has been primarily created and is being developed by Hangzhou Regional Centre (Asia-Pacific) for SHP, Hangzhou, China. It is the first attempt in China to set up a small hydro power plant data bank. To keep abreast of the times and contribute to the small hydro power exploitation, development and management as well as the creation of SHP statistics, a data bank plays a vital role for the automatic analysis of small hydro power plant data.

This data bank is realized on the LC 0520 D micro computer (compatible with IBM PC/AT) which has an advanced Chinese Character System. The Chinese small hydro power plant data bank, including that of some countries in Asia-Pacific region, is a computerized information system capable of carrying out data retrieval, insertion, modification, processing, extraction, analysis and printing. A Chinese character-disk operating system CC-DOS 3.0 which enables programming in the Chinese language has been adopted. The CdBase-III (Chinese dBase-III) has been adopted as a supporting software.

The application software is a data bank management system (DBMS) created specially for the establishment of the Chinese SHP data bank and also for the data management. The software is an interactive system and introduces users, prompted by menus, to operate with man-machine communication form and to enable them to carry out data retrieval, storage, insertion, procession, modification, deletion and printing. The model of the data bank is such that the data of each plant can only present one record. A "Small Hydro Power Project Technical Data Form" was designed and best possible efforts have been put to collect all data concerning the design and operation of SHP plants. The contents of the "Form" are based on lots of discussions and modifications by qualified and experienced experts on SHP. All the available data fall into two categories: technical data and productive data.

Each record contains more than 150 terms of technical data with regard to one SHP plant. These terms are divided into several categories: civil engineering, water turbine, generator, transmission and control, etc. The productive data includes annual generated energy, annual available hours, electricity tariff, annual income and expenses, and so on from small hydro power plants which can be compiled yearly. Data from SHP plants are usually collected by the rural electrification authorities of counties, then reported to the relevant sectors of provinces (through diskette). Data from provinces are collected by the Rural Electrification Department of Ministry of Water Resources, China (through diskette). After collection and forwarding to the Hangzhou Regional Centre, the data is ultimately transferred to a bibliographic data coding form.

In order to achieve the basic functions of a data bank, like insertion, processing, inquiry, etc. with a clear, physical and logical structure and convenience of operation, a network model for certain sub-banks was designed. In inquiries, users prompted by a menu make their choices of conditions by means of the mode of man-machine communication. Users may recall every record. There are many approaches and complex conditional inquiries to recall records.

The adaptability signifies that the database performs well. Accordingly, a total approach has been taken-up to respond to the inquiries. Quick ordering in terms of restriction of keywords, step by step finishing of enquiries are common routines while utilizing the database. For each plant a certain number of inquiries are assigned and they are the mediums between sub-banks. Also, more than one sub-bank may be opened in different regions according to selected conditions. Statistical calculation is necessary for some data, e.g., capacities and number of SHP plants satisfying certain prescribed conditions. Prompted by menus, users are allowed to make their choices of conditions. Thus the database is so designed as to present quick answers to a variety of users' inquiries.

The development of a Chinese SHP data bank is a long-term task and has not yet been completed. Many technical problems need to be solved and the functions of the data bank need to be perfected. The data stored in the bank should be kept up-to-date by frequent storage of new SHP data.

(Source: Extracted from "Creation and Development of Chinese Small Hydropower Plant Data Bank" by Wu Huajun, *SHP News*, No. 3, 1992, pp. 28-33.)

Energy Resources in Tibet: A Profile

Tibet has a land area of 1.22 million km² with an average height of 4000 m above sea level. The Himalayas run for 2400 km along the borders between Tibet and India, Pakistan, Nepal and Bhutan at an average height of more than 6000 m with Mt Everest reaching 8848 m on the Tibet-Nepal border. The country has a rugged topography and harsh climate and similarly the available energy resources exist in diversified forms and with an unusual composition. Hydro, geothermal, solar and wind are the main sources of power and there is a dearth of fossil fuel.

Hydropower

The Yarlung Zangbo river running on the Tibetan plateau has an enormous hydropower potential. The water level drops 2300 m in 260 km before passing into India. The average flow is around 2000 m³/s. Utilizing this resource remains a project for the future. Present developments are confined to its tributaries. Due to expensive hauling of construction materials over 2000 km, the dozen medium-sized hydro projects and hundreds of small stations are all run-of-the-river type with low dams. The first hydropower plant of 100 kW capacity was set up in the year 1928 but it was later washed away by floods. By 1991 there were ten medium-sized and more than 300 small hydropower stations in Tibet.

Geothermal

High temperature hot springs are scattered along both banks of the Yarlung Zangbo river. The geothermal energy resources in Tibet are estimated at 690,000 kcal/s. More than 600 fields have been discovered in Tibet. The Yangbajing geothermal field, a high temperature steam field has been intensively developed to supply the bulk of the energy demand in Lhasa. There were eight generating units in operation with a total installed capacity of 25 MW in 1991.

Solar Energy

Tibet receives an estimated average of 140 kcal/cm² of radiation heat from the sun per annum and has an annual solar incidence of 3200 hours. Solar heat panels are booming in Lhasa for serving bathroom and house-heating. Solar heaters for potable water supply and solar ovens are made and supplied by the local research institute.

Wind Energy

Meteorological surveys showed there are two wind belts in Tibet. One is in Northern Tibet, including the Erli region. Strong winds blow more than 150 days a year. The other wind belt lies in Southern Tibet, between the Yarlung-Zangbo river and the Himalaya mountains. Wind energy density in Tibet averages 150-200 W/m².

The first wind power machine in Tibet was a 2 kW set installed in 1982. In subsequent years, hundreds of wind power sets had been installed. Most of the units are small in size with a capacity of 100 W each. They are used to supply individual houses for electric lighting, radios, TV sets, etc. The largest wind power unit installed is the 7.5 kW set in Siquanhe county in Erli region, in West Tibet.

Traditional Fuels

Traditional fuels such as timber, dung and grass are the main sources of energy in Tibet. Dung from the yak, dried in strong sunshine, forms an important source of fuel in Tibet. It is estimated that about three quarters of the energy consumed annually in Tibet comes from traditional fuels.

Power Development

By June 1991, the total installed capacity of 433 power plants in Tibet amounted to 156.3 MW, including hydro, thermal and geothermal, but excluding solar and wind. An 110 kV power grid has been established in the Lhasa area, where more than 40 per cent of the power installations are concentrated. All the small hydro stations are isolated installations spread over the vast area of Tibet in order to serve the widely distributed inhabitants.

Power demand for industrial purposes is limited in scale and the domestic load, such as cooking and heating, constitutes a substantial share of the power demand in Tibet. Power consumption in tourism facilities also accounts for a considerable amount of the electric load. As such, the load factor remains low with the load curve showing a peak at meal times while dropping to a low figure at night-time.

A 600 million RMB Yuan (US$ 112 million) Yangzhuoyong pumped storage project, which has been under construction since 1989, will have four pump generator sets of 22.5 MW each. The pump generator set will comprise of a multi-stage pump, a vertical axis Pelton wheel and a motor generator. The project will use off-peak power from the Lhasa power grid to pump water into the lake and to release water from the lake to generate power to supply peak demand. The next hydropower project to be constructed in Tibet after the commissioning of the Yangzhuoyong lake project will be a 100 MW Zhikong hydropower project. The project with a medium height dam, will lead to the largest hydropower station ever built in the country.

(Source: Extracted from "Tibet: A Mixed Bag of Energy Resources" by Cheng Xuemin, *Modern Power Systems*, Vol. 12, Issue 5, May 1992, pp. 31-32.)

Energy and Economy, Asian Perspective

Asian countries are encountering a situation quite in contrast to the one they would have preferred. The economies in Asia are booming but the much required energy supply is lagging far behind. Constraints surround the availability and supply of energy and to strike a balance in order to satisfy the requirements is becoming urgent.

Asia's phenomenal economic expansion threatens to run out of the race because of energy shortages. The worst-affected countries are usually those with the fastest growth rates and, conversely, those least able to pay for new power plants. Philippines is worst-affected by brownouts and power outages and the industrialists continuously fear losing business to other regional businessmen. China also now reports shortages in the traditional energy-exporting northwest and southwest. Planners estimate that inadequate power has cost Guang-Dong province nearly 30 per cent of its potential industrial output. Indonesia barely manages to supply electricity to one-third of its 180 million people. Private generators in homes and offices and small power plants in industrial estates have now become the new status symbol. Similarly the Indian states are also facing the crunch in the energy sector. The energy problem even looms in the prosperous economy of Japan.

Asians, 40 per cent of the world's population, used just 22 per cent of world commercial energy in 1990. A decade of near-double-digit economic growth has whetted an appetite for more. But without massive new energy supplies before the end of the century, Asia's economic growth could wheeze to a halt. Although the overall fuel supplies appear to be adequate for the foreseeable future the immediate problem is a shortage of generating capacity. Many companies are viewing the building of new power plants as a lucrative job in the region.

The Asian Development Bank (ADB) expects the region's electric power demand to double during the 1990s, requiring an additional 300,000 megawatts (MW) – equal to about 500 large power plants. The costs involved are estimated to be about US$ 50 billion a year until the end of the century. The huge amount is far beyond regional governments' finances and even the funds available from organizations like the World Bank and the ADB will hardly meet the requirement. The private sector will have to meet the huge remaining shortfall and this will create job opportunities as well as competition. Schemes like build-own-operate (BOO) or build-operate-transfer (BOT) can help attract private investment in this sector. Participation by private sector companies like Hong Kong's Hopewell Holdings in Philippines and China, New World Development in China and Vietnam, Japan's Mitsui and Co. in Pakistan and Philippines amply prove the attraction and scope in this business.

Private sector involvement is also a difficult affair. Government approval for the private project and the development of clear cut rules are time-consuming and complicated. Payment in pieces to the private sector can to some extent reduce the financial burden on the host countries. Further, the criteria for success of the project

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Overseas Aid Sought for Power Industry – China

China plans to attract more investment from overseas to hasten development of the power industry. Several foreign-funded power stations are under construction and more are being planned by overseas joint venture firms.

According to the newly-established Ministry of the Power Industry, the country has listed scores of power projects courting foreign investment and technical co-operation, including three in Shanghai. Investment from overseas would help accelerate development of both thermal- and hydro-power projects.

In 1992, the country produced 742 billion kilowatt hours, or the fourth largest power output in the world. However, the country, with a population of 1.15 billion, still has a severe shortage of power supply despite steady growth over the years. The country's power industry can only satisfy 80 per cent of rising national demand.

To meet rising demand for power, a capacity to produce at least 120 million kilowatts per hour should be achieved by the year 2000. To install enough generators for this capacity, at least $715 billion in investment is needed.

Shi Dazhen, newly-appointed Minister of the Power Industry, said foreign investors are most welcome to participate in the industry's development programme.

Investment in the power industry now comes from the central government, local authorities, private enterprises and overseas firms. Foreign firms are expected to contribute more to the construction of power stations in the country.

Foreign businessmen's interest in China's power industry has grown rapidly. Investment from overseas in the industry will likely be extensive before long. The industry is ready not only to build power stations but also manage them with foreigners. This year, 57 large- and medium-sized power generators, with a combined capacity of 11.44 million kilowatts per hour, will be put into operation.

China's power shortage is expected to ease by 1995, when its annual power output is expected to have reached 920 billion kilowatt hours. The industry had originally planned to install, annually, generators that are capable of producing 13 million kilowatts per hour in 1993, 1994 and 1995. For the 1996-2000 period, generators capable of producing 15 million kilowatts per hour will be installed on an annual basis.

(Source: Extracted from *China Daily: Economics and Business*, April 29, 1993, p.2.)

Energy and Economy, Asian Perspective

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include the government's permission for investors to enjoy a fast return on investment, sharing of risks by the public sector, and an environment of bureaucratic assistance.

Management skills and financial reserves play an important role in determining the status of a country's energy sector – the reliability of fuel supply, minimum costs and least environmental damage. Japan which currently gets 26 per cent of its electricity from nuclear plants hopes to reach the figure of 43 per cent within two decades. Similarly, Korea, Taiwan and China are pressing ahead with new nuclear plants. But with high costs involved in the construction and maintenance of nuclear plants the forecasts for development of these plants are not so healthy. China, the world's largest coal user, relies on its huge coal reserves – 10 per cent of the world's – as its main fuel and expects coal use to rise to more than double by the century's end. Similarly, Thailand hopes to boost coal use from 22 per cent to 66 per cent of its electric generating capacity over the next 15 years. Altogether, Asia's utilities are expected to nearly triple their coal use to an estimated 600 million tons annually by the end of the decade.

Despite plans for a huge lift in the development of coal and nuclear power plants, many countries are showing an increasing propensity for the abundantly available and clean-burning natural gas. The Asian countries except China used natural gas to meet only 10 per cent of its energy needs in 1989 and the figure is predicted to rise to 17 per cent by the year 2000. Taiwan plans to boost its use of liquefied natural gas from 6 per cent of its current energy supply to 20 per cent by 2010. The most ambitious project under consideration is a 27,000-kilometer pipeline from Russia's Sakhalin Island through eastern China to Malaysia, Indonesia and Australia. Another ambitious undertaking is on the drawing board in Hong Kong. The territory's main utility, China Light & Power Co., plans to pipe natural gas from China's Hainan province through a $500 million, 450-km pipeline across the South China Sea to Hong Kong's $770 million Black Point plant, one of the world's biggest power stations. The gas will ultimately generate 6,000 MW, enough to meet the territory's anticipated electricity demands into the next century.

Planners in the region are developing alternative energy supplies and technologies. Possible choices include nuclear fusion, hydrogen-burning plant and solar photovoltaic cells. Japan's Sunshine Project, for instance, spends about $100 million a year on coal liquefaction and gasification. Both methods should create cleaner-burning power plants, while minimizing the difficulties of storing and transporting coal. Japan is also a leader in energy conservation. A recent study by the Paris-based Organization for Economic Cooperation and Development found that Japan reduced the amount of energy needed to produce $1 million worth of gross domestic product by a remarkable 33 per cent between 1973 and 1987.

Conservation offers the least expensive way to alleviate energy shortages frequenting the Asian countries. Kawasaki Steel Co., Japan, one of the world's most efficient steel works plants, uses waste heat to run a cogeneration electric plant. One Japanese study claims that developing countries can reduce energy needs as much as 17 per cent by adopting small energy-saving steps. Several Asian countries including Thailand may soon encourage conservation by beginning direct incentive payment to makers of more efficient motors, lighting, refrigeration and air conditioning. With a massive investment in new generation capacity and with a recent trend towards energy conservation, 21st century Asia has the potential to be a much brighter place.

(Source: Extracted from "Asia's Energy Crunch," *Asia Inc.*, Vol. 1, No. 2, August 1992, pp. 30-34.)

Training Courses/Workshops

1st International Scientist and Technologist Congress & Convention'93 – ISTCC'93
1-5 November 1993

The congress is organized by International Visitor and Convention Centre, Republic of Singapore, to promote the international exchange of ideas and experiences in science and technology. The areas covered include satellite, telecommunications, electrical and electronics, automobile, automation, environmental science and energy, medical and health care, chemicals, architecture and building, agriculture, space science, audio-visual, manufacturing and production, laboratories, etc.

The main speakers, are from Australia, Belgium, Canada, China, France, Germany, Hong Kong, Italy, Japan, Netherlands, Singapore, Switzerland, United Kingdom, United States and others.

Exhibition

An exhibition on science and technology will be held in conjunction with ISTCC '93. The 1st International Scientific & Technology Exhibition '93 (ISTE '93) will involve agencies in the fields of science and innovative technology. The exhibition will be held from 5-7 November, 1993 at the Singapore World Trade Centre – Exhibition Centre.

For further details contact:

Int'l Visitor & Convention Centre
150 Orchard Road, Orchard Plaza, #08-09
Singapore 0923
Tel: 65-736 1101
Fax: 65-235 3156, 65-235 3356

Book Review

Theory and Calculation of Applied Solar Energy Concentrating Systems

R.A. Zakhidov, G.Y.A. Umarov and A.A. Weiner
Gujarat Energy Development Agency
3rd Floor, B.N. Chambers
R.C. Dutt Road, Vadodara - 390005, India
ISBN 81-900282-0-0, 1992, 144 p.
(English Edition)

Gujarat Energy Development Agency (GEDA), Vadodara, India, received the rights from the Director, Institute of Power Engineering and Automation, Uzbekistan Academy of Sciences, Akademgorodox, Tashkent, the Republic of Uzbekistan to translate the Russian version of this book into English. This monograph gives basic theories of concentration of solar radiation. Original calculating models developed by the authors are presented which take into account the basic operational factors like characteristics of point source of radiation, shape and quality of reflecting surface, accuracy of tracking, etc. Results for the calculation of single mirror, multi-faceted and two-mirror concentrating systems (paraboloid-heliostats and paraboloid-hyperboloid) are presented. The effect of accuracy of tracking on efficacy of concentration and temperature regime of elements of transformation under the conditions of periodical disorientation is examined and the results are presented. The developed model allows calculation for multi-mirror optical furnaces with artificial point sources used in high temperature investigations.

The monograph is meant for scientific and technical researchers dealing with the calculation and designing of solar energy systems.

Solar Pumping: An Introduction and Update on the Technology, Performance, Costs, and Economics

Roy Barlow, Bernard McNelis and Anthony Derrick
World Bank Technical Paper Number 168
Intermediate Technology Publications and The World Bank, Washington, D.C.
ISBN 0-8213-2101-3 (U.S. edition)
ISBN 1 85339 179 4 (U.K. edition)
1993, 153 p.
Available at £12.50 per copy in UK from:
Intermediate Technology Publications, Ltd.
103/105 Southampton Row, London, WC1B 4HH, U.K.

This guidebook has been written to provide both a simple introduction to potential users and purchasers of solar pumps, and to review the current state-of-the-art in technology, costs and economics. The first three chapters act as a guide to those unfamiliar with PV pumping, illustrating typical applications and reviewing current technology. Following these are sections dealing with the range of currently available equipment and examining experience in the field. The final four sections cover the practical aspects of choosing a pumping system. This includes site evaluation and system sizing, a simple methodology for an economic assessment, and advice on procurement, installation and maintenance.

The appendices contain various data and information referred to in the text. Two of these are of particular note: Appendix G which contains quick reference data for wind, diesel and hand pumping scenarios; and Appendix I which reviews the current and future economics of PV pumping in general in comparison with other pumping alternatives.

The Sunshine Revolution Book and Video

Harald N. Røstvik
SUN-LAB Publishers
Steingaten 87
4024 Stavanger Norway
Fax: (47-4)-524062; Tel: (47-4)-533442
ISBN 82-91052-03-4, 1992, 188 p.

This colourful book with 300 illustrations provides information about solar architecture, solar cars, boats and planes, solar cooling and heating for cooking, desalination and crop drying in developing countries. The book and video gives you the figures and arguments you need as an environmentalist, consumer, investor, professional designer, architect, engineer or student.

Contents of the book include:

- The Environmental Challenges
- The Real Cost of Energy
- The Sun is a Star
- The Sun as a Deity
- The Sun in Art
- The Sun and Health
- Solar Radiation on the Earth
- Solar Energy in History
- Solar Thermal Heating and Cooling
- Solar Electricity
- Liberation Technology for Developing Countries
- Energy Consumed in Making Collectors
- Solar – A Good Investment
- An Oil Nation and Solar
- National Solar Programs
- Careers of the Future
- Obstacles and Opportunities
- Visions.

The video (15 minutes VHS-PAL) received the "1991 Gro Harlem Brundtland Environmental Foundation Award." The video deals with the solutions to environmental problems. It describes how clean and renewable solar energy can be adopted now.

Publications Received

BIOMASS ENERGY

* *Charcoal Production and Marketing in Gujarat*, by Prakash M. Shingi and S.P. Seetharaman, Regional Wood Energy Development Programme in Asia Field Document No. 36, Food and Agriculture Organization of the United Nations (FAO), Bangkok, Thailand, May 1993, 70+iv p.

* *Energy Utilization of Agro-food Industry By-products, Proceedings of the Seminar, Part 1: Session Report*, United Nations, Consultative Committee UNIDO, November 1984, Lille, France, 242+L p.

* *Energy Utilization of Agro-food Industry By-products, Proceedings of the Seminar, Part 2: Valuation of the Potential*, United Nations, Consultative Committee UNIDO, November 1984, Lille, France, 106 p.

* *Fluidized Bed Combustion, Proceedings of a Workshop held in Bangkok and Chiang Rai, Thailand, 6-9 November 1991*, edited by Suvit Tia and T.H. Commins, Association of South East Asian Nations, organized by the ASEAN Sub Committee on Non-Conventional Energy Research and the Pilot Plant Development and Training Institute of Thailand (PDTI), Bangkok, Thailand, 1991, 190+iii p.

ENERGY AND ENVIRONMENT

* *Sectoral Energy Demand Studies in Asia: Synthesis Report*, revised and edited by Thiery Lefevre, Regional Energy Development Programme, Economic and Social Commission for Asia and the Pacific, prepared in cooperation with the Government of France and the Asian Institute of Technology, United Nations, New York, 1992, 57+xii p.

* *A Framework for Building Long-term Economic Scenarios*, revised and edited by Thiery Lefevre, Regional Energy Development Programme, Economic and Social Commission for Asia and the Pacific, prepared in cooperation with the Government of France and the Asian Institute of Technology, United Nations, New York, 1992, 47+vi p.

* *Sectoral Energy Demand Studies in Asia, Proceedings of A Regional Workshop, ESCAP, Bangkok, 23-27 March 1992*, revised and edited by Thiery Lefevre, Regional Energy Development Programme, Economic and Social Commission for Asia and the Pacific, prepared in cooperation with the Government of France and the Asian Institute of Technology, United Nations, 1992, 268+vi p.

* *Sectoral Energy Demand in the Philippines*, revised and edited by Thiery Lefevre, Regional Energy Development Programme, Economic and Social Commission for Asia and the Pacific, prepared in cooperation with the Government of France and the Asian Institute of Technology, United Nations, 1992, 94+xxxiv p.+Annexes.

* *Electricity Supply to Rural Areas of Argentina*, Institute of Energy Economics (IDEE) and National University of Misiones, Argentina, International Development Research Centre (IDRC), Ottawa, January 1993, 140+vii p.

* *A Quantitative Analysis of the Energy Contribution Offered by the Various Integrated Energy Systems Designed within the Project UNDP/FAO-RER/80/001, REUR Technical Series 22*, by G. Pellizzi, F. Mazzetto and B. Biet Project Coordination Team, Food and Agriculture Organization of the United Nations, Regional Office for Europe, Rome, 1991, 43+iii p.

* *Labour, Machinery and Energy Data Bases in Plant Production, REUR Technical Series 27*, compiled by Juha Palonen and Erkki H..Oksanen, Work Efficiency Institute, Helsinki, Finland, Food and Agriculture Organization of the United Nations, Rome, 1992, 98 p.

* *Our Choices for 2010: From Minamata to the Global Environment, Final PG Report*, People's Research Institute on Energy & Environment (PRIEE), Ohdake Foundation, Japan, March 1993, 70+Annexes.

* *Status and Development Issues of the Brick Industry in Asia*, prepared by Auke Koopmans and Stephen Joseph, Regional Wood Energy Development Programme in Asia, Field Document No. 35, Food and Agriculture Organization of the United Nations, Bangkok, April 1993, 69+iii p.

HYDROPOWER

* *China's Construction in Four Decades (1949-1989), Electric Power Industry in China*, published by Coastal International Investment Consultant and Information Institute of Water Resources and Electric Power, MOE, MWR, ISBN: 962-404-010-9, 127 p.

Dual Purpose Energy Saving Fan - China

A new generation of energy saving fan for both cold and warm purposes has been developed by Ninbo Household Electric Appliance Factory, China. It uses a highly efficient PTC ceramic heating element which has a normal life of around 5000 hours and a heating efficiency of approximately 100 percent.

The appliance possesses advantages like energy conservation, constant temperature, least affect from voltage fluctuation, easily regulated heat productivity, safety, radiation free and fire-proof. Four safety devices for switch locking, dumping protection, overcurrent protection and overheat protection form an integral part of the appliance. PTC heating body with a constant temperature has an optimal combination, rapid heating velocity and a moderate impact current. The product can be used as a mini-electric fan in summer and as a warmer in winter and is available in both pedestal and hanging design.

(Source: Extracted from "A New Generation of Energy Saving Type Fan for Cold and Warm Purposes," *China Information Network on New & Renewable Energy Resources (CINNRER) Newsletter*, No. 4, December 1992, p. 6.)

World Renewable Energy Congress III

Jointly with ISES – Europe

Reading–United Kingdom
11 – 16 September 1994

This important congress is to be the third in a biennial series held in Reading University, United Kingdom. The theme of the 1994 Congress will be "Climate Change – Energy and Environment". The congress topics will be photovoltaic technology, solar thermal applications, wind energy applications, biomass conversion, solar and low energy architecture, and other related topics. The congress will be managed by an Organizing Committee and a Technical Committee in the United Kingdom under the guidance of a large International Steering Committee, and with the sponsorship of major international agencies, professional organizations, academic institution and private companies.

Key Dates

February 1, 1994 Last date for receiving abstracts.
February 28, 1994 Preliminary acceptance of abstracts.
April 15, 1994 Last date for receiving the full papers.

The organizers will do their best to notify authors within a short period of receiving their abstracts the technical committee's decision.

Please send your abstract – no more than 500 words – to:

Prof. A.A.M. Sayigh
Chairman of the Congress
Department of Engineering
University of Reading
Whiteknights, P.O. Box 225
Reading RG6 2AY
United Kingdom
Tel: (0734) 318588
or (0734) 875123 Ext. 7575
Dialling from abroad,
use (734) without the zero.
Fax: (0734) 313835

Diary of Events

- **6 – 9 June, 1993, Milan, Italy**

19th World Gas Conference

For details contact:
Piero Luigi CARIBOTTI
Secretary of the Papers Committee WGC-19
c/o SNAM S.P.A.
Piazza Santa Barbara
7 – INSO 3
20097 San Donato Milanesse (MI)
Italy
Tel: +39 2 52024871
Fax: +39 2 5204279

- **22 – 23 July, 1993, Hong Kong**

Power Generation in the People's Republic of China

For details contact:
AIC Conferences
Alan Smith, Asian House
1 Hennessy Road
Ste 1084, 18th Fl.
Hong Kong

- **10 – 13 August, 1993, Nashville, TN, USA**

Waterpower'93 – Hydropower: Its Role in World Energy

For details contact:
American Society of Civil Engineers
345 East 47th Street
New York, NY 10017
USA

- **26 – 27 August, 1993, Muroran, Japan**

International Symposium on Ocean Energy Development for Over-coming Energy and Environmental Crises

For details contact:
Prof. Hideo Kondo
Muroran Institute of Technology
Department of Civil Engineering and Architecture
27-1 Mizumoto-cho, Muroran
Japan 050

- **30 August – 2 September, 1993, Vermont, IL, USA**

First Biomass Conference of the Americas

For details contact:
Dr. Donald Klass
NREL
1617 Cole Boulevard
Golden, CO 80401
USA

- **13 – 15 September, 1993, Singapore**

Power-Gen '93 International

For details contact:
Power-Gen Asia '93
Time Centre
1 New Industrial Road
Singapore 1953

- **19 – 23 September, 1993, Cape Town, South Africa**

World Energy Council Assembly

Cont. p. 20

For details contact:
World Energy Council
34 St. James's Street
London SW1A 1MD
United Kingdom

- **20 – 22 September, 1993, Pincher Creek, AB, Canada**

Canadian Wind Energy Conference and Exhibition

For details contact:
Chi Li
Canadian Wind Energy Association
2415 Holly Lane, Suite 250
Ottawa, Ontario K1V7P2
Canada
Tel: +1(613) 737 0524
Fax: +1(613) 736 8938

- **21 – 23 September, 1993, Bournemouth, United Kingdom**

1993 ASME Cogen Turbo Power

For details contact:
International Gas Turbine Institute (IGTI)
Tel: (404) 847-0072

- **28 September – 1 October, 1993, London, United Kingdom**

Fuel Cell Symposium

For details contact:
Kay Russell
Conference Department
Elsevier Science Publishers Ltd.
Mayfield House
256 Banbury House
Oxford OX2 7DH
United Kingdom

- **September, 1993, Husum, Germany**

Husumer Windenergietage '93

For details contact:
Husum Messe GmbH
Zingel 5
2250 Husum
Germany
Tel: +49 4841 64517
Fax: +49 4841 81886

- **4 – 6 October, 1993, Munich, Germany**

3rd International Conference on Small Hydroelectric Power Plants

For details contact:
Commission of the European Communities
Forum für Zukunftsenergien e.V.
Godesberger Allee 90
5300 Bonn 2
Germany

- **5 – 8 October, 1993, York University, United Kingdom**

British Wind Energy Association Conference

For details contact:
David Bodger
Nottingham University
14 Shakespeare Street
Nottingham NG1 4JF
United Kingdom
Tel: +44(0) 602 516526
Fax: +44(0) 602 472977

- **17 – 21 October, 1993, Kansas City, MO, USA**

1993 Joint Power Generation Conference and Exhibition

For details contact:
The American Society of Mechanical Engineers
345 East 47th Street
New York, NY 10017
USA

- **18 – 22 October, 1993, Seoul, South Korea**

The 5th International Energy Conference

For details contact:
ENERGEX'93 Secretariat
c/o KIER
P.O. Box 77, Taedok Science Town
Taejon 305-343
Republic of Korea
Tel: +42-861-6230
Fax: +42-861-6231

- **17 – 19 November, 1993, London, United Kingdom**

International Conference on Renewable Energy – Clean Power 2001

For details contact:
Jane Chopping
IEE Conference Services
Savoy Place
London WC2R 0BL
United Kingdom
Tel: +44 71 240 176
Fax: +44 71 497 3633

- **22 – 26 November, 1993, Nagoya, Japan**

7th Photovoltaic Science and Engineering Conference

For details contact:
Prof. T. Jimbo
Fax: +81 3 3508 0820

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Library and Regional Documentation Center, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The "RERIC News" is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership along with the other four regular publications namely: RERIC International Energy Journal (formerly: Renewable Energy Review Journal); RERIC Holdings List; Abstracts of AIT Reports and Publications on Energy; and RERIC Membership Directory. For further details contact:

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Bangkok 10501, Thailand
Telex: 84276 TH
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Fax (66-2) 5245870

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Demonstrative Research for Photovoltaic Power Generation System in Thailand

In cooperation with the New Energy and Industrial Technology Development Organization (NEDO), Japan, the Thailand Department of Energy Development and Promotion has begun executing a research and development project on a photovoltaic electricity generation system for battery charging stations.

In Thailand, automobile batteries are used for home lighting equipment and as power resources for radios and televisions. There are battery charging stations in some areas for recharging when necessary. Energy sources include diesel electricity generation systems and commercial electric power sources. Photovoltaic electricity generation systems can be used for charging batteries in remote areas where the electricity grid is not accessible and a diesel electricity generation system is not economically viable.

The four-year project (April 1992 – March 1996) comprises two phases. During the first phase, a prototype system has been designed, manufactured and constructed in Thailand. The data from this prototype system has been used as a basis for research and development of a demonstrative plant. Changes in the solar module

power with the passage of time and under the high temperature and humidity conditions and the efficiency improvement of the balance of system (BOS), including a charge/discharge regulator, are being studied. During the second phase (April 1994 – March 1996), a 40 kW photovoltaic generation system will be developed based on the results obtained from the operation of the demonstrative plant.

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INNERTAP

Incorporates news from the Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

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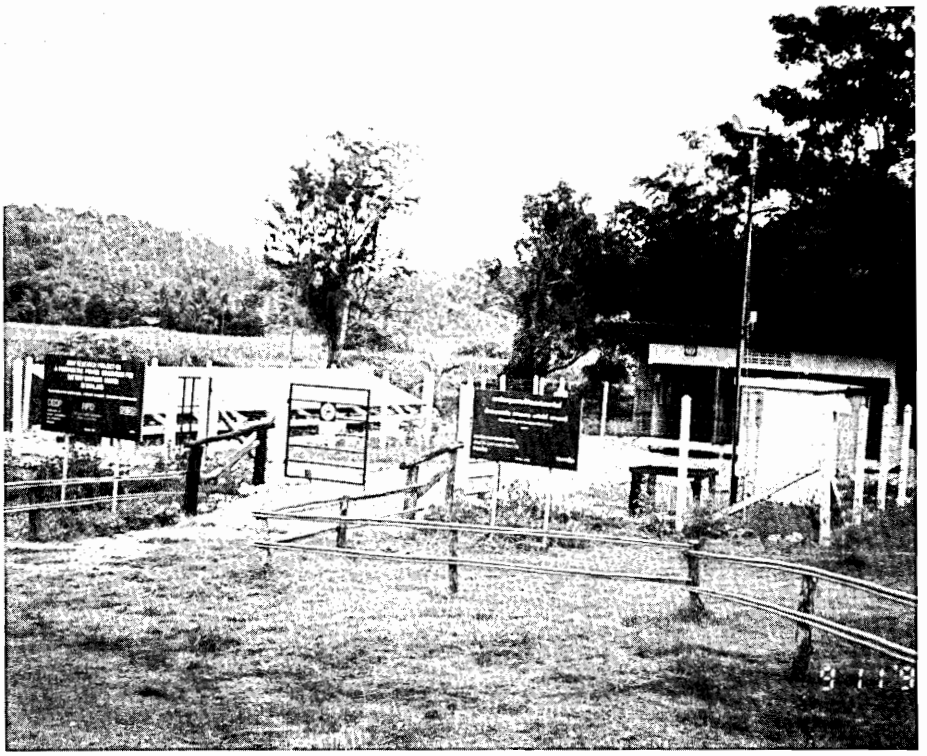
Supplement: Small Scale Wind Energy Systems

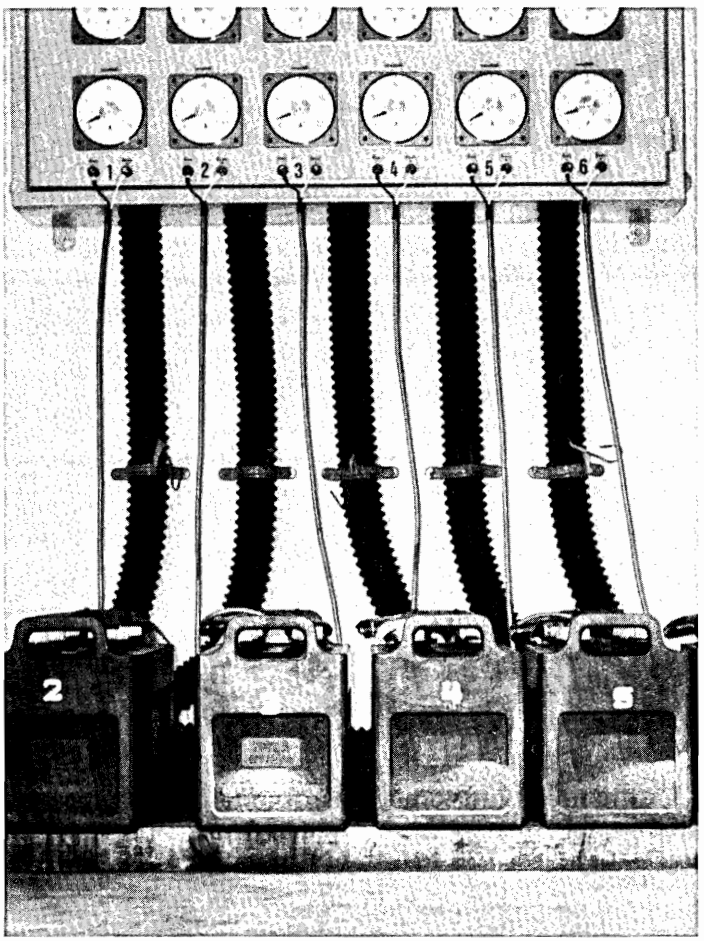
Demonstrative Research for Photovoltaic Power Generation System in Thailand

From P. 1



The first demonstrative plant co-sponsored by NEDO is located at Bann Bon Khao Kang Rieng, Thakrada Sub-District, Srisawas District, Kanchanaburi Province, 200 km to the north west of Bangkok. Construction and installation were completed in April 1993. The battery charging station with a 4 kW solar module is designed to be able to charge 16 batteries in one day. The battery used is a 12V type for trucks (110 Ah) and there are 147 batteries provided by the project. The 147 households are divided into 10 groups so that they can charge their batteries every 10 days. The load is restricted to a 20 W fluorescent lamp per household in order to obtain reliable data on the changes with the passage of time.

The PV system consists of 60 modules with an average maximum output of 70 W. Seven modules are connected in parallel making 8 sets, each of which can charge 2 batteries. Sixteen batteries can be charged at the same time. The remaining 4 modules are used as a power source for observation equipment. As the site is situated in latitude 14 degrees north, the angle of inclination of the solar module is set at 20 degrees.



Batteries are being charged.

Because of the surrounding temperature in Thailand which rises higher than 30°C, there is a possibility of a fall of the power output and the voltage in the electric wire (approx. 25 m). In order to secure a sufficient voltage for full charging at the terminal end, a module with 23 V rated output voltage is used.

In order to prevent batteries from deteriorating due to excessive discharging, an indicator showing the remaining electric capacity in three levels is installed and an excessive discharge protector, which disconnects the load when the voltage falls below a certain level, is installed in each battery.

Based on the results of the operation of the demonstrative plant, a 40 kW photovoltaic generation system will be developed.

For further details contact:

Department of Energy Development and Promotion
Ministry of Science, Technology and Environment
Saphan Kasat Suk
Bangkok 10330
Thailand

Sources: 1) Demonstrative Research for Photovoltaic Power Generation System in Thailand, New Energy and Industrial Technology Development Organization/Japan and Thailand Department of Energy Development and Promotion, March 1993, 12 p.

2) Photovoltaic Power Generation System for Charging Batteries, Butrada Srilerdchai and Chusakdh Aiempan, *Daily News Variety*, Sunday 20 June, 1993, p. 5 (in Thai).

Solar Technology for Rural Electrification – Indonesia

Rather than compete as a source of large-scale generation, solar companies in Indonesia are promoting solar technology as a means of supplying electricity to single-households in rural areas. A recent mission by the World Bank expressed support for the idea and $30m of funding under the government's Rural Electrification II (RE II) scheme, to start next year, is likely to be forthcoming.

Althought the government is politically committed to rural electrification, its programme grid extensions have been costly.

By 1992 the PLN, the state utility, claimed to have electrified about 40% of Indonesia's estimated 62,000 villages and to have 6.7m rural customers. This represents a connection rate of about 55% of households in each village, with the programme concentrating on the main island of Java where about 60% of Indonesia's 185m people live.

The cost to PLN of rural electrification through grid extensions would be about $300 per household assuming a 100% connection rate, rising to over $3,000 per household if only 10% connect. PLN has been running losses of over $100m a year, due in large part to its rural electrification programme.

Solar home systems (SHS), consisting of a single 55-100 watt panel with regulator and battery costing about $600 per unit, could be a cost-effective alternative. A study by R&S, an affiliate of the Shell oil company, indicates that to supply electricity to homes which are off-grid, only micro-hydro systems offer a cheaper alternative to solar. However, micro-hydro would only be suitable in a minority of village sites.

Actively supporting solar power, Indonesia's minister of technology, B.J. Habibie has recommended that 50 MW (peak) be installed in 1 million rural households between 1994-1999, 1.93 MW be provided for rural health centers, 0.67 MW be installed for water pumps and 0.42 MW for television repeater stations.

The household component is expected to cost $450m-$500m. If it goes ahead, companies such as R&S and BP Solar (a subsidiary of BP, the UK oil company), which have offices in Indonesia, would be key players.

However, it remains a big "If". A recently-concluded $1.65m Indonesian government-financed pilot project, Banpres, to electrify 3,000 homes highlighted several problems in providing solar power to rural communities.

The cost of SHS is at the borderline of affordability for rural households, and payments need to be staggered.

With Banpres, payments were made to the local co-operatives under the Ministry of Co-operatives but the collection rates in some villages fell as low as 50%. Technically, the project was a success, with the systems proving reliable and well-received.

The World Bank's expected approval of a $30m loan under RE II will provide an opportunity to improve on Banpres before progressing to B.J. Habibie's mega-project.

Industry officials also warn that the mega-project would involve copious red-tape with the involvement of at least five ministries.

There are also concerns that, whereas an SHS is ideal as an introduction to electricity, it could prove inadequate should household demand grow.

Foreign companies might be willing to invest in Indonesian facilities – it would cost about $7m to set up a plant, not including the manufacturing of the silicium for the photovoltaic cells – but only if there is guaranteed take-up. In the meantime, the industry is concentrating mostly on higher value solar products. BP Solar has supplied 100 refrigerators to rural clinics and a communication system for Java's railway network. R&S is currently undertaking a $10m project to supply 30-panel systems to a further 270 health centers.

(Source: Extracted from "Indonesia Takes a Chance on Solar", *Power in Asia,* Issue No. 131, 2 August 1993, p. 2.)

Solar Refrigeration for Drugs and Vaccines – India

"Solar Vaccine Saver VR 100" developed by an Indian company is unique in that there are no moving parts, motor, compressor or working fluid, for producing the refrigeration effect. The system uses a solid thermo-electronic module for pumping out heat, thereby producing a cooling effect. The electrical energy required is supplied by direct conversion of solar energy into electrical energy by photovoltaic (PV) modules provided with the system.

The system comprises a 120 Wp PV module driving a thermo-electric module of 600 watt capacity and is backed up with electrical energy storage. Stored energy operates the systems during night and cloudy weather conditions, ensuring a stable temperature for the drugs and vaccines (maintained between 4 to 10°C). It can hold four kilograms of vaccine and drugs. Energy storage is handled by sealed jell type lead acid battery charged and discharged through an electronic regulator with built-in controls for prevention of over-charging, deep discharging, short-circuit protection and protection against polarity reversal.

(Source: Extracted from "Solar Refrigeration for Preserving Drugs and Vaccine", *Urja*, Vol. 34, No. 1, July 1993, p. 54.)

Centre for Applications of Solar Energy (CASE)

The first, newly formed, Center for Applications of Solar Energy (CASE) is based in Perth, Western Australia and operates under the auspices of the United Nations Industrial Development Organization (UNIDO) with support from the Australian Commonwealth Government, the Government of Western Australia and Murdoch University.

The Perth CASE is the first of several such centers world-wide. The center will generally not undertake basic research nor engage in manufacturing activities. The mission of CASE is to bridge the gap between research and development organizations, innovative enterprises and the market-place within developing countries to stimulate the appropriate application of solar energy technologies and solar energy-related industrial development in developing countries.

The immediate objective of the CASE is to respond to demand from the developing countries for energy services by promoting solar energy technologies which are economically, culturally and technically appropriate.

Activities

Each CASE will be active in the following functional areas:

Promotion: Promote (advertise, lobby, exhibit, convene seminars) opportunities for the application of solar energy technologies within developing countries to governments, energy utilities, donors, financiers, manufacturers and end-users.

Product Development: Promote appropriate system design and solar based product development for use in developing countries. Adapt proven technologies to the specific needs of the market in developing countries.

Marketing: Undertake market research into the demand for energy services within developing countries which may be satisfied by solar energy technologies; organise marketing consulting services for enterprises providing solar energy products and services within developing countries.

Commercialization: Support the establishment of manufacturing infrastructure to allow production of appropriate solar energy technologies; facilitate the establishment of "incubator" units in which promising solar technologies may be developed and commercialized.

Finance: Broker arrangements for technology transfer into developing countries; negotiate with financiers, aid agencies and donors to establish financial arrangements to support the application, commercialization and industrialization of solar energy technologies within developing countries.

Education & Training: Conduct education and training programs to raise skill levels within developing countries to support the application, commercialization and industrialization of solar energy technologies.

Certification: Prepare evaluation and certification programs to characterize the cost-effectiveness, durability, operability and maintainability of solar energy technologies for developing countries.

Engineering Services: Prepare technical and contractual specifications for the acquisition of solar energy technologies on manufacturing facilities on behalf of purchasing organizations.

The CASE for Perth

Australia has developed strong links with research and commercial organizations concerned with solar energy in the Asia/Pacific region. The climate in Australia is also conducive to solar technology research and utilization. Australia is now a leader in the research, development and manufacture of solar energy technologies particularly where the requirement is for systems which are appropriate to the need and skill levels of people living in remote areas.

Western Australia is a major center for the commercialization of solar energy technologies with most activity centered on Perth.

Work Program: In the Work Program of the Perth CASE, the process of market evaluation has been given a high priority. This activity seeks to identify, through consultation with developing countries, energy service needs which are able to be satisfied by solar energy technologies. These needs, often shared by many developing countries, include but are not restricted to:

- Remote area power services,
- Water pumping services,
- Vaccine refrigeration services,
- Water purification and distillation services,
- Industrial process heating services,
- Domestic water heating services,
- Crop and timber drying services, and
- Domestic cooking services.

Considerable emphasis is placed on identifying more mature solar energy technologies; evaluating their technical, practical and economic viability; and developing application programs with the assistance of funding agencies, in-country experts, end-users and technology suppliers.

Invitation to participate:

– Government organizations and funding agencies are invited to submit project proposals involving the application of solar energy technologies suitable for the Perth CASE to undertake on a contract basis.

– Research, manufacturing, marketing, financing, aid and policy development organizations are invited to make general operation suggestions and specific project recommendations.

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World Bank Loan for India Wind

An 85 MW wind farm proposed by the World Bank is to be built in India. The project is intended to help commercialize wind technology. It is the first major renewables venture with World Bank involvement and its genesis was prompted by the commitment of the Global Environment Facility (GEF), formed to aid environmentally-benign developments in the Third World and jointly administered by the World Bank and the United Nations. Wind is just one of five elements in the renewables project. It also incorporates solar and small hydro.

The World Bank has long been criticized for not being sensitive enough to environmental issues and for supporting only conventional energy development. "We're now very sensitive to the environmental effects of investment," says Magdalena Manzo of the World Bank.

The planned development will more than double the amount of grid connected wind capacity in India, which currently totals just over 50 MW including some projects not yet complete.

Prospective developers were given details of the financing and competitive bidding arrangements attached to the World Bank loans at an information meeting in Delhi on July 2, organized by the Indian Renewable Energy Development Agency (IREDA). IREDA will broker the loans on behalf of the World Bank.

Addressing the meeting, Ms Manzo said: "Right now we are ready to dispense $28 million in the anticipation that this will be allocated within 12 months on a first come, first served basis. We may look at a second project, but this will depend on India's track record". Ms Manzo also said that if the Indian wind project was a success, the World Bank would consider financing similar projects in other countries too. The project in India is the bank's first foray into wind power.

Over 80 people attended the event which brought together World Bank staff, prospective wind plant developers, representatives of state utilities, officials of the Indian Ministry of Non-conventional Energy Sources (MNES), and suppliers of wind power technology. Of the $28 million made available by the World Bank, $15 million is from the International Development Association, administered by the bank, and $13 million from the GEF. According to MNES, another $50 million is expected from Danish overseas agency, Danida. IREDA is contributing $16 million and the contribution from private sector investors amounts to $31 million. The total cash thus available for 85 MW of wind power is $125 million. The credit line for wind farms is expected to be committed within three-and-a-half years.

At the meeting the main issues raised were the difficult and time consuming procedures attached to procuring a loan, the high interest rates being charged (15 percent), the need for independent examination of the performance of existing turbines and the need for a wind turbine test centre in India. It was broadly agreed that all the Indian states should adopt a uniform policy on wind energy generation.

At the closing ceremony, India's energy minister, Krishna Kumar, said he was, "Trying to persuade the state electricity boards to give as attractive a price as possible for purchases of wind energy". Currently, Tamil Nadu has fixed its rates at INR 1.25/kWh, Andhra Pradesh at INR 1.70/kWh and Gujarat at INR 1.75/kWh.

The 85 MW of wind power, which will be owned and operated by the project developers, is expected to be installed in at least one of four states: Andhra Pradesh, Gujarat, Karnataka and Tamil Nadu. Initial resource mapping has identified 28 wind plant sites in these states. So far the private sector in India has developed some 18.5 MW of wind power, nearly all in the southern state of Tamil Nadu.

(Compiled from "Global Aid for India Wind" by Ros Davidson, *Windpower Monthly*, March 1993, Vol. 9, No. 3, p. 19 and "World Bank Wind Forum" by Neelam Mathews, *Windpower Monthly*, September 1993, Vol. 9, No. 9, pp. 39-40)

New Use for Wind Power – Pumping Oil

A completely new use is being found for wind turbines in the oil-rich heartland of the United States. For the first time a Bergey Wind Co. Inc. turbine started to pump oil from a so-called "stripper well" in north west Oklahoma in late April. The project is being operated under an agreement between Bergey and the Oklahoma Independent Petroleum Association, says Karl Bergey, chairman of the company.

Oil from such partially-depleted wells is usually pumped up using the familiar "nodding donkeys" or oil pumpers. These are powered from the grid, often at high expense. But by coupling the donkeys with Bergey turbines, oil can be pumped from as deep as 7000-8000 feet without the use of batteries or costly grid power. "There are tens of thousands of stripper wells around the U.S. If this proves as economical as we think it is, we see a considerable market" says Mr. Bergey. Stripper wells are usually defined as those that produce less than ten barrels of oil a day. As well as the one already operating, according to Mr. Bergey three more were being installed in mid-May. Two years ago, Bergey had developed the technique for down-hole pumping without using an electric motor.

Traditional multi-bladed windmills could not do the job alone, explains Mr. Bergey, because the depth of the oil well would require a "sucker rod" that would weigh tens of tons. The "donkeys" have a counter-weight and so can be coupled with a Bergey Excel 10 kW for oil pumping. Neither can traditional multi-bladed turbines be readily coupled with the nodding donkeys because they are just not efficient enough and do not produce enough power.

(Source: Extracted from "Pumping Oil with Wind Power" by Ros Davidson, *Windpower Monthly*, June 1993, Vol. 9, No. 6, p. 15.)

Micro-Hydro in Muktinath, Nepal Local People's Initiative

Purang village, located in the Mustang district adjacent to Muktinath temple, has been electrified due to the initiative of the local people. The village is located at an altitude of 12,600 ft. and lies on the tourist trail of the Annapurna conservation area.

The area surrounding Muktinath is exceptionally scenic, but extremely dry with annual rainfall below 100 mm. Forest resources are minimal to non-existent. Firewood, used to satisfy the demand for domestic energy, has to be collected from the forest which takes several days to reach.

There is not even a primary school or government office in the area. Many of the villagers depend on income generated from the tourist trade. Potatoes and buckwheat are cultivated once a year and the cultivable land is limited. The villagers, though illiterate and totally isolated from international development activities, are intelligent enough to think of alternatives for their own survival. The only natural resource available in the area is the water flowing downhill from the shrine at Muktinath. In their style, the villagers gathered to discuss the details of a project to use hydroelectric power for their energy needs. This would replace kerosene for lighting and reduce the consumption of fuelwood for cooking. The idea of the villagers was materialised with the help of the district chairman. The funds were raised by the local people with some small support from external sources.

The villagers hired a consultant contractor from Butwal, an industrial center in the south-west of Nepal. He was responsible for the survey, design and installation of the project. The village was electrified by a micro-hydro plant with 9 kW capacity. Low wattage cookers were introduced to heat water using excess energy at the off-load time, this changed the cooking habits of the villagers and they realised that the technology could be used to improve their living standards. The increasing demand, however, could not be met by the 9 kW plant.

This time, the villagers consulted the Development Bank seeking assistance for further expansion. The Bank organised a study tour together with a donor. The impact the project made on the team was such as to encourage them to support a plan for further expansion.

A detailed survey and studies were carried out for the expansion. Replacement of the Crossflow turbine to a Pelton type was suggested with certain changes in alignment. The existing head was increased to give 25 kW from the same water flowing down from Muktinath. The necessary funds were raised through the bank loan, subsidy from the donor and contributions from the local community.

With the expansion, a hot shower system using wastage heat from the controlling device has been built. The power supply to each house and hotel has been increased based on requirement.

The villagers have always been aware of their fragile environment. The assessment of the environmental impact of the project indicates that there are no significantly adverse scenic, forest, land, water or human resources effects. The transmission line has been laid underground to avoid the scenic impact on the tourist route. The project site located downslope from the Muktinath temple does not interfere with pilgrimage. The use of low wattage cookers has lessened the burden on local supplies of fuelwood. Improved lighting provides comfort for visitors as well as residents.

The concept "environment" as understood by modern experts, may not be familiar to the villagers. However, acting in their own interests they have directed their efforts towards environmental protection through the exploitation of the natural resources in their vicinity.

(Source: Extracted from "Micro-Hydro an Environment Friendly Energy Option?" by Devendra Adhikari, *Hydronet*, 1/1993, p. 4)

Ukraine – A Major New Centre of Wind Power

Five thousand American designed wind turbines are to be installed in the Ukraine within the next five years. To be located in the Crimea, about 500 miles south of Chernobyl, the 500 MW of wind power set seems to make Ukraine a major new centre of wind energy development. Ukraine has needed to replace the power capacity lost by the close down of the infamous Chernobyl nuclear power plant.

This huge project is a joint venture between California company U.S. Windpower (USW) and the Ukrainian electric utility, Crimenergo. The 56-100 machine that USW has been producing for years will be used and USW said previously the machines would be made in the Ukraine. USW is to serve as designer, engineer and contractor on the project. The deal is worth an estimated $100m to USW although this will be paid in rotor and other parts that will be used to repair the company's turbines now operating in the United States. Mr Hap Ellis of the company describes the deal as having passed a major "milestone" in February. USW received a down payment in Ukrainian currency that will almost certainly allow the wind farm to proceed. "We are confident that the project has a high probability of success", says Mr. Ellis.

The project will double the size of USW's installed wind capacity. The largest wind company in the world, it operates 420 MW of wind capacity – 4200 wind turbines in the Altamont Pass in northern California.

(Source: Extracted from "Five Hundred Megawatt South of Chernobyl", *Windpower Monthly*, Vol. 9, No. 3, March 1993, p. 18.)

ADB Sponsors Energy Conservation Project in Malaysia

Under the technical assistance (TA) provided by the Asian Development Bank, the Environment and Energy Management Agency of France (Ademe), in association with partner consulting agencies in France and the Asian Institute of Technology (AIT) has won a contract to undertake an energy conservation project for Malaysia.

As the industrial sector is one of the largest energy consuming sectors, high priority has been placed by the government on industrial energy conservation measures in order to conserve indigenous energy sources, to improve the production efficiency and render the industrial sector more competitive in the export market. The project with a duration of one year was officially commissioned in August under the Ministry of Energy, Telecommunications and Posts as the executing agency. The consultant team from France will launch various activities, starting with a workshop and interacting with the technical advisory committee composed of experts from the Economic Planning Unit of the Prime Minister's Office, MIDA, FMM, TNB, Petronas, SIRIM, MITI and academic institutions such as UTM and ITM.

There is an urgent need for efficient utilization of energy resources in Malaysia. The energy demand in the industrial sector has been growing at a rate of almost 10% over the last decade, accounting for as much as 40% of the national demand. On the other hand, oil reserves are expected to be depleted in 15 years whilst natural gas would last 50 years. Moreover, oil and gas reserves are resources of high economic value for export and there are a lot of constraints in meeting the need for high investments in the energy supply and distribution sectors. Efficient use of energy contributes to the well-being of the nation as investments in energy efficiency provide better returns and less costs than new investments to increaseen ergy supply and production, increasing manufacturers' competitiveness and improving environmental conditions. According to a recent study, an energy saving of 2.5 million tons of oil equivalent, amounting to 20% of present energy consumption and representing around 1.5 billion Ringgits, may be achieved from now to the year 2000 if energy efficiency efforts are undertaken.

Under this project, the consultants will assess the cost and benefit of energy conservation measures, from the point of view of the industries concerned at the micro level as well as that of the government at the macro level. In order to do so, they will be required to establish the present pattern of energy demand in the industry sector, derive economic and energy ratios and assess the potential for reducing energy consumption through conservation, recovery, substitution, recycling, demand management, etc. The consultants will therefore analyze the available economic data and energy balances of the industrial sector, identify factories representing various sub-sectors of activities for carrying out preliminary and detailed energy audits. The energy auditing activities will be conducted jointly with the local energy auditors to provide on-the-job training to the counterpart staff related to the assessment of technical and economic viability of recommended solutions and environmental impacts of energy conservation measures.

Finally, the existing policies, programs and institutional arrangements related to energy conservation will be reviewed to assess their effectiveness. In order to develop and implement an energy conservation policy for industry, the human and financial resources needs will be assessed and the barriers (institutional, economic, pricing, etc.) to investments in energy conservation projects will be identified.

All phases of this project will be conducted by the French consultants in close collaboration with Malaysian counterpart staff, acquiring and exchanging up-to-date information and providing on-the-job training to enable an effective transfer of know-how.

Since 1974 France has implemented a specific energy policy focusing on the improvement of energy consumption efficiency. Ademe is a State Industrial and Commercial Body contributing to energy management, promotion of clean technology, limiting production of wastes and fighting all types of pollution. With a staff of more than 500, Ademe supports a large range of activities, from research and economic planning to advising and awareness campaigns, training, technology demonstration and developing innovative financial schemes. Through its regional offices, high skilled technical personnel of Ademe are assigned to stimulate energy management among energy users from different economic sectors, particularly from industry. Working with such a network of partners for many years has allowed an increase in the bulk of energy saving, even though the price of energy has decreased over the years. In addition to the activities in France, Ademe continues to collaborate with developed as well as developing countries for mutual sharing of experiences. During the course of this ADB financed Energy Conservation Project, Ademe can be expected to part Malaysia with almost 20 years of field experience gained.

An expected outcome of this project would be a good statement of the energy saving potential in the manufacturing sector in Malaysia through the identification of the branch involved, the technologies needed and the required funding. Right now, it may be assumed that a large portion of the energy saving potential has a very high profitability with a relatively short payback period. One very important result would be the definition of the need for services and equipment to be supplied by Malaysian consulting companies and equipment manufacturers and the participation of the private sector in realizing energy saving. A database of energy consumption patterns in industrial plants will be established. Assessment of the barriers to energy conservation operation will lead to the definition of an energy conservation policy. The incentive measures to be implemented by the Government in co-operation with

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ADB Loan for World's Biggest Pumped Storage Power Scheme – China

The world's biggest pumped storage power scheme, currently being built in Guangdong Province, People's Republic of China, will be partly financed by a $200 million loan, approved August 3th, 1993, from the Asian Development Bank (ADB). The 2,400 megawatt (MW) capacity plant, costing almost $1 billion, will alleviate Guangdong Province's severe shortage of peak-demand power.

The scheme stores energy like a giant battery. The project involves upper and lower reservoirs, linked by pipelines, and reversible turbines and motor/generators. It is the least-cost option to meet peak energy needs. At night, when there is minimal consumer demand, it utilizes inexpensive unused capacity from thermal power stations to pump water from the lower to the upper reservoir for storage. During the day, this water is allowed to flow to the lower reservoir through turbines, generating power to meet peak consumer demand. Four units of electricity will be used to pump the water up for every three units the water produces on the way down, but this is still a much cheaper option than installing generation facilities such as gas-fired turbines.

The project, near Lutian Town and about 90 kilometers from Guangzhou City, is being built in two stages. The first stage, with a capacity of 1,200 MW, was inaugurated in late July, 1993 and should be in full operation by February 1994.

The ADB loan will finance about 75 per cent of the foreign exchange requirements of the second stagc, which will provide another 1,200 MW of capacity and is due for completion by 1999.

Power output from the first stage facility will be distributed equally between Guangdong Province and Hong Kong. Water will be pumped to the upper reservoir using off-peak energy from the Daya Bay nuclear power station, which is owned jointly by Guangdong Province and Hong Kong. In the second stage, however, Guangdong Province will receive all the output as well as provide all the input through its coal-fired thermal power grid.

As with the first stage, the second stage will involve building massive underground tunnels, an underground power station with four 300 MW reversible turbines and generators, an outdoor switchyard and transmission cables. The fact that the tunnels and power station are underground helps to make the project environmentally sound.

In addition, the Bank is providing three technical assistance grants. One for $450,000 is to help the Ministry of Electric Power to promote foreign and private investment in the power sector and to carry out further tariff reforms. A second grant of $375,000 will set up a financial and management information system for the executing agency, the Guangdong Pumped Storage Joint Venture Corporation. A third grant, for $340,000, is for an electricity efficiency study in Guangdong Province.

(Extracted from "ADB News Release", No. 127/93, 3 August 1993)

Thames Water Makes Money from Sewage – UK

Established in 1974, Thames Water provides water supplies to seven million and sewerage services to eleven million customers in London and the Home Counties. This is achieved through 47,000 miles of water mains and sewers, and over 500 water and sewage treatment works.

Besides its core business, Thames Water will soon be generating and feeding enough electricity into the National Grid to meet the needs of 25,000 households. The key to this initiative is the anaerobic digestion of sewage sludge to generate methane-rich biogas which can be either burnt to provide heat or used to produce electricity. Thames Water is pursuing this second option vigorously, with no less than 11 sewage-to-electricity schemes totalling 18 MW in capacity.

The roots of the company's interest in energy are easy to trace. The water industry uses huge amounts of electricity – 70% of Thames Water's total energy demand is expended on water pumping alone, while a further proportion is needed to aerate sewage during treatment. Naturally, then, the efficient, economic use of energy is high on the company's agenda.

In fact, Thames Water and their predecessors have been generating electricity from sewage gas for half a century. At Mogden Sewage Treatment Works in Isleworth, dual-fuel engines were installed as long ago as 1936. They operated successfully on a mixture of sewage gas and diesel, producing both electricity for use on site and waste heat to keep the anaerobic digesters at the requisite temperature. And today, the NFFO (Non-Fossil Fuel Obligation, a UK's policy to promote renewable energy) and the ability to sell power to the grid, rather than simply using it on site as before, is enabling Thames Water to maximize the financial benefits from this unlikely resource.

At the works in Reading and

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ADB Sponsors Energy Conservation Project in Malaysia

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industry, trade associations and other partners will be proposed.

Further information regarding this project may be obtained from the Ministry of Energy Telecommunications and Posts (Mr. A.K. Roy, Principal Assistant Secretary, Tel: 256 2222, Fax: 255 3989) or from the Asian Institute of Technology (Dr. B. Mohanty, ADB/Malaysia Study Project Manager, Energy Technology Program, Fax:(66-2) 5162126).

SMALL SCALE WIND ENERGY SYSTEMS

Published with financial support from the Netherlands Minister for Development Cooperation
Editors: Goezinne & Veldkamp, Renewable Energy Consultants

EDITORIAL

There is a widespread misunderstanding that all interesting research and development is in the field of the large grid connected wind generators only. To disprove this contention, in this issue there are three articles dealing with new developments in small-scale wind energy systems: articles on solar/wind hybrid systems and mechanically driven centrifugal pumps (who has not been waiting for a low lift-high volume windpump?) from Germany, and one article from Nicaragua on a rope-and-washer windpump, which is already commercially available. Finally there is some news from the windpump market survey currently in progress.

Dick Veldkamp/G&V

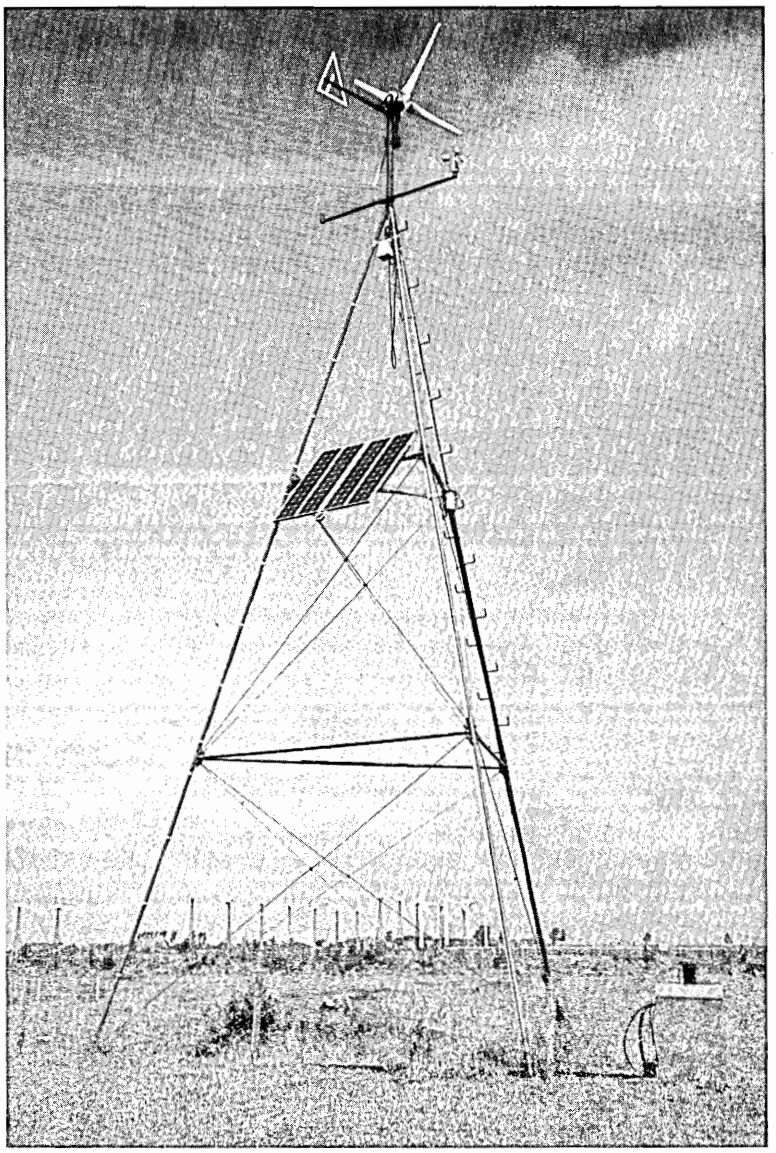

Fig. 1. Wind/solar hybrid systems at Kaiser-Wilhelm-Koog test site (North Germany) with upscaled 600 W/2 m wind turbine and 212 Wp photovoltaic panels.

CUTTING COSTS WITH WIND/SOLAR HYBRID SYSTEMS

Introduction

For the grid independent energy supply of small electrical consumers, photovoltaic (PV) systems have a well established market. As a design without moving parts they are appreciated as simple to understand, easy to install, reliable and almost maintenance-free. There is an increasing market for grid connected PV systems in the private sector.

Given enough wind at the location, small wind turbines are a cheaper alternative. However the combination of a solar with a wind generator may lower energy costs and at the same time increase the reliability of a minimum supply. This advantage of combined wind/solar hybrid systems was theoretically proven in a study Atlantis has carried out in 1989. There, the individual and combined output of wind and solar generators have been calculated for different climatic areas on the bases of their respective meteorological data. At most of the evaluated sites worldwide wind and solar energy complement one another in an ideal manner.

Simulation Model

But a more detailed analysis is necessary to assure an uninterrupted energy supply for autonomous consumers such as measuring and monitoring posts, telecom stations or housing in remote areas. For this purpose a computer simulation with time step integration was executed with the commercially available program TRNSYS as part of a research project at the Technical University of Berlin, Germany (TUB). The simulation program was completed with modules for modelling wind turbine, solar panels and wind time series. With these extensions the system behaviour

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CUTTING COSTS WITH WIND/SOLAR HYBRID SYSTEMS

From P. 1

of the entire hybrid plant could be analyzed and optimized for different parameters such as storage capacity, load or meteorological data.

In order to validate the simulation model by comparing the calculated results with measured data, four complete wind/solar hybrid systems were installed at locations in Germany with different climatic conditions: at the coastal Kaiser-Wilhelm-Koog (KWK) wind test field of German Lloyd, in Munich, in Mainz and at the wind test field of TUB in Berlin Gatow. The systems were equipped with a 300 W wind turbine, four 53 Wp PV panels and measuring equipment for climatic and operational data (Fig. 1). Nominal system voltage was 24 V, battery capacity 300 Ah and the permanent load a heat resistance of 20 and 30 W at inland and coastal sites, respectively.

Table 1. Comparison of investment costs for a permanent supply of 30 W from a wind/solar hybrid system and a pure solar system at a coastal site with 5.5 m/s average wind speed (DM 1 ≈ US$0.6).

Hybrid System		Photovoltaic System	
Wind turbine 300 W/1.5 m	DM 2,650	PV-panels 900 Wp	DM 12,850
Tubular tripod tower 11 m	DM 3,900	Mounting rig	DM 750
PV panels 212 Wp incl. mounting	DM 3,450		
Hybrid charge regulator	DM 1,250	Charge regulator	DM 2,150
Battery storage 120 Ah/24 V	DM 400	Battery storage 120 Ah/24 V	DM 400
Electric system incl. lightning prot.	DM 1,600	Electric system incl. lightning prot.	DM 1,850
TOTAL	DM 13,250	TOTAL	DM 18,000

Test Results

As part of the research project MAN Systemelektronik developed a special logger which transmitted the collected data via satellite to Munich once a day. This "high tech component" was added to the system, because for remote measuring and monitoring applications, not only the autonomous energy supply but also the line independent data transfer is of great relevance.

After a few modifications in the modelling of the numerical simulation, very good correspondence with the measured data was achieved. Shut down periods due to low battery voltage could be predicted very accurately. At this point the computer simulation showed to be a handy tool for an optimization of the system design. The different components can now be matched to specific site and load conditions.

It turned out that in all cases the battery storage had been oversized. The permanent load allows for a reduction to 120–200 Ah. At the far inland locations Munich and Mainz only 10 W instead of 20 W could be supplied without interruption. However, this value was improved to 15 W by increasing the PV capacity by two panels (106 Wp). A permanent load of 20 W in Berlin and 30 W at KWK was no problem after changing the angle of the PV panels to sixty degrees.

At all four locations the combination of wind and solar energy was proven appropriate for the purpose of supplying a certain amount of energy with higher security and lower costs. It turned out that wind and solar energy complement one another not only seasonal but also in the short and middle term weather course. In the graph the accumulated solar and wind energy output of the hybrid system in Munich is plotted for 1000 hours in the summer season.

Cost Effect

The cost effect is of course most striking at windy sites. To achieve the same security for a permanent supply of 30 W at KWK (with an annual average wind speed of 5.5 m/s) from a pure PV system, an installed capacity of 900 Wp would be necessary with 36% higher investment costs compared to the 300 + 212 W wind/solar hybrid system (Table 1).

Experiences

The experiences from one year operation of the four prototypes led to a few modifications of the wind turbine design. Especially the thrust controlled rotor tilt into a "helicopter" plane as power and speed regulation had to be redesigned significantly since the safety system is a key component for giving the wind turbine as favourable operational conditions as known from PV systems.

The improved design was also used for an upscaling of the 300 W/1.5 m machine to 600 W/2 m. The prototype of this wind turbine was tested and measured on a water level monitoring post in the North Sea. The new tilt governor keeps the power output at an almost constant level for a wide range of wind speeds (12–40 m/s). These measurements also confirmed the high efficiency of the rotor blades. The 2 m rotor reaches its nominal power of 600 W at only 10 m/s wind speed.

The blades have been designed for operation with a very low noise level. At German Lloyd 45 dB(A) was measured at a distance of only 14 m.

Since the beginning of 1992 the Atlantis hybrid systems are on the market. 28 plants are in operation now for very different applications: electricity and water supply for holiday houses, drinking water for cattle, energy supply for light on a camping site, for alarm systems, for environmental and climatic measuring stations and for an alpine emergency radio station. A lot of units have also been sold as demonstration and training facility at schools. The next wind turbine is scheduled for the German Antarctic research station to join the first machine which is running there successfully since October 1992.

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WINDPUMPS WITH CENTRIFUGAL PUMPS FOR DRAINAGE AND IRRIGATION

Introduction

For field drainage and irrigation, surface water is normally used which has to be pumped up only a few meters but in large quantities. A combination of wind turbine and centrifugal pump is well suited for these pumping conditions, that is for low lift and high flow applications.

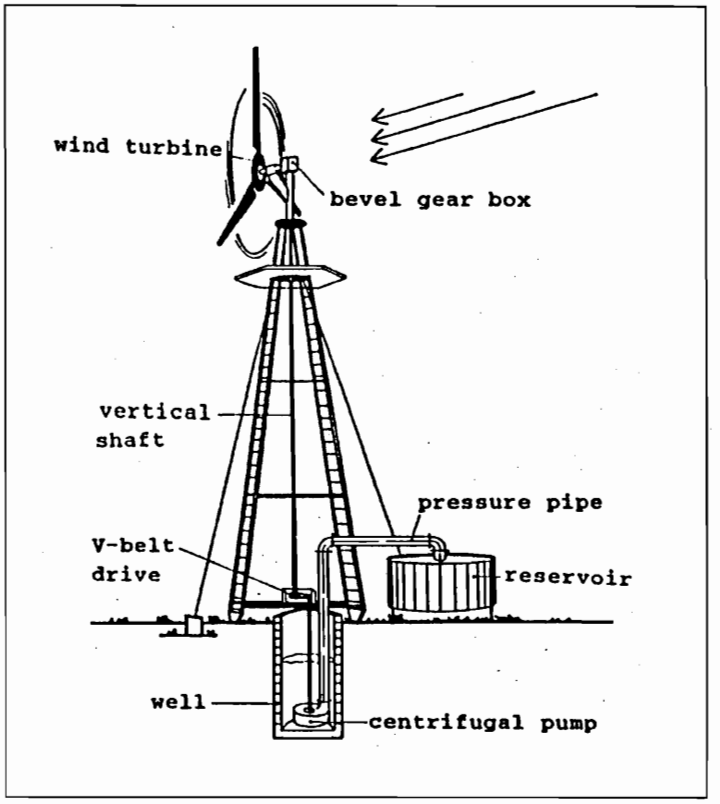
Technical Concepts

For these applications two systems have been developed and tested under various conditions. Both systems are running with variable speed. For lifting heads of less than 10 m a slow running centrifugal pump was designed for mechanical coupling to the wind turbine. In the first step, a prototype was improved systematically and optimized in terms of better efficiency with the help of lab tests at the Technical University of Berlin. In the second step, a product line of these wind-driven centrifugal pumps was developed. With six different sizes a range of total head between 1 m and 10 m and a power range between 0.5 kW and 10 kW can be suited. All sizes have a maximum efficiency of 70% to 76%. The pumps can be coupled either to an easy-to-manufacture sail wing rotor or to a pitch controlled rotor with three wooden blades. The pitch mechanism is controlled by centrifugal forces.

For lifting heads of less than 30 m the autonomously controlled pitch rotor is driving a synchronous generator, which is coupled to a centrifugal pump with an asynchronous motor. No electrical control system is necessary. With a multistage borehole pump groundwater can be pumped for irrigation.

Experiences

Different configurations of the two systems were tested. One of the sail wing rotors with 5 m rotor diameter and a mechanical coupled centrifugal pump was running at the German North Sea coast and has been certified by the German Lloyd. A capacity of 90 m³/h at 10 m/s wind speed and 2.2 m lifting head was measured.



Sketch of a windpump system with mechanically coupled centrifugal pump.

The pitch rotor with a diameter of 5.8 m was tested with mechanical and with electrical coupling. For a lifting head of 20 m a capacity of 13 m³/h at 10 m/s wind speed was measured. At the moment two windpumps with 6 m diameter pitch rotor are planned for drainage, one with mechanical and one with electrical coupling. A third one will be erected in autumn 1993 for irrigation with groundwater from 15 m depth.

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END-USER SURVEY OF WINDPUMPS AND OTHER PUMPING SYSTEMS IN SOUTH INDIA

An end-use survey was performed by RENCON, as part of the windpump market study undertaken by Halcrow Gilbert Assoc. for the Dutch government. Twenty users of different water pumping systems were questioned about their attitude towards various pumping systems. 12 windpump users, 4 diesel pump users, 3 electric and 1 PV pump user were interviewed and the sites were visited. Although the scope of the survey was limited, it revealed surprising applications, such as the use of windpumps for reclamation of degraded land by growing trees and bushes in and around Auroville.

The area between Madras and Pondicherry proved to be a densely windpump populated area. Part of this area is the township Auroville, a "human experiment", where the inhabitants show great concern for the environment and the use of renewable energy. The "windpump initiators" used various types of windpumps mainly for a combination of afforestation and agroforestry, to reclaim barren land while simultaneously living on it. In a period of about 20 years the whole area of about 10 km² was reforested with trees now reaching up to 15 m height. One user had grown 360 different varieties of trees from seeds gathered from all over India, thus creating a "gene bank" of great value. In order to keep up with the trees, the towers of the mills were lengthened, as far as up to 23 m height.

What is even more encouraging for windpump suppliers and users is that for the application of domestic water supply in the area studied, the modern AUREKA AV55 windpump applied proved to be the least

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END-USER SURVEY OF WINDPUMPS AND OTHER PUMPING SYSTEMS IN SOUTH INDIA

From P. 3

cost option second only to electric pumping. The annualized life cycle costs of the water pumped were less than US$ 0.03 per m^3 (at a pumping head of 10 m), while the yearly average wind speed is less than 3 m/s! The second generation AUREKA windpump developed at Auroville with a rotor diameter of 5.5 m pumped about 10,000 m^3 of water per year. It is the only source of water for the cafeteria-restaurant of the Auroville Information Center, which receives about 300-400 guests per day. It also supplies water for sanitary purposes for 6,000-10,000 visitors per month. The water output was carefully monitored over a period of one year. This was the only site where accurate monitoring was done, both on water output as well as wind speed.

The end-use survey confirmed the lack of proper monitoring of water pumping systems. It is the author's opinion that field data and experiences should form the real basis to prove the viability of renewable energy systems. Institutions promoting renewable energy could therefore put more emphasis on monitoring and end-use surveys.

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PROTOTYPE BECOMES COMMERCIAL – NICARAGUA

It was previously reported that technicians in Nicaragua had developed an experimental small windpump. This system builds upon the strength of a popular handpump. It was reported that at more than 30 m the handpump becomes very hard work and this makes the arrangement ripe for powering by alternatives, such as the wind. Mr. Henk Holtslag and his colleagues built a 3 m prototype windpump which through a pulley connected to the shaft, drove a standard handpump. "From 1986 until 1990 a wind energy project in Nicaragua tried to stimulate windpump use" says Dutch born Holtslag. Although the project more or less succeeded in setting up the production of a "classic" windpump (3 m) and a less successful "modern" windpump (5 m), one of the "problems" was still the relatively high cost of these windpumps (US$2200 and US$4000, respectively). He went on to say that the systems were also "complicated" which caused problems in production, installation and maintenance. This inspired him and his colleagues to build a "low cost windpump" for "local production and maintenance."

Developing A Low Cost Windpump

Their starting point was the popular Bomba de Mecate, the improved rope-and-washer handpump. The very first prototype in 1989 was with hindsight perhaps too simple and low cost, a mill that looked like the mathematic sign π with the low solidity rotor working in the middle of the cross beam. The wind on the west coast of Nicaragua is relatively mono-directional and the designers wondered if they could not use a fixed head machine. Wooden bearing surfaces for the shafts keep the costs to a minimum, and the direct driven shaft is connected to the handpump top pulley directly by a rope.

From that rather basic system it soon became clear that the manual securing required to protect the rotor in times of storm, would only cause problems. With no storm protection the designers felt that the system would end up on the scrap heap. Low cost did not mean technically inferior. Using their experiences on the production of the traditional multiblades and the CWD5000 and adding information gathered about the low cost windpumps of Peru and the Philippines, a new prototype was built. This was reported previously and differed from the first in that it had the ability to turn 120 degrees and had some automatic storm protection based on the hinge tail vane.

In 1990 the design then took the next few steps, increasing its wind tracking turning ability to about 300 degrees, development of a new tower and a simplified mill "head". Technical details may be given in a following article. Three of these commercial prototypes were installed.

From the experience of the three has come the step into full commercialisation in late 1992. At the time of writing (mid 1993) about 20 systems have been sold and installed within Nicaragua. Two systems are on offer: a 2.4 m diameter rotor which will pump to a maximum head of 25 m for a cost (including a 5 m tower) of approximately US$270, and a 3 m diameter rotor on a 10 m tower which can pump up to 50 m for a retail sales price of US$580. By offering an upgrade to the popular "improved rope-and-washer handpump" the windpumps are already visibly growing in popularity. Further developments will be reported.

Simon Batchelor/Gamos Ltd (UK)

Citation is encouraged on the condition that the source is indicated.
Reactions or other contributions are welcomed. Please write to:
Goezinne & Veldkamp, P.O. Box 775, 7500 AT Enschede, The Netherlands.
Fax: +31 53 31 03 30. Tel: +31 53 32 70 27. Telex: 44846 bchs nl.

Responsibility for the articles rests solely with the authors. Contributions should preferably not be longer than 300 words. For longer articles please contact the editors. The editors reserve the right to shorten reactions and articles.

Thames Water Makes Money from Sewage – UK

from P. 8

Slough, for example, dual-fuel engines were dismantled 10 years ago because they were proving uneconomic. Now, with the advent of the NFFO, generation is once more an economic proposition. The development of energy schemes at sites like these has also been facilitated by the privatisation of the water industry – more capital for investment can be raised. Reading and Slough are among the smallest of Thames Water's NFFO projects, which range in size from 250 kW to 7.8 MW.

At Maple Lodge Sewage Treatment Works, near Rickmansworth, 1.5 MW of power will be sold to the grid once connection has been completed. When sewage arrives at Maple Lodge it passes through screens and is automatically raked. Next it undergoes grit removal and storm water separation before being pumped into sedimentation tanks. The sludge is then fed into eight circular primary digesters, each 22.25 m in diameter and with a capacity of about 3400 m^3. To ensure a constant feed to the digesters, sludge is also brought in from smaller sewage works by either tanker or sewer. On average, sludge spends 48 days in the digesters, at 26-28°C, during which time 45-50% of the organic matter is converted to biogas, two-thirds methane and one-third carbon dioxide.

The biogas is fed to the Power House. This contains four six-cylinder engines, which use the gas to generate power, and three compressors that supply air to the activated sludge plant. The heat the engines produce is used to provide hot water for a heat exchanger. The sludge is circulated through the exchanger to maintain the digestion temperature. Any excess heat is used by the site's heating system.

Once digested, the sludge leaves the tanks and completes the treatment process. Treated water from Maple Lodge is ultimately discharged into the neighbouring Grand Union Canal.

Thames Water's energy initiatives still go further. Another batch of sewage-to-energy schemes is currently being evaluated. A large program of pump efficiency improvements is under way, and energy performance monitoring and targeting is a matter of priority. The sale of electricity generated from sewage gas represents only part of Thames Water's overall drive to use energy to the best advantage of the organisation as a whole.

(Source: Extracted from "Sewage Power" by Barry Hague, *Review*, Issue 19, Summer 1992, pp. 6-7)

China Increases Liquefied Gas in Energy Mix

China is keen to increase the use of gas from its present minimal position in the energy mix. In addition to developing field gas onshore and offshore, planners want to boost the burning of liquefied petroleum gas (LPG) and to introduce liquefied natural gas (LNG) for power generation. They also want to exploit coal-seam gas. Petroleum Authority of Thailand (PTT), a state-owned company with extensive domestic gas experience, has been talking with the Chinese about development of gas in southwest China. The aim is to set up LPG extraction and bottling plants and a distribution network.

The PTT initiative follows last year's moves by Japan's Iwatani International to create LPG storage terminals in Shenzhen and Dalian and to distribute gas it imports from the Middle East in the Chinese market. Iwatani has established a joint-venture firm, Shenzhen Iwatani Gas Machinery, to import and sell LPG in Guangzhou, southern China. The Chinese partner, Shenzhen Petroleum, is a public oil company.

Recently the Japanese partner said that plans had been laid for the venture to share an existing tank, with capacity of 600 tons (t), in addition to building a new 500-t tank by 1993. In the northeastern city of Dalian, subject to local authority approval, Iwatani, through an unidentified joint venture, would construct two 500-t tanks and related facilities by about 1994.

China has steadily increased its ability to import and distribute LPG, partly by calling in foreign expertise. Shanghai Municipal Gas made a deal with Totalgaz to revamp an LPG bottling centre in its district.

The initiative to use LPG has been given new impetus now that the National Environmental Protection Agency has begun a program to tighten controls over industrial pollution. Several thousand firms responsible for most of the pollution will be encouraged to change production systems and to switch, where possible, to less polluting fuels, such as LPG and LNG.

An example is Jiangsu province's decision to sign an agreement with Wing-Merrill International, by which LNG would be imported from 1997 to

Cont. P. 10

Small Hydropower – India

Only small hydropower projects not exceeding 100 MW, are to be permitted in the Eighth Plan according to a recent decision of the India Planning Commission. The decision follows a request by the Indian Prime Minister that the Commission set up an expert panel to work out guidelines for balancing environmental protection and development. The panel was also asked to arbitrate between the Ministry of Power and the Ministry of the Environment to hasten decisions about six major hydro projects stalled due to strong opposition from environmentalists.

The panel decided that big projects not only cost more but also create serious problems, e.g. deforestation caused by the construction of a vast transmission network. The smaller projects are easier to commission and will not require such a network.

(Source: Extracted from: *SHP News*, No. 4, 1992, p. 2.)

Natural Gas for Vehicles – Malaysia

"Petronas" – the Malaysian state-owned oil and gas company, concluded a contract with Sulzer-Burckhardt valued at 1.6 million Swiss francs for the supply of six NGV (Natural Gas Vehicles) filling stations in 1991. Delivery was completed in 1992.

Malaysia has large resources of natural gas, and its industry is expanding rapidly. The country's gross national product shows an annual growth of 8 %. Seven new power stations and an extensive gas pipeline system are planned to meet the increasing demand for electricity.

Once the gas pipeline has been built, additional medium- and low-pressure distribution networks can be provided for factories, houses and for NGV filling stations. This, in turn, will reduce smog and facilitate an increase in the export of oil.

However, a NGV infrastructure is needed before the complete gas distribution network can be put into operation. Petronas has therefore called for a "mother/daughter" system, by which the mother station is linked directly with the distribution network.

The natural gas will be compressed to 250 bar and pressed into dispensers and storage bottles at the mother station. This will enable the local vehicles to tank directly from the dispensers and, with the aid of mobile storage bottles mounted on semi-trailers, to supply the daughter stations in locations far away from the distribution network. Each daughter station is equipped with a compressor, which maintains the level of pressure during the filling operation.

Apart from the dispensers and the mobile storage system, which were designed by Sulzer Precom Services, the contract calls for the supply of seven compressors, two for the mother station and one each for the five daughter stations.

The contract concluded with Petronas is of major significance because it is a bridgehead into the potentially large Malaysian market and also a showcase for countries in Southeast Asia. And, in particular, for the Republic of Singapore, whose government attributes great importance to a clean environment.

(Source: Extracted from "Natural Gas for Motor Vehicles in Malaysia", *Energy Digest*, Vol. 22, No. 2, 1993, p. 36.)

China Increases Liquefied Gas in Energy Mix

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develop China's first big combined-cycle gas turbine plant, rated at 2,400 MW.

The use of coal-seam gas has also been found beneficial in trimming pollution. And Japanese interests are helping to build a 300,000 t/y ammonia and 500,000 t/y urea plant, in Shaanxi province, based on a gasified coal feed.

With LPG set to grow, China is working to make sure tankers to handle the trade are locally built. In the late 1980s, it began preparing to create the first indigenous 3,000 cubic meter LPG carrier, having consulted with European builders on optimum design. The aim was to develop a prototype for a string of such carriers. Since then, much has been learned.

(Source: Extracted from "Liquefied Gas to be Boosted as Energy Source", *Petroleum Economist*, July 1993, p. 40.)

CFC-free Energy Efficient Refrigerator

The Whirlpool Corp. (USA) is the winner of a $30 million contest to produce a chlorofluorocarbon-free, super energy efficient refrigerator. The Company used refinements in conventional technology rather than any radical new approaches to win the award, which was offered by a consortium of electric utilities.

The company said it would begin selling refrigerators early next year that have none of the chlorofluorocarbon chemicals (CFCs) used in conventional refrigerator equipment and that will use at least 25 percent less energy than current government standards.

The new refrigerators will have prices similar to those of current models in markets served by the participating utilities as $30 million put up by 24 utilities will be used to offset engineering and development costs.

The company expects to sell 250,000 of the refrigerators between 1994 and 1997, the lifespan of the

Cont. P. 11

Asian Countries to Cooperate on Energy and Environment

The United Nations Development Programme (UNDP), the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) and the Asia Pacific Development Centre (APDC) have agreed on a joint programme for Asian cooperation on energy and the environment.

A total of 23 countries will participate from 1993 to 1997 through expert group meetings, workshops and training courses conducted by regional and national institutions.

The objective of the programme is to provide the participating countries with adequate tools to produce and use energy in an environmentally and economically sound manner. The programme also aims at enhancing regional cooperation between participating countries to make best use of scarce energy resources.

The programme will contain six components: Energy-environment planning; coal development and utilization; natural gas and petroleum development; rural energy and environment development; conservation and efficiency; and electric owner systems management.

The programme receives support from UNDP amounting to US$3.5 million, US$2 million from the government of Australia and US$800,000 from the government of France. Participating countries will contribute in kind a total equivalent of US$5.7 million.

(Source: Extracted from "Asian Countries to Cooperate on Energy and Environment", *Bangkok Post*, 23 July 1993, p. 16.)

Stove Images Are Needed

To all stove projects which might be interested!
We need your help for the successful realization of our project

Stove Images – an illustrated documentation of traditional and improved stoves in Africa, Asia and Latin America is in the pipeline: Volume 5000, in English, French and Spanish. The publication is financed by the Commission of the European Communities (CEC) within the scope of "Actions in Favour of Tropical Forests".

Objectives: The main objective of this publication is to contribute to the improvement of ecological and domestic conditions worldwide. The specific aim is to propagate knowledge and experience, by supplying an overall picture of different stove technologies and dissemination strategies used in Africa, Asia and Latin America. It also promotes the dissemination of appropriate and efficient stoves.

Target Groups: The principal target groups of the publication are national and international organizations and projects involved in various development fields: Environmental, Energy, Agro-Forestry, Improved Stoves, Women, Rural Development, Health, Education, etc. as well as those involved in funding and research.

We need good photographs of traditional and improved stoves (in use – if possible) and the corresponding technical data.

CFC-free Energy Efficient Refrigerator

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super efficient refrigerator program. Customers can expect to save $100 to $150 per year on their electricity bills with the new appliances.

Because a refrigerator is turned on all the time, it is one of the largest users of electrical power in a typical home, accounting for about 20 percent of total consumption. Refrigerator makers have been struggling to meet federal requirements for more efficient operation, while also looking for substitutes for CFC chemicals used in the refrigerant fluid and in the foam that insulates the refrigerator. Production of the chemicals is set to cease in 1995.

In the Whirlpool model, the CFC-12 used as the refrigerant in conventional models is being replaced by a compound that has no chlorine. The chlorine in CFC is regarded as the culprit in ozone degradation. The CFC-11 in the foam is to be replaced by a chemical with less chlorine, but this will probably be banned as well in the future.

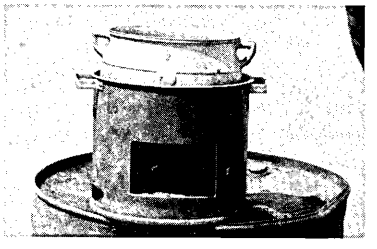
Whirlpool said its design includes an improved compressor and better insulation, as well as a computer chip-controlled defrost system that adjusts the length and frequency of power consuming defrost cycles.

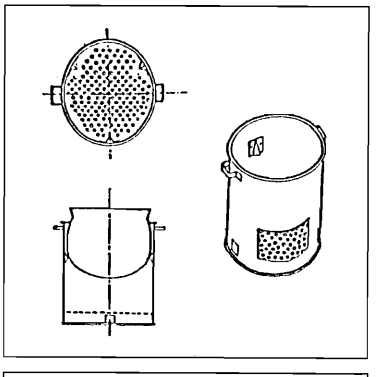
(Source: Extracted from "Whirlpool Refrigerator Wins $30 Million Prize", *Wisconsin Energy News*, Vol. 14, No. 3, July – August 1993, p. 5)

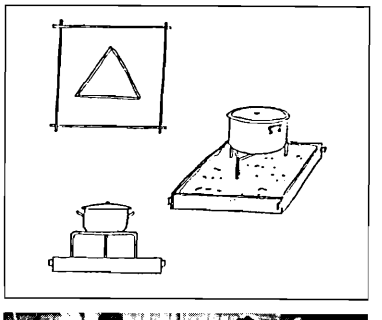
Stove Data Sheet

Traditional Stove (TS)/Improved Stove (IS)

Project Name/Address:
Country/Places:
Name of Stoves:
Users:
Fuel Type:
Material:
Standard Size:
– mm Diameter:
Price:
– % Subsidized:
Stove Maker:
Production Method:
Efficiency (Lab test results):
Fuel Saving (Field test results):
Smoke Output Test:
Dissemination System:
Dissemination Statistics:
Specifics:
Start of Dissemination:
End of TA project:







Design Drawings:

Technical drawings or sketched presentations should include a top view, a cross-section and drawings in perspective.

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Book Review

European Directory of Renewable Energy Suppliers and Services 1993
Bruce Cross (ed.)
James & James Science Publisher Ltd.
5 Castle Road, London NW1 8PR, England
1993, 428 p.

This is the third edition of this Directory – a European renewable energy reference book. It is organised into two main parts.

The first part covers a wide range of renewable energy aspects and contains overviews, lead articles and case studies. This part is further divided into the following sections: European update, Biomass, Geothermal, Rational use of energy, Hydro, wave & tidal, Instrumentation & metering, Photovoltaics, Solar thermal, Wind, and General information.

The second part lists European companies and organisations active in different fields of renewable energy. This part consists of Classified Listing, Organisation Listing and A-Z Listing. In Classified Listing the names of companies and organisations are given according to the type of equipment, applications or services they provide. A country-wide list of organisations is given in Organisation Listing. Nearly 4000 companies are listed in alphabetical order in A-Z Listing which specifies the name, address and main activities of each company.

The book can serve as a useful reference source for those involved or interested in the field of renewable energy, especially, for users who are in need of equipment or services.

THE POWER GUIDE
An International Catalogue of Small-scale Energy Equipment, Second Edition
Intermediate Technology Publications Ltd.
London
1993, 256 p.

With introductions by Professor Wim Hulscher, University of Twente and Dr. Peter Fraenkel, IT Power.

This substantial and invaluable guide to small-scale energy equipment will help anyone who has to decide which small-scale energy source, and its conversion technology, is most appropriate for their specific situation, and where they can obtain the necessary equipment.

The Power Guide provides guidelines on choosing the most appropriate renewable energy source as well as giving information on hundreds of products from almost 500 manufacturers and suppliers in more than 40 countries throughout the world. The book covers:

- micro-hydro, hydraulic ram and river current turbine products;
- windpumps and wind generators;
- biomass pre-treatment, combustion and steam systems, and gasifiers;
- solar photovoltaic equipment;
- internal combustion engines.

Each chapter begins with guidelines for equipment selection and the advantages and drawbacks of using that particular energy source. This is followed by manufacturers' data containing key information about the equipment (guideline information only on internal combustion engines and biogas and ethanol equipment), for which sources of local supply information are provided.

The book builds on both the previous edition of The Power Guide, and the equipment directory produced by the Technology and Development Group of the University of Twente in the Netherlands as training course material. The data has been comprehensively revised and updated on the basis of research carried out by members of the Technology and Development Group, ITDG in the UK, and Densitech bv of the Netherlands.

256 p. Line drawings and photographs. Paperback. October 1993. ISBN: 1 85339 192 1. Price: £25.00/US$ 47.50. Postage & packing: 20% UK & Europe, 25% Rest of World. For acquisition or other information please contact:

Intermediate Technology Publications Ltd
103-105 Southampton Row
London WC1B 4HH
United Kingdom

Electricity System Performance: Options and Opportunities for Developing Countries
Synthesis Report of The Cooperative Programme on Energy and Development
Commission of the European Communities
Directorate-General
Telecommunications, Information Industries and Innovation
L-2920 Luxembourg
ISBN 92-826-4505-3, 1992, xi+136 p.

This report is a synthesis of several studies undertaken by the Cooperative programme on energy and development (Coped) network of centres between July 1990 and June 1991.

There is evidently a gap between perceptions in the North and South of the mechanisms that are undermining the performance of the electricity supply industry (ESI) of Developing Countries (DCs). In these circumstances, an independent and thorough assessment of the recent performance of the ESI of DCs can play a positive role. This report offers some support in this direction by evaluating trends in performance of the ESI in DCs in the last 15 years.

The project was designed to answer two groups of questions:

(i) What is meant by the performance of the Electricity Supply Industries (ESI) of Developing Countries (DCs)?

(ii) What are the main opportunities to improve performance of the ESI in DCs?

The report covers key DCs in Africa, Asia and Latin America. They are representatives of the DC situation both quantitatively and qualitatively. Six studies were undertaken by Coped centres in their own countries (Argentina, Brazil, China, India, Mexico and Thailand) and one compared the experience of five small African Countries (Burkina Faso, Cote d'Ivoire, Mali, Niger and Senegal).

These studies were supplemented by specific studies about the performance of the ESI in industrialized countries carried out by the European centres of Coped.

The data used in this report were mainly collected in each country that was studied. Interviews with key policymakers were made in each country in order to obtain the local perception of ESI performance.

The concepts of efficiency, and how they relate to the ESI are reviewed in chapter 2. It explains the enormous difficulties confronted when comparing performances of electricity systems in different countries.

The next four chapters summarize the main findings of the country studies. Each chapter considers the evolution of performance over time by grouping the country studies into similar pairs.

Chapter 7 considers the perspective on performance that emerges from the experience of ESI in industrialized countries, first from the experiences of reform in the United Kingdom and in the United States of America, and then from the perspective of the major lender to the power systems of developing countries – the World Bank.

Chapter 8 summarizes the main findings of the project while the concluding chapter suggests policy guidelines for the future development of DCs' ESI, of relevance to both internal and external agencies.

Analysis of a Solar PV System Driving a Piston Pump Equipped with a Matching Valve Part 1: Quasi-steady Analysis

Douwe de Vries and Paul T. Smulders
Eindhoven University of Technology
1993, 40 p.

This is the report of the research performed under contract to ECN as part of a project on solar pumps executed by WIP (Germany), GENEC (France) and ECN (the Netherlands) and TUE as sub-contractor. The project is supported by the EC within the JOULE program.

Existing solar pump systems can be composed of solar cells, batteries, controllers, inverters, motors, transmissions and pumps. In this study a simple system incorporating a matching valve, without the battery, controller and inverter is proposed. In this system a number of problems are eliminated. The good matching of the components in the solar pump system, incorporating a piston pump with a matching valve that controls the system, renders considerable improvements in efficiencies in comparison to those of the existing systems. As the efficiency is more or less constant over a large range of irradiation values, the system is insensitive to the irradiation pattern. There is no external control in the system. The valve behavior is passively controlled by the speed of the pump. The transmission and pump can easily be produced locally. Cells and motors can in principle be bought off the shelf.

The report is organized into four chapters. Chapter 1 considers existing solar pump systems, their problems and users' requirements. The characteristics of different components for the proposed system are treated in Chapters 2 and 3. In Chapter 4 the coupling and matching of the components is clarified, and the simulation results are also presented. The calculations are done in matlab.

The analysis presented is quasi-steady. It is supposed that for a certain value of irradiation the system responds by operating in a steady state. In reality, especially at low irradiation values the system shows dynamic behavior. In a report to be issued at a later date, this dynamic behavior will be treated in more detail.

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5600 MB Eindhoven
The Netherlands

Remote Area Power Supply (RAPS) Design Manual

W.D. Cowan, M.L. Borchers, A.A. Eberhard, G.J. Morris and C. de V. Purcell
Energy for Development Research Center
University of Cape Town
Energy Branch, Deparment of Mineral and Energy Affairs
South Africa
1992, two volumes

Energy supply is one of the many constraints facing rural development in Southern Africa. Electricity from RAPS systems has a special place here. RAPS systems include all off-grid technologies for generating electricity, from a small single solar panel to large diesel electricity generating systems or a wind generator producing hundreds of kilowatts.

The manual is produced as a resource for designers of RAPS systems in Southern Africa, and for those who are interested in installing, procuring or specifying RAPS systems. The primary objective of the manual is to make locally developed design knowledge assessible for wider application in Southern Africa.

The manual is designed in the form of a core design section (Volume 1), followed by a number of supplementary "resource files" (Volume 2). RASP systems can be designed using computer aided design methods, or "by-hand". Both approaches are included in the design section of this manual.

Volume 1, beside the general consideration and comparision of RASP systems, presents the design of solar

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Book Review

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photovoltaic (PV) systems. The components of the PV design include: needs and load assessment, solar radiation, PV modules and arrays, batteries, battery regulators, power conditioners, PV system sizing, RAPS financial evaluation, wiring and installation, supplier/user interface, performance measurement and testing, standards, codes of practice and specifications.

In Volume 2, the resource files include background theory, local data (e.g. test results for locally available RAPS system components, data on appliances, local solar radiation data, etc.), case studies, industry reports, new research findings, and user guides for the design software which is distributed with this manual. The software is POWACOST (Version 2.1) developed by EDRC for sizing, costing PV systems and providing comparative energy costs for the conventional alternatives, diesel generators and rural grid extension.

The manual is produced at the Energy for Development Research Center, Energy Research Institute, University of Cape Town. Staff at EDRC have been engaged in RAPS research for several years – particularly in photovoltaics – monitoring systems in the field, testing components, and developing refined design methods and computer software.

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Publications Received

BIOMASS ENERGY

* *Business Opportunities for Power Generation from Biomass Residues in ASEAN, Volume 1: Rice Sector*, compiled by S. Jayasinghe, EC-ASEAN COGEN Program, Asian Institute of Technology, Bangkok, Thailand, 1993, ii+45 p.+App.

RENEWABLE ENERGY

* *European Directory of Renewable Energy Supplies and Services 1993*, edited by Bruce Cross, James and James Science Publishers Ltd., London, United Kingdom, 1993, 428 p.

SOLAR ENERGY

* *Solar Cells and Their Industrial Applications*, published by United Nations Industrial Development Organization (UNIDO) as number 31 of UNIDO's series "Advances in Materials Technology: MONITOR", compiled by Ms. A. Mannoia, Technology Development and Promotion Division, Department for Industrial Promotion, Consultations and Technology, UNIDO, P.O. Box 300, A-1400 Vienna, Austria, March 1993, 81 p.

Diary of Events

- **11 – 12 October, 1993, Kuala Lumpur, Malaysia**

Energy Efficiency: Regional Forum for Utilities, Industrial and Commercial Energy Users

For details contact:
IIR SDN BHD, lot 297
Wisma Stephens
Jalan Raja Chulan
50200 Kuala Lumpur
Malaysia
Tel: 241 0325
Fax: 244 5935

- **12 – 15 October, 1993, Porte de Versailles, Paris, France**

Energies 93, the Energy Management and Renewable Energies Exhibition

For details contact:
SEPFI – TECHNOEXPO
8, Rue de la Michodiere
75002 Paris
France
Tel: (33-1) 4742 9256
Fax: (33-1) 4266 1428

- **19 – 20 October, 1993, Ankara, Turkey**

OECD Workshop on Renewable Energies and the Urban Environment

This workshop is being held in the framework of the OECD Project on "Environmental Improvement Through Urban Energy Management".

For details contact:
Renewable Energies and the Urban Environment
Ms. Hale Hatipoglu
Greater Ankara Municipality
Belko, Mesnevi Sokak No: 27
A. Ayranci, Ankara
Turkey
Tel: (90-4) 440 7861
Fax: (90-4) 440 7867

- **14 – 23 November, 1993, New Delhi, India**

Techmart India'93

The business forum, organized by UNIDO in cooperation with the National Small Industries Corporation Ltd. of the Government of India, focuses on food processing technologies, new and renewable sources of energy, auto components, high technologies and leather processing.

For details contact:
Chief
Industrial and Technological Information Section
United Nations Industrial

Development Organization (UNIDO)
Vienna International Centre
P.O. Box 300, A-1400 Vienna
Austria
Tel: (43-1) 211 31, extension 3693
Fax: (43-1) 232 156 or 230 7584
Tlx: 135612 uno a

- **16 – 17 November, 1993, London, United Kingdom**

World Electricity Conference

For details contact:
Financial Times Conference Organisation
102-108 Clerkenwell Road
London EC1M 5SA
United Kingdom
Tel: (071) 814 9770
Fax: (071) 873 3969/3975

- **17 – 19 November, 1993, London, United Kingdom**

International Conference on Renewable Energy – Clean Power 2001

For details contact:
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IEE Conference Services
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United Kingdom
Tel: +44 71 240 176
Fax: +44 71 497 3633

- **22 – 26 November, 1993, Nagoya, Japan**

7th Int. Photovoltaic Science and Engineering Conference

For details contact:
Prof. Takashi Jimbo
c/o Japan Convention Services Inc.
Nippon Press Center Bldg.
2-2-1 Uchisaiwai-cho
Chiyoda-ku, Tokyo 100
Japan
Tel: (81-3) 3508 1213
Fax: (81-3) 3508 0820

- **6 – 8 January, 1994, Calcutta, India**

International Conference on Combined Cycle Power Generation

For details contact:
Prabir Basu
Department of Mechanical Engineering
Technical University of Nova Scotia
P.O. Box 1000
Halifax B3J 2X4
Canada
Tel: (902) 420-7531
Fax: (902) 429 4867

- **12 – 13 January, 1994, London, United Kingdom**

Power Generation and Supply

For details contact:
IIR Ltd.
28th Floor, Centre Point
103 New Oxford Street
London WC1A 1DD
United Kingdom
Tel: (071) 379 8040
Fax: (071) 412 0143/0146

- **23 – 26 January, 1994, New Orleans, LA, USA**

13th Wind Energy Symposium at the 1994 Energy Sources Technology Conference & Exhibition.

For details contact:
Sally Goldesberry
American Society of Mechanical Engineers (ASME)
1950 Stemmons Freeway
Suite 5037C
Dallas, TX 75207
USA
Tel: +1 (214) 746 4901
Fax: +1 (214) 746 4902

- **14 – 18 February, 1994, Jerusalem, Israel**

Comparative Assessments on Solar Power Technologies

An international conference organised by the Ministry of Science and Technology focusing on comparative techno-economic solar power studies, in which the basic assumptions and evaluation techniques are stated in detail, and on conceptual techniques (standards, ground rules, guidelines), aiming to facilitate assessments of various technologies on a common basis.

For details contact:
Dr. M. Wolff
Ministry of Science and Technology
PO Box 18195
Jerusalem 91191
Israel
Tel: +972 2 825 183
Fax: +972 2 820 591

- **24 – 25 February, 1994, Rome, Italy**

Offshore Wind Energy in Mediterranean and other European Seas (OWEMES)

For details contact:
Dr. G. Gaudiosi
c/o ENEA
CRE Casaccia
Via Anguillarese n. 301-00100
Rome AD
Italy
Tel: +39 6 3048 3994
Fax: +39 6 3048 6315/4203

- **3 – 4 March, 1994, Curaçao, Caribbean**

International Wind Energy Conference '94

Organized by Kodela utility with European Commission's Directorate General for Energy (Thermie programme).

For details contact:
Karel Tujeehut
Kodela, P.O. Box 230
Willemstad
Curaçao
Netherlands Antilles
Tel: +599 9 627 898
Fax: +599 9 626 261

- **11 – 15 April, 1994, Amsterdam, The Netherlands**

12th European Photovoltaic Solar Energy Conference & Exhibition

For details contact:
WIP Sylvenstrasse 2
8000 München 70
Germany

- **June 1994, Frankfurt, Germany**

24th ACHEMA – International Congress on Chemical

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Diary of Events

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Engineering and Biotechnology

For details contact:

DECHEMA
Theodor-Heuss-Allee 25
D-6000, Frankfurt-Main 97
Germany
Tel: 4969 7564 235
Telex: 0412490 DCHAD

- **20 – 24 June, 1994, Cocoa Beach, FL, USA**

Hydrogen'94 – The 10th World Hydrogen Energy Conference.

For details contact:

Carolyn Burby
Florida Solar Energy Center
300 State Road 401
Cape Canaveral
Florida 32920 - 4099
USA
Tel: USA+(407) 783 0300 Extn. 112
Fax: USA+(407) 783 2571

- **21 – 25 June, 1994, Basel, Switzerland**

Energy Visions 94

For details contact:

Energy Visions 94
Messe Basel
PO Box, CH-4021 Basel
Switzerland

- **25 – 30 June, 1994, San Jose, CA, USA**

Solar'94: Golden Opportunities for Solar Prosperity

For details contact:

American Solar Energy Society
2400 Central Ave. G-1
Boulder, CO 80301
USA
Tel: +1 303 443 3130
Fax: +1 303 443 3212

- **4 – 6 July, 1994, Brighton, United Kingdom**

Second UK Congress of Biotechnology: Biotech'94

For details contact:

Julie Morgan
Conference Officer
Institute of Chemical Engineers
Davis Building
165-171 Railway Terrace
Rugby
United Kingdom

- **22 – 26 August, 1994, Kiev, Russia**

10th International Heat Transfer Conference

For details contact:

10th International Heat Transfer Conference
Institute of Engineering Thermophysics
Ukrainian SSR Academy of Sciences
2a Zhelyabov St.
SU-25 2057 Kiev
Russia

- **11 – 16 September, 1994, Reading, United Kingdom**

World Renewable Energy Congress III

For details contact:

Prof. A.A.M. Sayigh
Dept. of Engineering
University of Reading
Whiteknights, PO Box 225
Reading RG6 2AY
United Kingdom
Tel: +45 (0) 734 318 588
Fax: +45 (0) 734 313 835

- **10 – 14 October, 1994, Salonica, Greece**

European Wind Energy Association Conference'94

For details contact:

Hellenic Wind Energy Association
19th Km. Marathon Av.
Pikermi Attika 190 09, Athen
Greece
Tel: +30 1 603 9900
Fax: +30 1 603 9904

- **9 – 16 September, 1995, Harare, Zimbabwe**

ISES 1995: In Search of the Sun: The 1995 ISES International Congress

For details contact:

The Conference Convenor
1995 ISES Solar World Congress
P.O. Box MP 119
Mount Pleasant, Harare
Zimbabwe

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Library and Regional Documentation Center, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The "RERIC News" is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership along with the other four regular publications namely: RERIC International Energy Journal (formerly: Renewable Energy Review Journal); RERIC Holdings List; Abstracts of AIT Reports and Publications on Energy; and RERIC Membership Directory. For further details contact:

Regional Energy Resources Information Center
Asian Institute of Technology
G.P.O. Box 2754
Bangkok 10501, Thailand
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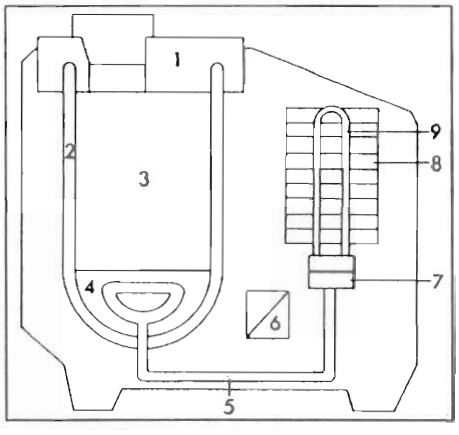
ISSN 0125-1775

Vol. 16 No. 4 December 1993

Room
Washington, D.C. 20523-1801 FEB

Thermoelectric Solar-Powered Refrigerator for Vaccine Storage

The World Health Organisation (WHO) is implementing an "Expanded Programme on Immunisation" (EPI) to reduce the high rate of infant mortality in developing countries (about 15% of live births). This programme entails the preventive vaccination of infants under one year against dangerous widespread diseases. All vaccines must be preserved at approximately 4°C. The transport of the serum from the manufacturer to the recipient requires a continuous cold chain. The rural health centre, the last link in this chain, is the most important since only here has one got the chance of reaching an appreciable proportion of the children.



1 lid with opening
2 dewar vessel
3 cooling cabinet
4 latent heat store
5 inner circuit
6 power electronics
7 heat pump (peltier element)
8 air heat exchanger
9 outer circuit

Operational chart of the cooling system.

Portable solar-powered cooling system.

The absence of electricity mains and the uncertain supply of gas or kerosene rule out conventional solutions using compressor or absorber refrigerators. Even compressor systems coupled with photovoltaic installations offer an expensive and unreliable compromise, in part because they depend on long-life battery units. For this reason, the Interdisciplinary Project Group for Appropriate Technology in cooperation with the WUSELTRONIK engineering association has developed a refrigerator especially for use in cases where certain conditions apply with regard to application, position, climate and infrastructure. Some conditions have been standardised by WHO (e.g. ambient temperature 43°C by day, 32°C

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INNERTAP

Incorporates news from the Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

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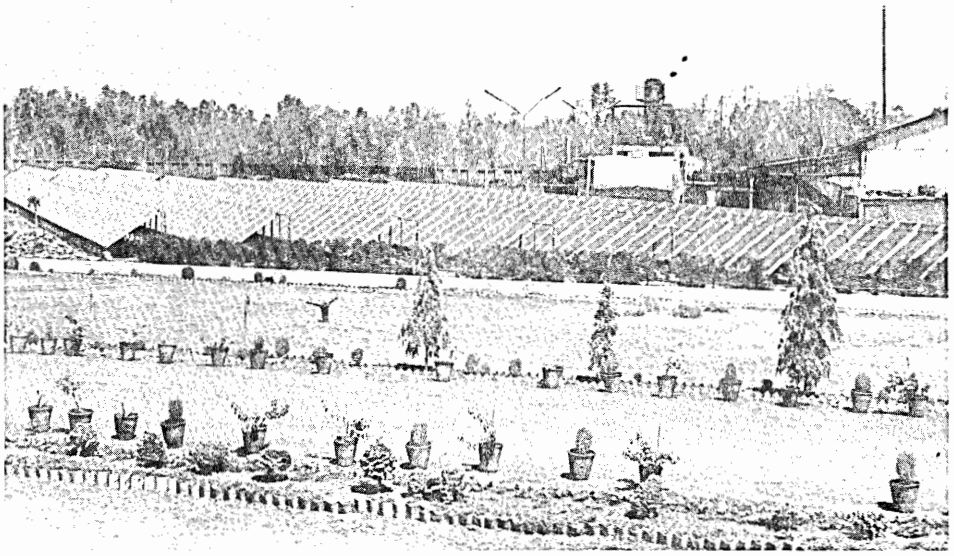
Largest Solar Water Heating System in India

Steelhacks Industries, an Indian Company, has installed a 50,000 litre capacity solar water heating system (SWHS) in a soybean extraction plant, Vippy Solvex Products Ltd., Dewas City, India. This system, which is claimed to be the largest SWHS in India, is used for pre-heating water before feeding it to the boiler.

Absorbers, totalling 1300 m^2 (650 panels x 2 m^2 each), can deliver 50,000 litres of water per day at a minimum temperature of 85°C. The absorbers are made of copper with a black chrome selective surface.

The system, costing Rs 6.4 million, can save 750 tons of coal a year which is equivalent to about Rs 1.5 million. The Ministry of Non-Conventional Energy Sources and M.P. Urja Vikas Nigam Ltd., Bhopal have jointly granted a subsidy of Rs 1.6 million, while the Indian Renewable Energy Development Agency (IREDA) has provided a soft loan of Rs 1.9 million.

Steelhacks Industries started manufacturing SWHS in 1982, and so far it has installed a total capacity of 600,000 litres per day through 9300 m^2 of solar collectors in different parts of India. The annual saving of conventional energy from these systems is estimated at 8,370,000 kWh. "UNISOL" is the brand name of the company's products.



For further information contact:
Steelhacks Industries
9A/1 GIDC Estate
Vithal Udyoganagar
Gujarat 388 121
India
Fax: 011 2692 31835

Thermoelectric Solar-Powered Refrigerator for Vaccine Storage

From P. 1

by night, internal temperature 2-6°C, internal volume 20-40 litres).

By using a thermoelectric heat pump (Peltier element) and a refrigerant circuit, heat is extracted from a water container in the base of the cooling cabinet. As a result the liquid wholly or partially freezes to ice, which keeps the interior at the nearly constant temperature of 4°C. Even if the heat pump is starved of energy, this temperature is maintained for three days, provided the ice store has been charged. Energy for the heat pump is supplied by solar cells with power input varying from 30 to 60 W depending on radiant intensity. The extracted heat is lifted by the heat pump to a high level and is dissipated to the atmosphere through a high surface area heat exchanger by free convection only (no fan).

The cooling compartment is enclosed in a 40 litre dewar vessel, made of strong boro-silicate glass. By use of this highly efficient vacuum insulation, the heat influx can be reduced to less than 5W, even at an ambient temperature of 43°C. By comparison, a PU-foam insulated container of the same volume and with 3 cm thick walls would allow heat inflow of around 50 W which then has to be pumped out again with a corresponding high waste of energy.

The ice latent heat accumulator functions as an energy store and replaces the maintenance-intensive battery units normally used. This large thermal bulk makes active control of the cold department temperature redundant.

The heat pumping is achieved purely electronically by means of Peltier elements, semiconductor units of 16 cm^2 area. This pump has no moving parts and therefore has a long service life. The system lifetime is at least 10 years.

For operating in the tropics, the housing is made of corrosion resistant material. The fridge is designed as a "top-loader" to minimise heat influx. Although the lid can be removed as a whole for cleaning occasionally, only one segment of it has to be removed to take out the vaccine vials. The cold chamber contains a metal basket which can be turned until the desired compartment is placed under the open segment.

The technology is environmentally sound. The insulation is principally by vacuum and not with CFC-foamed polyurethane. A simple hydrocarbon serves as refrigerant instead of R12 (a CFC). No environmentally damaging batteries are used.

For further information contact:
W. Wasserthal
Lentzeallee 86
1000 Berlin 33
Tel: (030) 31471 298/338

Announcement

5th AIT-WHO Training Course on SOLAR REFRIGERATOR REPAIR & MAINTENANCE

DATE : 30 MAY - 10 JUNE 1994

VENUE : Energy Technology Program, Asian Institute of Technology (AIT), Bangkok, Thailand

COURSE DESIGN :

This two week course is designed to provide intermediate training in solar photovoltaic (PV) technology with emphasis on refrigeration for vaccine storage. It is specifically designed for persons with some prior PV experience or basic electrical training who has a current work requirement for planning, installing, maintaining or supervising programmes relating to rural based solar photovoltaic systems for refrigerated vaccine storage.

The course emphasizes hands-on work supported by sufficient theoretical study to enable a full understanding of the practical components of the course. In general, mornings will be a combination of lecture in theory plus demonstrations illustrating the lecture. Afternoons will be spent on practical works with participants working in small groups of three to five, each group having their own instructor. Practical work will consist of experiments with actual components to show their operation and failure modes, actual installation of solar equipment, troubleshooting practice and repair of faulty units. Participants will be closely integrated into the training process with advanced participants assisting in the instruction. Instructors in the course include AIT technical staff and external instructors from overseas having long, practical experience in photovoltaics and solar refrigeration.

PRE-REQUISITES :

Candidates should have an understanding of basic electricity and should have job responsibilities relating to the supervision, installation, repair or maintenance of solar PV systems.

LANGUAGE :

Candidates should have ability to understand, speak and write ENGLISH language.

FEES AND EXPENSES :

- Individual Tuition (Course materials and stationary included) fee is US$1300. Lower rates may apply for three or more participants funded from one source.
- Accommodation at AIT Hotel costs US$35/day single occupancy. Lower rates are available for double occupancy.
- Meals at AIT Hotel is around US$15/day. Lower rates are available at the student cafeteria.

APPLICATION/REGISTRATION :

The number of participants is limited to 20. Applications using the pre-registration from should reach AIT NOT LATER THAN 31 MARCH 1994. Acceptance will be on FIRST COME FIRST SERVED basis, hence candidates should send applications as soon as possible. For more information, please contact:

The Secretary	Fax no.	:	(662) 5245439 or 5162126
Energy Technology Program	Telex no.	:	84276 AIT TH
Asian Institute of Technology	Cable	:	AIT Bangkok
GPO Box 2754, Bangkok 10501	Telephone	:	(662) 516-0110-29 Ext. 5408 or 5440
Thailand			

5th AIT-WHO Training Course on
SOLAR REFRIGERATOR REPAIR & MAINTENANCE

Asian Institute of Technology, Bangkok
30 MAY - 10 JUNE 1994

PRE-REGISTRATION FORM

Name:_____

Sex:_____ Date of Birth:_____ Nationality: _____

Job Position:_____

Employer's Name:_____

& Address:_____

_____ _____ _____
Telex Telefax Telephone

Sponsoring agency: _____

_____

Education:_____

Experience of Repairing Refrigerators (in years):_____

Compression Refrigeration training course Attended (date,place): _____

_____

_____

Signature:_____ Date:_____

Please mail or fax this form to The Energy Technology Program of the Asian Institute of Technology before 31 March 1994.

Mailing Address:
Secretary
AIT Energy Technology Program
GPO Box 2754
Bangkok 10501
THAILAND

Fax Number: (662) 524-5439

RERIC OCCASIONAL PUBLICATION

Thailand Improved Charcoal Bucket Stove Technology and Dissemination

Prepared by A. Koopmans

1993, 58 p., ISBN 974-8209-85-7

In response to a growing concern about increasing scarcity and prices of fuelwood and charcoal in Thailand the Forest Products Research Division of the Royal Forest Department in cooperation with the National Energy Administration (NEA), Thailand and with technical assistance from the USAID, embarked on a project to improve the efficiency of the traditional biomass/wood stove in 1982. Among others, an improved charcoal bucket stove (ICBS) was developed which consumed less fuel, cooked faster and at the same time could accommodate a full range of pot sizes commonly encountered in the household. After considerable testing in the laboratory and in actual household use, thousands of ICBSs were constructed and disseminated, while manufacturers, both formal and informal, were trained by NEA and encouraged to produce them for sale.

The Booklet provides technical details concerning manufacture of the stove. It also describes the dissemination program undertaken in Thailand and the difficulties encountered and successes achieved. The technical problems relating to production of the ICBS were solved more easily and completely than problems relating to the sustainability of dissemination strategies and quality control.

Contents:

- Background Information
- Technical Development of the ICBS
- Production Technologies Related to the ICBS
- Setting Up a Small Unit for ICBS Production
- Present Status of ICBS Production and Dissemination Efforts

Available from: **Regional Energy Resources Information Center (RERIC)**
Asian Institute of Technology
P.O. Box 2754, Bangkok 10501
Thailand
Fax: (66-2) 524 5870

Price: **US$ 30.00 air-mailing included (USA, Canada, Europe, Japan, Australia, New Zealand and Middle East)**
US$ 20.00 air-mailing included (Developing Countries)

Payment: ***Payment can be made by a bank draft drawn in USA and made payable to*** **"Regional Energy Resources Information Center/AIT"**

Order Form

I wish to order ..... copy/copies of "Thailand Improved Charcoal Bucket Stove: Technology and Dissemination" and I enclose the corresponding payment.

Name:_____

Address:_____

_____ Amount Paid: _____

Date: _____ Signature: _____

First Self-Sufficient Solar House in Germany

The self-sufficient solar house built in Freiburg by Fraunhofer Institute for Solar Energy Systems (ISE) is the first German house where the sun provides 100% lighting, heating and electricity needed to ensure the usual degree of comfort. The project began in 1988 and the house has been completed after 14 months of construction. The project was supported by the BMFT (German Federal Ministry for Research and Technology), the State of Baden-Wurttemberg, the City of Freiburg and many industrial companies.

Open to the Sun

A special feature of the house is its curve to the south to maximise south facing areas to get more solar energy. While the shorter, straight northern facade minimises the area which does not see the sun. The roof area is occupied by solar cells and a new type of solar collectors for domestic hot water.

The living area in the house is 145 m². In the basement there is a cellar and equipment rooms. On the ground floor there is a kitchen/living room and a public lecture room. Four residential rooms are located on the upper floor. One of the project leaders, Dr W. Stahl, has lived for a week with his family in this house and has complete confidence in the sun as the energy source.

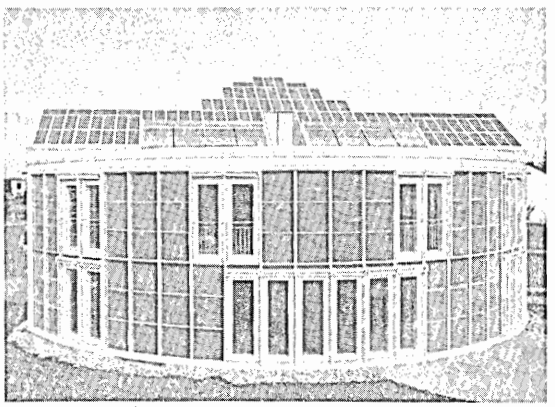
Heating

Thorough energy saving measures, particularly excellent conventional thermal insulation on the north wall and for the roof and basement (the foundation block and basement walls are surrounded by an insulating layer of glass foam) and ventilation heat recovery, have greatly reduced transmission and ventilation losses. The application of "transparent insulation" (TI) technology developed at ISE on the southern facade deserves special attention. Plastic TI materials, which transmit solar radiation well and simultaneously are good thermal insulators, are mounted in front of the black wall. The solar radiation passes through the TI material and heats up the solid wall. After a delay the heat is released into the adjacent room. Thereby, solar heating is still possible after sunset. The use of the TI material reduces the supplementary heating needed to the equivalent of 30 litres of oil. A roller blind system regulates the solar input. When heat is needed, the walls look black, when it is not, roller blinds are let down and the facade has a silver gleam. Supplementary heating is rarely required and is supplied by the hydrogen storage system.

In a new type of collector system for heating water in winter, the absorber insulated with the TI material absorbs direct radiation from the sun on the upper surface and indirectly, via a reflective trough, on the lower surface. This results in acceptable water temperatures even during winter. The hot water is stored in a 1000 litre tank. Moreover, the exhaust heat from the fuel cell also heats the water, so it is not wasted.

On the Roof Solar Cells Generate Electricity

The 36-m² photovoltaic solar generator supplies 4.2 kW electricity under full sunlight. When necessary this can be converted to alternating current and fed into the domestic circuit (230 V/50 Hz). Excess electricity is stored in lead batteries (19.2 kWh), which can supply power for several cloudy days. If the lead batteries are charged, the hydrogen storage system will be used as described below.



The house is equipped with conventional household appliances chosen because of their energy efficiencies. This reduces the electricity consumption to about one third of that for an average family.

Storing Solar Energy from Summer for Winter

The seasonal energy storage system based on hydrogen is the core of the house. Use of this technology made the difference between a truly self-sufficient solar house and a minimal-energy house.

About 1500 kWh energy can be saved from summer for winter by electrolysing water into hydrogen and oxygen and storing both gases in pressure tanks. The tank pressure is 30 bars. The volumes of the tanks are 7.5 m³ and 15 m³ for oxygen and hydrogen respectively. In the winter, the alkaline fuel cell (0.5 kW) can generate electricity directly (reverse process to electrolysis).

The exhaust heat (70°C) from the conversion is used for supplementary heating of the hot water.

Flameless catalytic combustion of hydrogen provides heat for cooking on the hydrogen gas stove and for the minimal additional space heating needed in winter. Both the 2 kW membrane pressure electrolyser and the systems for catalytic combustion of hydrogen were developed at ISE.

Costs

When talking about the investment, one should remember that this is a prototype building. In addition to the building costs of about DM 900,000 for the low energy house (including conventional

Cont. P. 4

Solar Tower for Power Generation and Desalination Israel

A group of Israeli experts led by Dr. Dan Zaslavsky, dean of the Agricultural Engineering Faculty at the Haifa Technion, has been working on a project to use the heat of the desert to generate power and desalinate sea water.

Water is pumped to the top of the tower and sprayed into the centre, where it rapidly evaporates in the dry desert heat.

The air is cooled by evaporation, becomes denser and falls down. Its moving speed accelerates under gravity and achieves 80 km/hour by the time it reaches the bottom. This downdraft is used for driving turbines to generate electricity.

The college has established Desert Sluices Ltd, a new company to exploit the new SNAP technology (Sneh Aeroelectric Power).

The target is to generate power from dry desert air and brackish or sea water at a cost of 2.5 – 3.5 cents per kWh.

A by-product of the process will be desalinated water at a cost of about half the current price.

A typical full-size SNAP plant would have a generating capacity of 500 MW. It would also desalinate 100 x 10^6 m^3 of water annually. The plant would incorporate a wind tower about 1 km high and 503 m in diameter.

An engineering construction company in Florida says that building the tower would not be difficult. The tower is cylindrical and could be built in two years at a cost of about $ 300 million.

The technology, originally conceived by Dr. Philip Carlson at Lockheed in the 1970s, was developed independently during the 1970s at the Technion. And Technion team developed several key new concepts making SNAP economically more attractive and eliminating important environmental concerns.

(Source: Extracted from "Solar Power Tower Also Desalinates Sea Water", *Modern Power Systems*, Vol. 13, No. 9, September 1993, p.19.)

Powerful Solar Cooker

In May 1993 Prof. Klemens Schwazer, an expert in thermodynamics at the solar energy department at Aachen University in Germany, demonstrated a new type of solar cooker at UNEP's Headquarters, Nairobi, Kenya. Made up of a flat collector and a cooking unit, the solar cooker produced boiling water within hours.

Receiving the gift, Ms. Elisabeth Dowdeswell, Executive Director, emphasized the importance of the stove: "This is a timely gift. Appropriate technologies and their transfer to developing countries are a key to sustainable development".

The cooker has two major innovations: it can be adjusted as easily and quickly as a gas cooker, but is more powerful than an electric cooker (up to 200°C). Moreover, the heat can be stored overnight for cooking after sunset.

It can cook gourmet meals including bread for up to 25 persons. The collector is placed outside, while the cooking unit can be installed indoors or outdoors. The heat is stored by pebbles in a steel vessel and transferred by vegetable oil such as peanut oil, which allows the high temperatures needed to bake and fry without any high pressure.

Prof. Schwazer has been working for six years on the project. In December 1992, he and his team demonstrated the cooker in the remote desert mountains of northern Chile. The team will go on to southern India, Namibia and Mali.

Such stoves costing about US$ 2200 need no maintenance for up to 20 years and can be manufactured locally. The stoves can greatly improve the quality of life in rural areas and help prevent desertification and deforestation.

For further information contact:
Prof. K. Schwazer
Tuchbleiche 12
5170 Julich
Germany

(Source: Extracted from "Baking Bread with Pebbles, Oil and Sun" by Beatrice Lacoste, *Ecoforum*, Vol. 17: 4, September 1993, p.14.)

First Self-Sufficient Solar House in Germany

From P. 3

building services and the transparent insulation), a further DM 700,000 was spent on additional technical equipment and measurement systems. The hydrogen technology and photovoltaics are the major components of these costs. In contrast, the active and passive thermal systems are relatively inexpensive and offer much closer economic competition to conventional energy sources.

The self-sufficient solar house integrates a number of concepts originated or developed further at ISE. Some concepts have achieved technical maturity and could be applied on a large scale, while others, particularly hydrogen technology, require further research and development. Thus, this is a demonstration model for the house of today and tomorrow. It is also a research laboratory for advanced energy technology with applications far beyond the residential sector.

For further information contact:
Dr A. Zastrow
Public Relations Officer
Fraunhofer Institute for Solar Energy Systems
Tel: +49 761 4014 147
Fax: +49 761 4014 116

Fraunhofer Institute for Solar Energy Systems (ISE)

The major objective of the Fraunhofer Institute for Solar Energy Systems (ISE), Germany is to conduct research on the technical possibilities of using solar energy and to develop systems for its collection, conversion, storage and processing. The aim is to develop small, decentralised systems, which are also economically viable under the radiation conditions of Central Europe.

The institute consists of five scientific departments: Systems Technology, Collector Development, Solar Cell Technology, Materials Research, and Energy Storage. The major focus of institute's research and development activities are thermal conversion, photovoltaics and energy storage.

Thermal Conversion

The departments of Systems Technology and Collector Development concentrate on transparent insulation materials and their use in thermal conversion systems. A new class of these materials will allow the most efficient thermal use of solar energy on building walls by combining high transparency with good thermal insulation. The development, production and characterization of selective thin films are another focus of research.

Some examples of research projects are storage collector systems for heating domestic water, highly efficient flat-plate collectors for generating process heat, large-scale thermal collectors, and roller blind systems for energy flow control.

Photovoltaics

The initial materials for photovoltaics are being developed and analysed in the departments of Materials Research and Solar Cell Technology. Technology for producing less expensive and/or highly efficient solar cells is also being developed.

Block-casting is a standard procedure for manufacturing multi-crystalline Si wafers for solar cells. The mould materials and the temperature control during cooling, which have a major impact on the wafer quality, are being investigated.

Conversion efficiencies of more than 22% have been achieved with GaAs cells made by liquid phase epitaxy on GaAs substrates. In order to produce GaAs thin film cells on foreign substrates (Si, Ge) with high efficiency various epitaxy methods are being investigated.

Using clean room technology, monocrystalline Si solar cells with efficiencies of more than 20% can now be produced at the institute.

Examples of some projects in this field are:

- Liquid-phase and gas-phase epitaxy, GaAs/GaAlAs solar cells
- Defects in multicrystalline silicon
- Fundamentals of block crystallisation
- Transformerless inverters for grid connection and stand-alone operation
- Photovoltaic power supplies for remote houses.

Solar cells and their modules are measured in the PV calibration laboratory. Procedures to determine annual efficiencies are being worked out.

Advanced appliances using solar energy are being developed, drawing on the know-how derived from experience with energy saving-electronic components and technology. The institute provides advice to companies which want to introduce new solar-operated products to the market. Specifications for devices and components are determined which guarantee regular operation under special conditions.

Energy storage

Due to the seasonal and daily variations of solar radiation, inexpensive and efficient energy storage systems are of special importance. New types of storage systems with particular emphasis on hydrogen technology are being investigated in the department of Energy Storage, for example, the isolation of hydrogen via electrolysis, the conversion of hydrogen to electricity in fuel cells and catalytic combustion to produce heat.

New technologies are also being used to develop energy conversion equipment. For example, ion exchange membranes can act as the electrolyte both in electrolysers and in fuel cells, and a combined device with high efficiency for both processes can be developed. A compact hydrogen storage system like this represents the only option for long-term storage of electrical energy. For mobile vehicles the membrane fuel cell is the best alternative to the internal combustion engine because of its extremely high power/weight ratio.

The catalytic reaction of methanol to hydrogen is also being investigated.

Catalytic reaction of fuels to produce heat can be applied for heating, cooking and to drive absorption refrigeration machines and gas turbines.

Research on conversion of natural gas to electricity in high-temperature fuel cells is being carried out. This represents a very important link between the current energy supply technology and the hydrogen technology of the future. Fuel cells produce electricity more efficiently than conventional power stations. The molten carbonate fuel cell which operates at 650°C with natural gas is particularly suited for application in combined heating/power stations.

A "self-sufficient solar house" has been built to study the combined effect of the various active and passive solar thermal systems and the photovoltaic generator with different types of short-term and long-term energy storage.

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Virginia Law Promotes Photovoltaic Manufacturing

Recognizing the vast energy- and job-generation potential of solar photovoltaic technology, Virginia has enacted new legislation providing up to $ 22.5 million over a five-year period from 1995 to 1999 for incentives to be paid to PV manufacturers who set up production lines in the state.

The incentive is to be paid at the rate of 75 cents per watt of the rated capacity for panels sold in a calendar year, up to 6 megawatts a year. If applications for grants exceed 6 megawatts per year, then payments will be apportioned among eligible applicants. The grant will be paid from the Solar Photovoltaic Manufacturing Incentive Grant Fund.

In addition to the grants, Virginia's state-funded Center for Innovative Technology co-sponsors research in the energy field with companies in Virginia and provides a linkage between industry and Virginia's colleges and universities.

"If you're going to be a solar energy player, then the incentive grant program provides a competitive edge for you to be in Virginia," said L.G. Winter of the Metropolitan Economic Development Council (MEDC) in Richmond, Virginia.

"The Richmond area and Virginia have the existing base needed to support the PV industry, plus an internodal distribution network and a quality of labor and life that's attractive to industry of this type," Winter said.

According to J.W. Fairburn, director of economic development for Hanover County, Virginia (located in the Richmond metro area), wage rates are ideal for small to medium size manufacturing firms and the labor supply is plentiful and has a strong rural component. This together with Virginia's right-to-work law breeds a wholesome work ethic which helps rank Richmond manufacturing productivity fourth nationally.

At the same time, the Richmond area provides the urban environment needed to attract and retain key management, supervisory and research talent.

Land values are attractive, and local government aggressively implements fast-track permiting. For example, AMF Industries was able to construct a 375,000 square-foot plant in Hanover County in eight months, something that might have taken as long as two years in many parts of the country.

The area's excellent internodal transportation system and interstate network provide access to major U.S. markets, even to overseas markets through port facilities.

A workforce training program, unique to Virginia, can save new and expanding companies $ 900 to $ 1200 per worker hired.

"Virginia has an intense interest in the companies that are engaged in emerging technologies, like those in the solar photovoltaics field," said Winter. "Our electric utility, Virginia Power has led the way nationally in purchasing power from independent producers instead of relying totally on its own captive generating capacity, and it has pursued a solar photovoltaic demonstration project near Richmond for a number of years. Virginia's universities also have been engaged in solar PV research projects." he said.

For example, Virginia Tech has developed a prototype solar powered airport runway lighting system that is drawing attention from state and federal agencies for its energy conservation potential, and from the military for its possible use in remote airfields.

United Solar Systems Corporation, a PV manufacturer, has already announced its intention to build a $ 30 million, 85,000 square-foot complex in Virginia. The plant is scheduled to be on-line in 1994. The company is a joint venture of Canon, Inc. and Michigan-based Energy Conversion Devices, Inc.

MEDC provides economic development services free of charge to prospective companies to facilitate the

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20 Year Warranty for Solar Products

Solarex, an Amoco company, has extended its product warranty in the USA to an unprecedented twenty years. This announcement of the new 20-year warranty coincides with the company's 20th anniversary in the photovoltaic industry.

The new Solarex warranty now certifies that every module rated 38 watts or higher will generate at least 80 percent of its minimum rated power for twenty years.

Len May, Solarex Vice-President, Sales and Marketing, says "Solarex modules have always been built to meet or exceed all industry standards for quality and safety. In applications throughout the world – and in the harshest environments imaginable – our PV modules have demonstrated unsurpassed reliability and staying power. The new Solarex 20-year warranty is not only a promise of what high power modules can do, but also a testimony to the reliability they've already achieved. PV buyers have typically been told to expect a 20 year life from their PV modules. The expected life of these modules is now at 30 years. In the past, buyers have had no real assurance that the modules would truly perform for 20 years. This new warranty gives the buyers that assurance."

By extending the period over which PV systems can be financed and depreciated, this 20 year warranty will significantly reduce the monthly cost of PV system ownership for a variety of users including electric utilities.

Solarex, a global leader in solar electric technology, is the first manufacturer in the industry to back its high power modules with such a long-term warranty.

(Source: Extracted from "Solarex Announces New 20 Year Warranty", *Solar Progress*, Vol. 14, No. 3, Spring 1993, p.14.)

Towards the "World Solar Energy Decade"

A high-level conference of government experts, held in Paris, has called for a global programme for the development of renewable energies. The culmination of the plan would be a United Nations World Solar Decade, projected for 1995-2005.

The meeting, described as a "world summit of expertise in renewable energies", was attended by 384 experts concerned with the new energy technologies for minimising the environmental impacts of energy consumption. The Paris conference was sponsored by the European Community and many specialist agencies.

It will be followed by a world conference on solar energy in 1994 and a conference to be attended by heads of state in 1995 which would formally launch the World Solar Decade.

Last year, world shipments of photovoltaic cells rose by 5 %, to provide generating capacity of 58 MW. The price is still rather high, however, improvements are expected to reduce costs considerably.

Until recently, solar power shared only 3.5 % of world expenditure on energy research and development, but now Spain has increased national funding to 17 %, Germany to 16 % and Switzerland to 14 %. Delegates to the Paris meeting suggested that finance for the solar decade could be raised through a special tax on international air traffic fuel.

A world solar educational system should be established, to culminate in the creation of a network of international centres on renewable energies, recommended by the delegates.

The centres, located in the developing countries and obtained by upgrading existing institutions, would carry out research and development, information collection and dissemination.

Some of the centres would promote North-South technology transfer, while others would assist South-South co-operation.

At a seminar organised by the UN's Economic Commission for Europe (ECE), energy experts have approved proposals for a global solar power development agency. A 100-MW, internationally financed solar power plant was also suggested to be built.

The experts at the seminar also recommended measures to encourage commercialisation of photovoltaic power systems, increased exchanges of specialists and the widespread inclusion of new energy technologies in the curricula of technical schools and universities.

(Source: Extracted from "UN to prepare for 'World Solar Energy Decade'" *Petroleum Economist*, Vol. 60, No. 9, September 1993, p.45.)

Virginia Law Promotes Photovoltaic Manufacturing

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client's decision-making process and to help expedite new facility locations. Services include site location planning and consultations on real estate, construction, labor and training, utility, finance, relocation, community analysis, transportation and permitting.

For more information contact:
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Thai-German Biogas Programme

Increased large-scale livestock farming, particularly of pigs, and the growth of agro-industry combined with more stringent environmental regulations in Thailand are opening up new perspectives for biogas technology.

"Biogas technology is the only waste treatment process we know that allows even partial cost recovery", says Dr Piyawat Boonlong of Chiang Mai University (CMU) and coordinator of CMU's part in the Thai-German Biogas Programme (TG-BP).

Bioenergy is not yet economical in itself. However, according to TG-BP estimates, biogas from their new plants, when converted to electricity, can reduce overall waste treatment costs in Thai piggeries by roughly one third. Water re-use and sale of fertilizer from the digested sludge could increase cost recovery to 40% or more.

The programme is a joint undertaking between Chiang Mai University, the Department of Agricultural Extension and Gesellschaft fur Technische Zusammenarbeit (GTZ), the German technical cooperation agency. Work began in 1988. The viability of its improved biogas technology has been demonstrated among smallholders in five northern provinces around Chiang Mai. The programme is now focusing on medium- and large-scale piggeries in the region.

Each year, the 6-8 million pigs raised in Thailand produce lots of waste. Cattle and chicken raising, a wide range of agro-industries and even municipalities are other growing sources of organic pollution.

A Modular Double Biogas System (MDBS) was developed by TG-BP to treat such wastes. The core of the process is an Upflow Anaerobic Sludge Blanket (UASB) digester that rapidly processes the bulk of the less heavily polluted wastewater from the piggery. UASB water retention time is five days or less.

The more heavily polluted fraction passes through a more conventional fixed dome or channel digester where retention times are up to 50 days. Slurry from the large digester is separated into solid fertiliser and further feedstock for the UASB. Both digesters produce biogas.

Seven of these installations now serve pig raisers in north and northeast Thailand. Early results are so promising that the programme wants to expand to west and central Thailand.

Investment costs for the system

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Brunswick's Grid Connected Hybrid System

Brunswick Electricity Supply Department (BESD), Australia, commissioned its hybrid wind/photovoltaic grid connected renewable energy system on June 21, 1993. The project has been funded by the Federal Government through a Local Government Development Program (LGDP) grant.

BESD provides power to the City of Brunswick, an area of 10 km^2 about 5 km north of Melbourne GPO. BESD has been cooperating with the adjacent Centre for Education and Research into Environmental Strategies (CERES) for the past ten years. Over 25,000 students and adults go through the centre each year. The wind/PV hybrid system will supply enough power for CERES, with excess going to other users on the grid.

With the exception of the 9.6 kWh "smoothing" battery bank, the system is entirely Australian designed and constructed with Australian equipment. As shown in the figure, the system includes a Bergey/Westwind 10 kW wind turbine and 48 BP Solar 75 Wp (3.6 kWp) solar modules feeding 96 volts into a 12/16 kVA Butler Solar/Siemens Sunsine grid-synchronous inverter (415 V 3-phase, 50 Hz AC sinusoidal).

There are three microprocessors which control the three-phase inverter and system. These microprocessors monitor the state of the system and any one may order a disconnection if it detects a serious system problem.

The wind turbine is a three blade, horizontal axis permanent magnet rotor unit which auto-furls in extremely strong winds.

In the next phase of the project, the solar array will be expanded onto the roof of the BESD building. The next 48 panels will be Solarex 83 Wp and financed by supportive individuals and organizations at A$ 600 per 75 Wp panel. Customers are being invited to purchase a solar module and add it to the system. Then "Solar Energy Credits" will be given on the electricity account on the basis of the actual power generated. Credit will be 15.02 c/kWh, being 80% of the Commercial E tariff (businesses with little overnight or weekend consumption) which is currently 18.77 c/kWh. Output from a A$ 600 purchase is expected to be 10 kWh per two months billing period in winter rising to 15 kWh in summer.

Customers can also "tick a box" in their electricity bill and pay an extra $ 2 (or $ []) towards solar modules.

Brunswick firmly believes that rather than talking about renewable energy, we need to go out and harness it. By involving the community, it will enable people to help build an environmentally sustainable future.

For further information contact:

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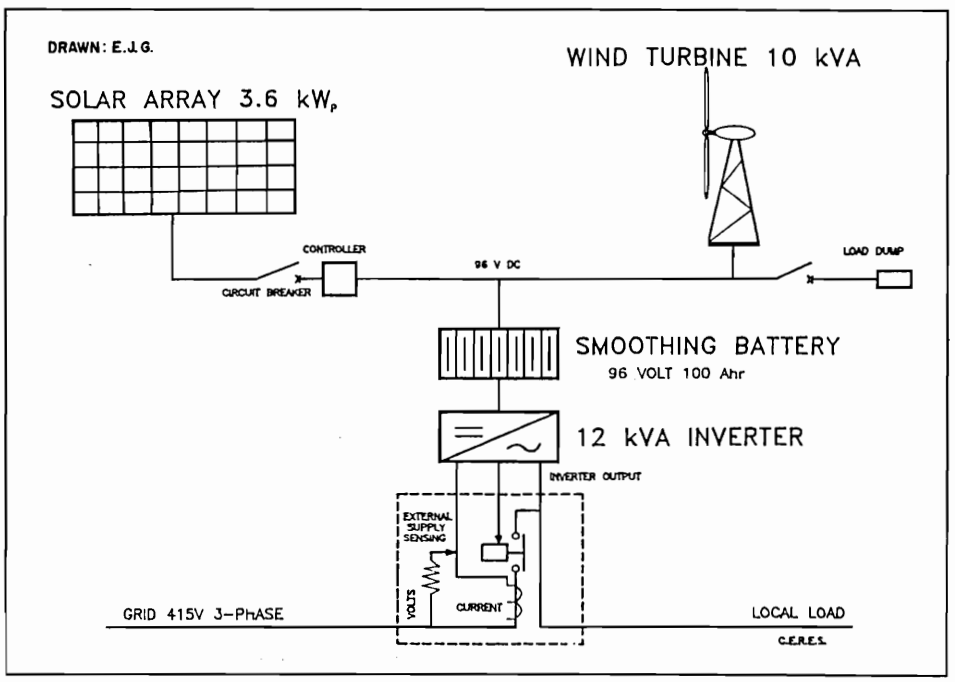
(Extracted from "Brunswick's Grid Connected Renewable Energy System", *Solar Progress*, Vol. 14, No. 3, p.19.)



Schematic diagram of the Brunswick's grid connected hybrid system.

Thai-German Biogas Programme

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are high – about US$ 65,000 for a 500 m^3 plant that could treat wastes from 1,800 pigs. Some farms raise 10 times that number and more. However, the electricity from biogas offers better cost recovery the bigger the system becomes.

A difficult problem is that not all farms can use all their biogas. And excess gas production is too small to be bottled. Ideally, producers should be able to sell their gas as electricity to the Electricity Generating Authority of Thailand (EGAT). But as Dr Piyawat says, "At the moment, EGAT prefers to deal with only large producers such as sugar refineries".

However, everything may yet work out. Gas volumes could be large enough to receive proper attention. In any case, even partial gas use represents at least some cost recovery and a cleaner environment.

(Extracted from "A Bigger Role for Biogas", *Biogas Forum*, 1993/III, No.54, pp.7-9.)

Biodiesel Prospects

Biodiesel, a new fuel, is entering the competition as petroleum refiners face new sulfur and aromatics limits. Derived from vegetable oils and animal fats, it emits far less of most regulated pollutants than standard diesel.

"Biodiesel contains virtually no sulfur or aromatics, and substantially reduces emissions of carbon dioxide, hydrocarbons and particulates," says Kenlon Johannes, executive director of the National Soy-Diesel Development Board (Jefferson City, Mo.). In fleet tests in more than 50 cities worldwide, biodiesel has matched diesel's performance as far as power, fuel mileage and engine wear.

So far, more than 200,000 m.t./yr of production capacity has been installed in Europe, with a further 500,000 m.t./yr planned by 1995.

However, biodiesel costs nearly twice as much as diesel in the U.S., and government subsidies would be needed to make it competitive. As a new fuel, it may also pose new emissions problems.

Subsidies in Europe

In the European Community, biodiesel's major attraction is its proposed exemption from fossil-fuel taxes. The EC proposal aims to limit taxes on biofuels to 10% of those on fossil fuels, thus making the price of the two about the same. So far, in Austria, Germany and Switzerland biodiesel has been exempted from all sales and road taxes. In France the tax is 25% of that for diesel. In addition, direct subsidies are also given to farmers for oilseed cultivation for energy use.

However, emissions reduction claims for the fuel are now in question. According to a life cycle analysis recently completed by Germany's Federal Environment Office (UBA, Berlin), rape seed methyl ether offers a 65% advantage in gas emissions – on a CO_2 basis – when compared with standard diesel. But when other greenhouse gases such as nitrous oxide and methane are included in the analysis, its advantage slips to 35%.

UBA argues that higher nitrogen oxides emissions from the intensive farming required to produce the oilseed crops diminish biodiesel's overall impact on greenhouse gas emissions.

In the 1980s, scientists solved viscosity problems of vegetable oils by esterifying them, converting branched triglycerides into linear monoesters that are like the straight hydrocarbons in regular diesel.

Vegetable oils are first filtered, then degummed and refined by alkali, to remove free fatty acids. Then, a 90:10 ratio of oil is combined with a mix of alcohol (methanol or ethanol) and catalyst (sodium or potassium hydroxide) in an agitated reactor. The process can be batch or semi-continuous. Glycerine and ester products can either be recovered and distilled or reclaimed by flotation, settling or centrifugation, after which the product is washed.

Cutting Costs

Ways to cut the cost and improve the quality of biodiesel include increasing yields of vegetable oils, using less-expensive and waste oils, improving the esterification production process, and producing a biodiesel with a lower glycerine content.

For example, a Sequential Extraction Process, developed at Iowa State University (USA), is increasing yields of corn oil to 90%, up from 72% for traditional corn-milling routes. In this process, dried corn is contacted with 97% ethanol at 75°C in a series of countercurrent extractors, using a 2:1 solvent-to-corn ratio. As the oil is extracted, the dry corn absorbs the water in the alcohol, dehydrating it. The extracted oil plus alcohol is sent to an evaporator to vaporize the alcohol, leaving behind pure corn oil.

At present, soybean oil sells for about $0.21/lb, and biodiesel produced from it costs about $2/gal. As ester products generally cost about ten times more than oil feedstock, the producers are also looking at using cheaper feedstocks.

Concerns over cholesterol and saturated fats are likely to leave a cheap, plentiful supply of animal fats – one low cost alternative – 13.5 billion gal of which are generated in the U.S. each year. They now cost around $ 0.1/lb.

A process, developed by GraTech, Inc. (Leawood, Kan.) can make biodiesel out of any feedstocks – either separately or in mixtures. In contrast to conventional batch or semi-continuous transesterification, GraTech's process is continuous, operating at under 200°F and less than 50

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Biodiesel vs Diesel #2

Properties	Soybean	Rape seed	Diesel #2
Cetane rating	52.0	54.5	47.8
Flash point (°C)	171.0	83.9	80.0
Cloud point (°C)	1.1	–2.2	–12.2
Pour point (°C)	–1.1	–9.4	–28.9
Viscosity (cs) at 40°C	4.1	6.0	3.2
at 100°C	–	2.4	1.26
Sulfur (wt. %)	0.04	<0.005	0.29
Density (kg/L)	–	0.874	0.852
Heat of combustion (kJ/kg, gross)	38,460.0	35,375.5	38,536.6

Source: University of Idaho.

Promising Future for Renewable Power – Australia

According to Dr Mark Stevens, an Australian energy expert, renewable energy could provide 30 per cent of Australia's power demand within 30 years. And by then the cost of electricity from a combination of renewable and traditional sources could be only 10 to 15 per cent higher than at present. "This relatively small difference would be less if the environmental costs associated with producing electricity by burning fossil fuels were included in its costing," he said.

At present, only about 11 per cent of Australia's electricity is generated from renewable sources and these are concentrated mostly on two hydro schemes, in Tasmania, off the southern tip of the mainland, and in the Snowy Mountains of south-eastern New South Wales.

Although declining, the cost of electricity from renewable sources is still considerably more expensive per kilowatt-hour than that from coal or gas-fired plants. Moreover, most Australian electricity authorities have an excess of generating capacity. "This means there is little scope for introducing new power plants before the turn of the century," Dr Stevens said. "However, as ageing coal-fired plants come up for replacement and as the cost of renewable energy technologies becomes more competitive, the opportunities for renewable technologies will increase."

Dr. Stevens believes solar energy, Australia's most abundant natural resource, will play a key role in the future power needs of the country. And some form of energy storage is also needed to provide a reliable electricity supply at night or during cloudy periods.

(Extracted from "Expert Predicts Viable Future for Renewable Power in Australia", *Urja*, Vol. 34, No. 1, July 1993, p.49.)

Soybean Oil-Diesel Mix for City's Trolley

In Owensboro City, Kentucky, USA, the mixture of soybean oil and diesel is being used on an experimental basis in one trolley. If things work out, other buses will be switched to this soy-diesel. No modifications to vehicles are needed.

Several other cities across the country, including Cincinnati and Evansville, Ohio, are using the product.

Owensboro conducted extensive tests before trying soy-diesel. The advantages of the fuel include reduced emissions and less odor.

The Kentucky Soybean Association (KSA) has agreed to help underwrite the cost of the program by paying the difference between what the city is paying for petroleum-based diesel and the soybean-diesel.

"Nobody's going to pay $2.4 a gallon when they can get it for $1, and we can't do it forever," said Debbie Ellis of KSA. However, producers hope to increase demand for the fuel with programs like the one in Owensboro.

The KSA's goal is to increase awareness of the product and the demand for soybeans and ultimately increase prices that farmers receive for their crop. As the initiatives continue toward cleaner, less toxic fuel, the price could go down.

(Source: Extracted from "Cleaner Soy Oil-Diesel Mix Powering Ky. City's Trolleys", *Journal of Commerce*, October 18, 1993, p.3B.)

Biodiesel Prospects

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psi. The system cuts reaction time from hours to minutes, reducing processing costs by one-third to one-half.

Cutting Glycerine

A prerequisite for any biodiesel is low glycerine because traces of the chemical can clog injection nozzles during combustion. Austria has been first to set a national biodiesel standard with a maximum of 0.25% and 0.03% for total and free glycerine, respectively. In 1993 these limits will be tightened to 0.24 and 0.02%. A similar proposal is currently being reviewed in Germany. U.S. companies are informally following Austria's lead.

Meeting Austria's standards is a potassium hydroxide-catalyzed process developed by Vogel & Noot GmbH (Graz). Other processes are reducing glycerine content by more closely controlling the phase separation step.

In a process being developed by researchers at Canada's Saskatchewan Research Council, transesterification is eliminated entirely, and fatty acids are directly converted into normal paraffins. The process uses a standard nickel-molybdenum catalyst and runs at 360–380°C and between 600 and 1500 psi. Overall product cost, at $0.18–0.20/L, is the same as that of diesel's.

Whatever the outcome of the controversy over cost and performance, biodiesel is carving a niche for itself in the fuels market.

(Extracted from "Vegetable Oils: From Table to Gas Tank" by Jayadev Chowdhury and Ken Fouhy, *Chemical Engineering*, February 1993, pp.35-39.)

Power from Bagasse

Generating electricity from waste biogas in an integrated-gasifier combined cycle plant can turn a sugar mill into a power plant in a process being developed by Brascep Engenharia Ltd., a Brazilian engineering and construction firm. The process was presented at the first Biomass Conference of the Americas, held in Burlington, Vermont, USA from August 30 to September 2.

A $75-million, 30-MW demonstration plant to prove the concept is planned to start next year in Bahia State. Funds for the project come from the Global Environmental Facility, a World Bank-United Nations Development Program venture, Shell do Brasil, Electrobras, and industry (all

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SMALL SCALE WIND ENERGY SYSTEMS

Published with financial support from the Netherlands Minister for Development Cooperation
Editors: Goezinne & Veldkamp, Renewable Energy Consultants

EDITORIAL

Practically all the news in this edition of 'Small scale wind energy systems' is wind pumping news.

Wind pump R&D is inspired by the desire to design a reliable, cheap machine that can be locally made. The major problem lies in the conflict between reliability and cost effectiveness, with local production as a major variable. It is a tantalising problem, explaining the continuous quest for the ultimate wind pump design.

Nevertheless wind pump R&D budgets are not something to tell your children about. With all the effort already put in, with not too many success stories, is difficult to convince policy makers of yet 'another R&D program'. We probably have to wait for some 'major technical break-through' or some successful field projects before R&D will be on the payroll again.

For those that do not believe that successful projects exist, please read the article 'Winds of Fortune in the Sahel'.

Frank Goezinne/G&V

The Phoenix of Wind Baron – Navajo and Mozambique

The business of Wind Baron, producers of a "cadillac" windpump has been very turbulent. By 1984 they had developed a high quality system with a counterbalance designed to use very light winds. The then Chairman of the Board, Richard Sutz, explained that the design had been conceived to address the problems of water lifting on Indian homelands. In the Navajo homeland, ground water was at 300 m depth and at these depths the conventional "traditional American multiblade" windpump had difficulty starting, even when fitted with a very small pump. The Wind Baron Mark IV was fitted with a dramatic counterbalance at the top of the tower. The large counterbalance mass was working off the pump rod, so the resulting structure had to be very strong. This led in turn to a high price for the machine.

Potential users around the world remained sceptical that the costs were justified. Although some "one-off" machines were installed in Mexico, Botswana, and the Navajo, Wind Baron never reached a large market and had to cease production for a while. Even so, one system was installed at the Lethbridge test site, and the company worked with the researchers to improve the design. The biggest design change came with the inclusion of a shaft mounted rotary counterbalance subsystem.

Revived Hope

In about 1989, the companies' hopes were revived by the possibility of a Senate bill asking USAID to prioritise wind energy for their work. Production started again in 1990, with a new system called the Softwind. Softwind, because the windpump starts in unbelievably low winds even on a large pumping head. 1990 saw the installation of a Softwind at the Genado Test Station in the Navajo nation, AZ, USA. This system performed well and resulted in an order for 20 machines fulfilled in 1992 from the local government. Thus Wind Baron flies again, fulfilling its original aim of serving the Indian homelands.

Meanwhile the Softwind, with a 6.4 m diameter completed a season of tests at the Lethbridge Site. It performed well with none of the early problems with downtime. During the 18 week test, the system pumped 6,000,000 US gallons and only shut down for minor repairs. Its total availability was 98.4%, which is above the average for the other machines on the site. It should be noted though, that the head for the test was only 5.5 m, and even with the large diameter pump, this is not the same as having a deep lift. In the Navajo, the systems are on deep heads.

However Wind Barons chequered history was not to be shed off so easily. In 1992 Wind Baron was also considered for application in Mozambique. USAID, sought to purchase 50 windpumps for their water development programme. The partner NGO looked at the systems, and thought that they may be applicable. At the last minute USAID decided not to fund the programme, and thus Wind Barons order books had a small set back. The industry will be watching with interest and hope, to see if Wind Baron can sustain its current flight.

Simon Batchelor/Gamos Ltd (UK)

POLDAW – A New Windpump for the Rural World

Under test in UK is a new windpump designed for MANUFACTURE and use in developing countries.

The two designers, Sandy Polak and Paul Dawson, have a strong track record in engineering design and in particular with windpumps. In recent years they have been involved with designing Formula One racing cars and the latest machinery for UK industry, and so it was with an eye for reliability and cost effectiveness that they turned their attention to the latest windpump. Their promotional information for manufacturers and agents says "The POLDAW windpump has been developed as a very low cost machine which nevertheless achieves high standards of reliability and robustness. It has been designed for easy manufacture using universally available components and material sizes. The low cost brings the advantages of windpower within reach of a wider range of purchasers than ever before".

It was their concern to bring windpower to the reach of as many people as possible that prompted Polak and Dawson to design this latest machine. In the early 1980s' they were part of M Neale Consulting Engineers Ltd, who were awarded the contract to "finish off" the IT Windpump. As part of that contract from the British Government and managed by IT Power, Paul Dawson worked in Kenya for many months with Kijito Windpumps. Kijito had taken the IT design and invested heavily to develop it to a standard suitable for Kenyan conditions. Paul Dawson developed further the design of the Kijito, and worked with Merin Limited in Pakistan to "complete" the IT Windpump Package. Over the following decade, both Dawson and Polak conducted a number of consultancies for IT Dev Tech, the UK lead for the IT Windpump. The history of the IT Windpump is complex and the relationship of the various players to each other is not always clear, however Paul Dawson became a strong friend of Kijito and has continued to have technical input to their activities. Sandy Polak, also had a considerable input to the development of the IT Windpump Package. Recently he provided technical support to Stewarts and Lloyds in Zimbabwe.

Building a New Windpump

But the IT Windpump is of 6 metres diameter, and while its cost is justified in many deepwell situations, both Polak and Dawson were left with a desire to see a lower cost smaller windpump suitable for wider use. For some years they tried to interest a number of agencies, including ITDG, but for one reason or another no agency would rise to the challenge. So using private funds they went ahead anyway.

The result is a 3.5 m diameter windpump with 12 blades. Sitting on a 6 m, 3 leg tower, the system can start in a minimum 3 m/s windspeed and is fully protected up to 50 m/s survival winds. The rotor at 55% solidity is a compromise between the traditional multiblade which typically has an 80% solidity, and the modern Dutch designs which have solidities of 40%. This means that the machine can be a direct drive without gears, running at a typical speed 50 rpm, with a maximum of 110 rpm. Protection from over running and storms is by turning the rotor on edge to the wind, thus presenting minimum area and minimising forces.

One of the unique factors in the machine is a novel use of bushes. Only three standard flanged ball bearings are used, and the remainder of the moving parts are supported by various wood plastic and rubber bearings and bushes. "This", Dawson says, "minimises the cost of bought-in components."

The brochure says the intended pump stroke is 100 mm and can be used with pumps diameters in the range 50 to 150 mm. Polak adds that "any reciprocating pump can be used. We have developed a sizing chart to allow the supplier to select the right size. We have also developed a range of shallow well pumps to complement the windpump. The system is counter-balanced to give optimum starting." As low as 3 m/s.

Under Test – the World is Waiting the Manufacturers Package

The first machine, under test in Somerset UK, looks the part. It is a sleek windpump which travels smoothly round, noiselessly. Set on a hill to give it a good test, the system has operated for a number of months with virtually no downtime. Of course, with a design life of 20 years, no one wants to wait the full 20 years to prove its application. With the expertise of professional consulting engineers behind it, the system should be ready for release by the time this is published.

What is most important to potential manufacturers, is that Polak and Dawson have not just created a one off windpump and then offered it to institutions for copying. They have from the start created a manufacturing package with drawings, material requirements, production manuals, installation manuals, etc. From their years of experience they know the value of hardware support. They can offer not just the design but the reasons behind the design. They have calculated weights of material (400 kg for the machine), times for manufacture (80 hrs per machine) and developed a package that is easy to implement.

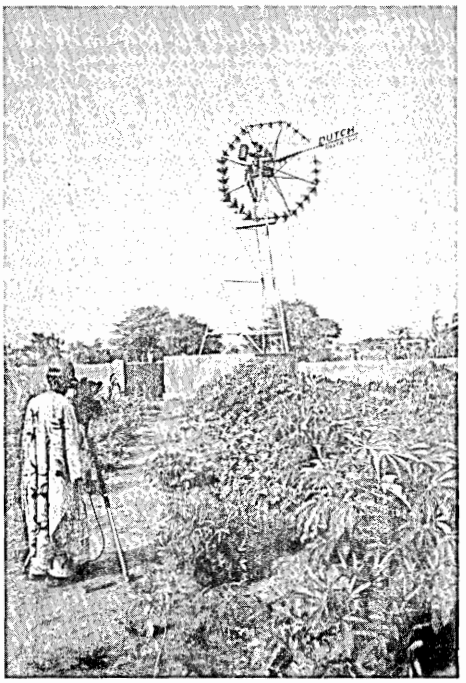
For manufacturers and agents interested in promoting this new machine in countries around the world, contact Mr S Polak, Neale Consulting Engineers Ltd, 43 Downing Street, Farnham GU9 7PH, UK. Fax 44 252 737106.

Simon Batchelor/Gamos Ltd (UK)

Winds of Fortune in the Sahel

As the dry Harmattan winds continue to erode the sandy soils of the Sahel some communities have begun to fight back against the desert and more may follow. Wind pumps for small scale irrigation are beginning to create small pockets of green that represent a step towards environmentally sustainable development and most important for many in these impoverished communities the wind pumps make money.

Six years of study and application of wind pumping technology has recently been completed by the University of Waterloo and its Sahel partners in Niger, Burkina Faso and Mali. The results show that wind pumps can provide an effective and reliable water supply system that can be managed at the community level.

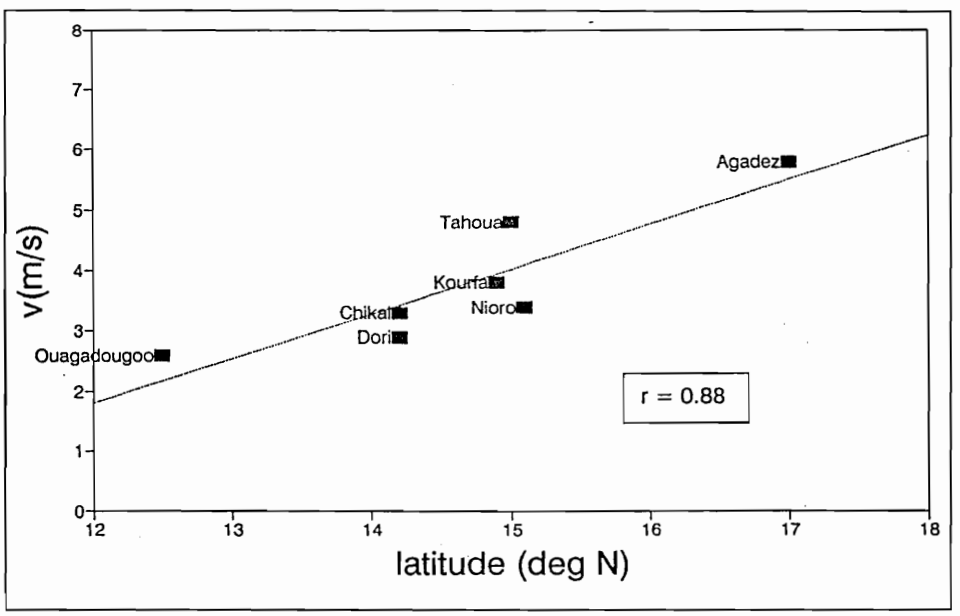


Delta 16 windpump (Nioro, Northern Mali).

Resources and Matching

Wind resource mapping with 11 automated data loggers now provides six years of detailed information on wind regimes across the Sahel. Mean windspeeds show a strong correlation with latitude increasing from 2.5 m/s at Ouagadougou in the south (12.5 N) to 5.5 m/s at Agadez in the north (17 N). Exploitation of the wind energy resource particularly for water pumping is viable over most the Sahel. While annual and inter annual variations exists the extensive data base now available enables two site correlation techniques to be used to properly match rotors, pump size and storage capacities with local applications.

Irrigation of small, communal gardens represents the most frequent type of wind pump end use. For these cases the optimization of system components for wind patterns with significant diurnal variations (typical of the dry season garden period) has shown some unexpected results. With storage tank capacity set equal to mean daily output, reliability in water supply actually improves when the cut-in wind speed is increased from 1.1 to about 1.5 times the mean wind speed. This relatively high start up speed allows the system to operate more efficiently during the stronger mid day windspeeds and provides for the most cost effective installation.



Mean windspeeds vs latitude (7 stations, January 1991).

Wind Pump Testing

A variety of classical (Aermotor, Dempster, Southern Cross) and modern (Dutch Delta 12, Kijito, CWD 5000) wind pump designs have been tested and found to be technically viable when properly maintained even under the extreme dust conditions.

A survey of 37 wind pump sites across Niger showed that the majority of repair problems were below ground and included worn or failed pump seals, and rusted or damaged rods, couplings and pipes. Service and repair of below ground components has become the main theme of the post installation program.

The local manufacture of wind pump equipment is being initiated carefully. The attempted commercialisation of prototype designs has in some parts of the Sahel led to major equipment failures and discouraged the use of wind pump technology in general. Quality control in manufacture and quality in provision of timely and cost effective service will be critical for any successful manufacturing operation. A joint venture is now under way to link an international commercial manufacturer (Dutch Industries, Canada) with a local Sahel company (PTE – Sahel Tech) to establish local sales, service and eventual manufacture of wind pump equipment.

Socio-economics

The sustained commercial revenues from the wind pump/garden activities provide the economic basis for wider use of wind pumps. The communities surveyed have consistently demonstrated

Cont. P. 4

Winds of Fortune in the Sahel

From P. 3

an ability to generate revenues in excess of US $ 4000 from the communal harvest allowing for repayment of all investment costs for most sites within a 2 year period. Over 90% of the garden produce is marketed locally without the need for transportation infrastructure, storage facilities and the ability to compete in the frequently over supplied urban markets. The monetary gains from the wind pump garden programs provide both the means for covering repair costs and the motivation to overcome the social and organizational difficulties that frequently plague communally managed water supplies.

Most of the 60,000 water points across the Sahel remain under utilised and represent a significant potential market for wind pumps. Improved access to commercial credit allowing for the installation of wind pumps on a cost recovery basis will be a key factor in helping develop this market.

Training and Capacity Building

Capacity building has been a key factor in the success of the Waterloo project with emphasis on developing the human skills and institutional structures required to advocate, install, and maintain wind pumps as well as the ability to deliver user level training. With these capabilities in place the prospects for expansion of wind pumping technology in the Sahel appear to be good.

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RED Reading Train on Windpumps

Renewable Energy Development (RED) from the Netherlands, and Reading University, UK, recently teamed up to train engineers in windpump design and end use. The engineers came from Pakistan and the Philippines. In the case of the Philippines, one of the participants was a manufacturer. The course involved all aspects of windpumping. Technical subjects included both the aerodynamics of rotors and fluid dynamics of pumps, however Dr John Burton emphasised to the students that the "pump wears the trousers"! During the lectures and tutorials Dr Burton refers to an English expression regarding marriage, the person most dominant in the coupled relationship is said to "wear the trousers". The students were left in no doubt that the pump cannot be left as an after thought, but should be the starting point of any technical design discussion.

Hardware – Software

Of course, the hardware is only a fraction of the necessary process for successful implementation of windpump programmes. Jan De Jongh, manager of Red, conducted extensive tuition on the software aspects of successful programmes. Jan De Jongh taught on the socioeconomics of programme planning, conducted role play games regarding feasibility studies, and reviewed the global market including both the supply and demand. Having been involved with the recent Halcrow Market Study, Mr De Jongh was able to give the students a very up to date picture.

Supplementing the input from both Red and Reading, the POLDAW team also shared their insights into successful windpump application (see accompanying article). The POLDAW team recently designed and built a new lightweight windpump for local manufacture. The students went to see the new machine, and favourable comments were received.

All in all, the course was evaluated by the students as a success and they hoped that many other engineers and decision makers have the opportunity to study such a complex but important subject.

Simon Batchelor/Gamos Ltd (UK)

Course on the Implementation of Wind Energy

The third international course on the implementation of wind energy of RED/ECN will take place from 21 March to 1 April 1994 in the Netherlands. The course is primarily intended for decision makers and project managers. Educational level: Bsc. technology or economics. The course addresses wind resource assessment, planning, pre-investments studies, technology assessment, manufacture and O&M. Practical work is part of the course as well. The course fee is Hfl 6.450 (approx. US$ 3225). This fee includes board and lodging, course material and two excursions. For information please contact C. Looijestein, ECN, P.O.Box 1, 1755 ZG Petten, The Netherlands. Tel:+31 2246 4459. Fax: +31 2246 3483. Telex: 57211 REACP NL.

Frank Goezinne/G&V

Citation is encouraged on the condition that the source is indicated.
Reactions or other contributions are welcomed. Please write to:
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Family-Hydro Units in Vietnam

Many areas in Vietnam are not expected to have grid extension due to the high costs. It is mainly in these regions that individual families have turned to family-hydro units to get electricity for lighting and for charging batteries, which are subsequently used for lighting or sometimes television.

The majority of the equipment available in Vietnam is imported from China, though similar equipment is now being manufactured in Vietnam. The Renewable Energy Research Centre (RERC) in Hanoi is currently producing 200 W and 1 kW family-hydro sets, which are sold for US$ 75 and US$ 350 respectively. These are more expensive than equivalent Chinese equipment, but they supply more power and are more efficient.

The cost comparison of different equipment available in Vietnam is presented in the table (the price does not include draft-tube or piping). However, the Chinese equipment is often rated at a higher capacity than that which it can actually deliver. In the test, for example, the maximum output obtained from one Chinese set with 200 W stated capacity was only 84 W (0.4 A, 210 V), while Vietnamese equipment provided approximately 200 W (1.0 A, 200 V). The RERC equipment is not yet as popular as the Chinese equipment because it is new to the market and more expensive for its stated capacity.

Family-hydro equipment available in Vietnam.

Turbine Type	Origin	Power (W)	Head (m)	Flow rate (m^3/s)	Cost in VN (US$)
Propeller	China	100	1-2	0.015	28
Propeller	Vietnam	200	1.5-2.5	0.020	75
Turbo	China	250	6-15	0.005	32
Propeller	Vietnam	1,000	2-4	0.080	350

The most popular models are those in the range of 100 to 200 W, requiring a 1.5 – 2.0 metre head to provide a 220 V a.c. output. In comparison to the 1 kW model, the 100 W model has a lower efficiency and higher cost per unit of energy. But the cost of the 1 kW model (US$ 350) is about twice that of the annual income of a typical Vietnamese. The 1 kW unit has been shown to have a payback period of under a year when the electricity is sold within the village.

The Chinese equipment comes in two forms, one using a fixed blade propeller with guide vane and the other using a turbine similar to a turbo. Often bamboo is used as piping for the latter model, which requires a head of 6-15 metres.

The generators are six-pole permanent magnet machines, providing a 220 V a.c. output. The RERC 1 kW also provides a 12 V d.c. supply. Most family-hydro units typically have no governing or protection devices, and thus the voltage varies greatly with the load. A flow regulator is provided with the turbo machine.

Installation is relatively easy and the majority of individual families have set up the equipment themselves without expert help. Often the site conditions available are not used to their greatest capacity, but the advantages of not having to rely upon distant organisations or engineers normally outweigh the disadvantages.

The popularity of the family-hydro units is due to their low cost and easy installation. There are many reports that suggest that the Chinese models are mechanically unreliable, but even if one works for only 15 months, it can be a cheaper option than battery charging at a nearby village as shown below.

Batteries are charged from diesel sets for typically VND 2,500 (US$ 0.23) per charge for a 60 Ah, 12 V battery (at best, this is equivalent to US$ 0.33/kWh).

A typical family-hydro unit may supply 100 W for 3 hours/day, normally for lighting. At a price of US$ 28 for the set (US$ 280/kW), if maintenance and operation costs are assumed to be negligible, the purchase of a family-hydro unit would be economical, compared with battery charging, if it operated for at least 15 months. It is clear that family-hydro can often be the cheaper option than the other sources of electricity.

However, for most rural Vietnamese these costs are still very high and only the more wealthy can afford them. Usually the lowland rice farmers have a higher income than those in the highland areas, that is why the low-head version is the most popular model. The Vietnamese authorities are reportedly providing subsidies in some districts for people buying the Chinese units, and the Renewable Energy Research Centre in Hanoi has been subsidising most of the units it has sold within the country.

For further information contact:

RERC
Hanoi National Institute of Technology
1 Dai Co Viet
Hanoi, Vietnam

(Source: Extracted from "Family-Hydro in Vietnam", by J.P. Green, *Hydronet*, 2/93, pp.2-3.)

Power from Bagasse

From p. 10

in Rio de Janeiro).

In this process, bagasse chips (2–2.5 inches in size) are dried to 30 % moisture and gasified in a pressurized fluidized bed at 800–900°C and 30 bars. Then the gas is cooled to 450°C to condense out the alkalis, and the clean gas is burned in a turbine to produce electricity.

A 340 m.t./h sugarcane plant can generate 80 MW, of which 10 MW is consumed by the mill itself. The remainder can be sold to external utilities, bringing $30 million revenue a year in comparison to $ 25 million from sugar production.

(Extracted from "A Power Plant with a Sweet Tooth", *Chemical Engineering*, Vol. 100, No. 9, p.23.)

Big Wind Development Project – Argentina

Argentina is entering the field of wind development. On September 2 the province of Buenos Aires announced plans for the connection of 500 MW of wind power to its electrical grid. More than half this amount will be financed by private investors and developed in small projects. The remainder will be developed by the Buenos Aires utility (ESEBA).

Danish wind turbine manufacturer Micon A/S is a major player behind the announcement. For the past three years the company has assisted ESEBA and the provincial authority to develop a detailed strategy for wind energy development. An important component of this strategy is an agreement granting projects with Micon turbines exclusive rights to power purchase contracts for sale of 500 MW of wind power to the grid for a specified time span. Micon considers it as "the largest ever power purchase contract for wind produced electricity."

The 500 MW contract was signed by the director of ESEBA, Hugo Flombaum, and by the director of Micon's Argentinean subsidiary, Svend Enevoldsen. The agreement does not prevent other wind companies selling wind turbines in Buenos Aires, says Mr Enevoldsen. But they would be unable to obtain power purchase contracts.

According to Mr Enevoldsen "Argentina is not interested in just buying wind technology. The country's aim is to develop its own wind power industry and our role is to help them do that." A major part of the agreement is transfer of wind turbine production and Danish wind know-how to Argentina. This must be achieved by the time the first 100 MW of Micon turbines are installed in the country. The aim is to produce turbines at a Micon-owned factory in Argentina. The 500 MW project will start with a 20 MW ESEBA wind farm of Micon turbines, to be installed 50 km west of Mar del Plata, a coastal resort.

Outside the framework of the 500 MW contract, Micon is also currently installing a 10 MW wind plant in the southern province of Chubut. The project is a joint development between the local utility, Micon and Denmark's programme for industrialisation of developing countries (IFU).

Argentina's interest in wind power has been stimulated by the recent privatisation of the power sector, a desire to diversify its resource base, and in recognition of the environmental advantages of renewable energy.

The country's power system is made up of a mixture of hydro (6610 MW), thermal (10,172 MW), nuclear (1018 MW) and 1 MW of geothermal. The relatively large amount of hydro gives the system a big inherent storage capacity, making it particularly suitable for absorption of a fluctuating energy source, such as wind. Total annual demand for power is 42,288 GWh.

Micon has so far identified a site for a 200 MW wind plant in the south of Buenos Aires province. The remainder of the 500 MW will be developed mainly as clusters of wind turbines from 5 MW to 50 MW.

The Danish model has significant influence on Argentina's wind power strategy. Much of the 500 MW is to be built and owned by private electricity consumers. Micon will plan individual projects and then offer shares in these to private people. As in Denmark, investors will deposit cash into a wind co-operative bank account, reaping the rewards later in the form of "free" electricity.

In Argentina, investment in wind power is a good business. "The cost of electricity ranges from 4 to 30 cents at the fringes of the grid. There is no need for subsidies or other financial stimulation, just a market framework", says Mr Enevoldsen. "What makes wind power seem expensive is financing the high capital cost of development. If the money does not have to be borrowed we could produce power for one cent a kilowatt hour", he adds. Financing of the large scale wind plants will be through Argentinean pension foundations, says Mr. Enevoldsen. They see the power supply system as a secure investment area and are prepared to offer attractive financing.

(Extracted from "Argentina Announces Huge Wind Development Project" by Lyn Harrison, *Windpower Monthly*, Vol. 9, No. 10, October 1993, pp.16-17.)

High Geothermal Potential New Zealand

According to a recent estimate, the geothermal potential in New Zealand may be as high as 4770 MW and it is capable of providing base load generating capacity.

Several small projects, ranging from 10 to 30 MW, are likely to go ahead in the country in the near future, says the managing director of consultants Geothermal Energy NZ.

Last year a private company signed a contract to supply Trans-Power, the newly privatized grid company, with electricity from a 35 MW geothermal plant near the government owned units at Wairakei and Ohaaki. Mauri landowners are also planning a 110 MW plant near Rotorua in the centre of North Island.

New technologies, such as the Kalina cycle which is expected to be available next year, are making geothermal power more economical.

According to the company, a 25 MW geothermal power plant can generate electricity at a cost similar to a gas fired plant and cheaper than coal or hydropower.

Geothermal power should be considered as a good means of entry into the long term energy market, suggests Geothermal Energy NZ.

(Source: Extracted from "Geothermal Potential Approaches 5 GW", *Modern Power Systems*, Vol. 13, No. 9, p.12.)

Wind Power Test Programme USA

Three US utilities, namely Green Mountain Power of Vermont, Central and South West Corp, Texas and Central Maine Power have been selected as hosts for a national wind power programme by the US Electric Power Research Institute (EPRI) and the US Department of Energy (DOE). The goal of the programme is to assure commercialization of wind power plants capable of supplying electricity at a competitive price.

Next year two more utilities will be selected as part of the second phase of the programme.

The object of each phase is to fund projects that will have at least 6 MW of wind power plant with 20 advanced turbines at each site. Such turbines which are subject to testing will incorporate improvements such as more efficient blades, lighter materials, streamlined designs and fewer parts for reduced weight and cost.

The electricity generated by most of the 17,000 turbines in the USA costs between 7 and 9 cents per kWh. By the end of the decade, with improvements in technology and plant operation, the price should come down to 4 cents/kWh in most parts of the country.

Green Mountain Power will get $ 3 million for an 8 MW wind power plant. The utility presently has two wind turbines which have been tested under harsh winter conditions since 1989.

Central and South West receives $ 2 million towards the cost of a 6 MW plant in the far west of Texas to improve its current understanding of the technology.

Central Maine Power gets $ 1 million for a project with US Windpower in Maine. A 250 MW facility is envisaged and the first 30–50 MW could be in operation by 1995.

DOE and IPRI will assist utilities with installation, site operation, and performance evaluation. The utilities will take the lead in selecting specific project sites and wind turbines.

(Source: Extracted from "Three Utilities Benefit from Wind Power Test Programme", *Modern Power Systems*, Vol. 13, No. 9, September 1993, p.12.)

Waste Heat Recovery Project in India

The first major waste heat recovery project in India is scheduled to be commissioned by January 1994 at the Uran gas turbine power station owned by the Maharashtra State Electricity Board (MSEB). The scheme comprises four waste heat recovery boilers downline of four existing 108 MW capacity gas turbines, two 120 MW turbo-generators and other equipment such as water treatment plant, fire fighting equipment and transformers. Without using any more fuel, 240 MW additional power will be available from the station.

In September 1993, the first boiler was commissioned, by January all four boilers and two turbo-generators will be in operation. One of the special features of the project is the installation of direct air-cooled condensers for cooling steam from the steam turbine exhaust.

The contractors for the project are Siemens AG and Siemens India. Out of the Rs 8.5 billion (US$ 283 million) cost, the foreign exchange component is Rs 6 billion (US$ 200 million) which is being financed by an equivalent credit from Germany.

The MSEB is planning similar combined cycle power stations at different locations in the state, subject to gas being made available by the central government.

(Source: Extracted from "Waste heat scheme gets set", *Power in Asia*, 27th September, 1993, Issue No. 135, p.12.)

200 MW Geothermal Power Plant Philippines

The state-owned NPC has signed a 25-year contract with the Philippines National Oil Corporation (PNOC) for the development of the 200 MW Tongonan geothermal power plant on Leyte.

Under the build-operate-own (BOO) contract, the PNOC's Energy Development Corp. will sell electricity to NPC for 1.65 pesos per kilowatt-hour. The power generated will be supplied to the Cebu grid. The BOO contract is necessary because the NPC has the sole right to produce power in the Philippines.

According to the contract, the PNOC is mandated to finance, design, manufacture, supply and maintain the power plant and produce at least 1,370 gWh to the NPC for the first year of operation.

The PNOC has contracted out the power plant component of the project to the private sector under a build-operate-transfer scheme signed earlier. The 130 MW Upper Mahiao area was awarded to Ormat Inc. of the US, while the 70 MW Malitbog area was awarded to Magma/Mission Energy of the US.

The development of the Tongonan power plant is part of the NPC's ambitious 200 million peso Leyte-Cebu undersea cable interconnection project. The first transmission line circuit is expected to be in operation by March 1996 and the first generating plant by April 1996. The power plant complex is scheduled to be online by July 1996.

The project will cost $ 64 million, which will be borrowed from the World Bank. The NPC is expected to borrow $ 147 million for the submarine and overhead transmission lines.

The Leyte-Cebu project is the first phase of the $ 1.6 billion Leyte-Luzon interconnection project, which aims to bring 640 MW from the Leyte area to the Luzon grid.

(Source: Extracted from "PNOC Cleared to Sell Power into NPC Grid BOO Deal", *Power in Asia*, 27 September, 1993, Issue No. 135, p.14.)

S$1 Million Electricity Saving in Government Buildings Singapore

Enery saving measures implemented in 30 government buildings in Singapore have helped cut electricity bills by S$ 1 million a year by achieving an energy consumption reduction of between 15 and 20 per cent.

The potential for savings in commercial buildings is also large. The Public Utilities Board has conducted an energy audit of 26 buildings and reported that an 8.8 per cent saving in electricity consumption could be achieved, largely through improving the air-conditioning systems.

These findings were reported in November 1993 at a seminar on Green and Healthy Buildings organised by the Centre for Building Performance and Construction at the National University of Singapore and the National Council on the Environment.

Turning out green and healthy buildings involves choosing the appropriate design and materials, using construction methods that will conserve resources and minimise waste, and installing systems that will optimise energy usage, minimise pollution and ensure good indoor quality.

The Public Works Department managed to cut the electricity bills of 30 buildings and 20 public facilities under the Island-wide Energy Management Network (IEMN) which cost S$ 6.8 million to set up. The IEMN control centre in the Ministry of National Development registers and manages the energy use in the complex, the Ministry of Labour, City Hall, eight libraries and the underpass below Nicoll Highway.

Besides timers and dimmers, energy-saving measures adopted include rescheduling the operating hours of the buildings' services and equipment to coincide with occupancy levels.

(Source: Extracted from "30 Govt Buildings Cut Electricity Bill by $1M a Year", *The Straits Times*, Friday, November 12, 1993, p.25.)

New Tubes Save Energy: Thailand

In September Thailand launched a major campaign to persuade consumers to switch to energy-efficient fluorescent tubes. This is the start of its 4.82 billion baht ($ 189 million) electricity saving programme. The campaign is aimed at reducing demand by 300 MW, or 1,097 GWH, in 1998.

With the campaign, EGAT would have no need to invest about 10 billion baht in new power plants, reducing the fuel bills by 640 million baht a year and cutting down carbon dioxide emissions from power plants by 1 million tons annually.

This is part of the larger six-phase demand side management (DSM) scheme which aims to reduce electricity demand pressure.

Power demand is expected to double by 10,000 MW in the ten-year period or 1,000 MW a year. The most recent peak demand of electricity recorded on July 27 was 9,730 MW. EGAT's total installed generating capacity was 12,079 MW at the end of the month.

The focus of the upcoming campaign is to replace the existing 20-watt and 40-watt fluorescent tubes with the new generation 18- and 36-watt tubes. The latter though consuming less power offer the same illumination as the former. Electricity saving for the new 36-watt tube is four watts as compared to the existing version and two watts for the 18-watt tube.

Five major fluorescent tube producers in Thailand have agreed to halt manufacturing the 40 watt and 20 watt tubes by September 1995. They also agreed to bear the cost of changing their production equipment to manufacture the new generation of tubes. The price of the new tubes would be about the same as the old ones.

Next immediate targets of this energy saving programme will be on air-conditioners and refrigerators. The entire DSM programme will be implemented from 1993 to 1997.

(Source: Extracted from "Lighting Scheme Aims to Cut Capacity Pressure", *Power in Asia*, No. 134, 13th September 1993, p.14.)

Storage Cooker for Small-scale Electricity

Most households supplied with electricity from a micro-hydro are not able to cook with conventional high power cooking rings, as there would not be enough power and anyway would be expensive. More and more micro-hydro schemes are being designed or modified to produce electricity for lighting, which means that there are peaks in the early morning and in the evening, but plenty of "off-peak" power available at other times. Thus, there is a need to develop a cooker which has low wattage and uses the off-peak electricity.

Intermediate Technology's micro-hydro team, in Nepal and UK, has developed an electric heat storage cooker, which stores off-peak energy and releases it when needed. The work has been funded by the Overseas Development Administration (ODA) since 1990 and Dulas Engineering has conducted the UK based R & D work. The 250 watt element heats up a small, insulated store of pebbles to around 500°C.

A small fan then blows air through the cooker, which is capable of reaching frying temperatures, and of boiling a litre of water in 10 minutes.

The cookers can be manufactured using local materials and skills. They can be used to cook two meals a day for a family of four adults.

Twenty cookers have been tested in two villages. Test results indicate that the cooker does reduce cooking time and cut smoke levels in kitchens. It also reduces fuelwood consumption considerably.

However, the poorest households probably cannot afford the cooker. Further technical investigation is required to reduce the cost of the cooker.

The technology is one of the best long-term options where wood is scarce and forest is to be protected.

(Source: Extracted from "Creating a Storage Cooker for Small-scale Electricity", *Appropriate Technology*, Vol. 20, No. 2, September 1993.)

$1.1 Trillion Investment Need – Asia

A study by consultants Arthur D. Little reports that Asia may need US $ 1.1 trillion of investment by 2010 to meet the rising electricity needs of fast-growing economies.

"This investment for power generation capacity alone is based on relatively conservative estimates of economic growth in the Asian region. It assumes yearly economic growth of five percent and annual growth in electricity demand of seven to nine per cent", says Dan Goldman, manager of Asian Energy Practice.

According to the International Monetary Fund, Asian economies will grow by an average of 6.75% in 1993/1994 versus almost 8% last year. Asia will require 720 gigawatts of new capacity between 1990 and 2010 to meet the requirements of its booming economies, Goldman said. China will need 40% of the new capacity to meet its soaring needs, India 15% and Japan 12%.

China and Japan account for about two-thirds of installed Asian capacity. "The sheer size of Chinese market cannot be ignored", Goldman said. Beijing has ordered authorities to implement all development plans for new power plants this year, warning that its economy will face a huge power shortage if work is not speeded up. At present, its power capacity is 165 million kWh, and China is targeting at least 280 million kWh by 2000.

Power outages have already crippled economic growth in the Philippines and threaten other Asian economies such as Thailand, Malaysia and Indonesia. More than half of Asia's new power plants will be coal-fired. "Coal will remain the dominant fuel for power generation but gas-based technology will share the strong growth," Goldman said. He sees few nuclear plants being built outside China.

Nuclear power development will be determined by environmental concerns in Japan and South Korea, and by high costs and security concerns in Southeast Asia.

Fears of power interruptions are increasingly setting priorities for international lenders and Southeast Asian governments. Indonesia topped the list of Asian Development Bank (ADB) borrowers in 1992 with $1.21 billion, including a $350 million loan for a single power project.

Some countries such as Malaysia and the Philippines are breaking state power monopolies, allowing so-called independent or private power producers to build new plants. "The Philippines is a classic example of a country where long-range planning was inhibited during the 1980s, causing insufficient capacity additions," Goldman said.

"The private power sector may be an efficient approach to meeting large capacity requirements in the future. Indonesia, Malaysia and Thailand are slowly moving in this direction in order to avoid the power shortages that the Philippines is currently facing," he noted.

(Extracted from "Asia Needs $ 1.1 Trillion Investment in Power Sector", *Progress*, Vol. XXXX, No. 2, September 1993, pp.1 & 8.)

Pollution-Free Vehicle

Chrysler Corp.'s Dodge Caravan has been certified by the California Air Resources Board (ARB) as the first electric vehicle produced by a major American manufacturer under its 1998 Zero Emission Vehicle rule. The van certified for sale as a 1994 model was built four years ahead of schedule.

Under the rule, 2 percent of all vehicles produced by California manufacturers must be pollution-free by 1998. And the figure goes up to 5 and 10 percent by 2000 and 2003 respectively.

The Dodge Caravan is powered by 30 six-volt batteries, either nickel-iron or nickel-cadmium, which have life expectancies of 100,000 miles and an operating range of up to 80 miles between charges. The van takes 27 seconds to accelerate from zero to 50 mph and can reach a maximum speed of 65 mph.

Despite some drawbacks, the caravan still represents a significant step toward the realization of the ARB's vision of reducing California's air pollution problems with pollution-free electric vehicles, says ARB Executive Officer James Boyd.

According to ARB estimates, an electric car with a 100,000-mile life is 200 times less polluting than the cleanest models running on any other fuel, even when power plant emissions are included.

As many as 40,000 new electric vehicles are expected to be sold by the 1998 deadline.

(Source: Extracted from "California Approves All-electric Dodge Caravan", *Public Utilities Fortnightly*, Vol. 131, No. 16, September 1, 1993, p.8.)

Molten Salts Cut Emissions of Toxic Gases from Incinerators

The National Renewable Energy Laboratory (NREL, Golden, Colorado), the US Dept. of Energy has cooperated with Rockwell International Inc.'s Rocketdyne Division (Canoga Park, California) to develop and commercialize a molten-salt oxidation process that can cut emissions of chlorinated organics from hazardous waste incinerators. Under a $4.4 million agreement, NREL is running tests on a 6-in. diameter unit to generate design data for piloting the process in the summer of 1994. Rockwell will provide conceptual designs and economic analysis.

The new process eliminates the need for a costly wet scrubber by treating the hydrogen chloride (produced during incineration of chlorinated organics) with metal carbonates. Moreover, a low reaction temperature (700–800°C) minimizes the genera-

Cont. P. 16

Molten Salts Cut Emissions of Toxic Gases from Incinerators

From P. 15

tion of nitrogen oxides and permits the use of relatively low-cost construction materials.

In the bench tests, molten salt (the eutectic mixture of the carbonates of sodium, lithium and potassium) is introduced at the top of a column equipped with a 91 cm high bed of 1.59 cm stainless-steel rings. The air containing about 5,000 ppmv each of such test organics as trichloroethylene, methylene chloride, and carbon tetrachloride, is preheated to about 500°C and introduced at the base of the column. After flowing upward through the bed, up to 99.9% of the organics in the air are destroyed.

(Extracted from "Molten Salts Capture Toxic Gases from Incinerators", *Chemical Engineering*, Vol. 100, No. 10, October 1993, p.23.)

ADB to Include Environment Costs in Power Assessments

The ADB will include environment costs in all future assessments for electric power projects in the region.

The new policy follows calls by donors for investments to be "efficient, selective and environmentally clean", said Shehzad Shadiq, director of the Energy and Industry Division. This means that the environmental protection will have a major impact on both the design and financing of new power plants in Asia.

At present, about 55% of the fossil fuel burned in Asian power plants is coal and China's average is even higher.

"Fuel diversity is going to be a big issue. Most of our borrowers like China, Indonesia and India are single fuel economies. Ten or 15 years down the road we will have to see more diversity", said Shadiq.

Regardless of fuel source, the ADB will continue to support the cheapest alternatives. Where feasible, the ADB promotes gas, which burns cleaner than coal or oil. It is also considering aid for pipeline projects and recently commissioned a study on regional gas reserves.

Environmentally, gas is the preferred fuel of the future. A combined cycle is more efficient and has less maintenance costs, said Shadiq. Gas currently accounts for only 11% of the fuel used in Asian power plants, however, the ADB is targeting 22%.

Some Asian countries like Malaysia and Thailand are encouraging private firms to build power plants to help solve energy shortages. State planners and independent producers tend to favour gas because plants are cheaper and faster to build.

(Source: Extracted from "ADB to Include Environment Costs in Power Assessments", *Power in Asia*, 27 September, 1993, Issue No. 135, p.16.)

Training Courses/Conferences

Workshop on Managing Energy Risk

March 14–16, 1994, London, United Kingdom

Many forms of energy are related to the price of oil or oil-based products. The oil price now responds to climate, production quotas, wars, political upheaval and many other factors. Futures and options markets have a major impact on world oil markets and their prices, which in turn affect the price of the many oil products.

Understanding how the markets work and, perhaps more importantly, how to use the markets to the benefit of the company, is of prime importance to anyone involved in the purchase, sale or consumption of energy.

This workshop explains how and why the futures and options markets work. It will enable participants to identify when and how to use the markets in line with their own company philosophy and policy. It will also enable them to minimise the risk of losing money from oil movements.

Subjects include energy futures, traded options, trading strategies, and risk management.

For details contact:

BRI financial Training
92 Islington High Street
Camden Passage
London N1 8EG
United Kingdom
Tel: 071 359 0427
Fax: 071 359 0311

Renewable Energy: a Strategy for the Environment

March 26 – 31, 1994, Reading, United Kingdom

This seminar will review the role of renewable energy systems in minimizing the global environmental problems associated with ozone depletion, acid rain and rising carbon-dioxide levels. Future strategies for the application of renewable energy systems will be discussed in the light of case histories.

Major topics covered during the seminar will include:

- Climate change and global warming
- Acid rain and the problems associated with industrial pollution
- Renewable energy and its future:
  Wind energy, Biomass, Photovoltaic, Wave energy, Energy conservation and low cost indigenous houses, Management and economics of energy, Commonwealth renewable energy programme, and Renewable energy: global scenario.

For details contact:

International Seminar Dept.
The British Council
10 Spring Gardens
London SW1A 2BN
United Kingdom
Tel: +44 (0)71 389 4264/4252/4226
Fax: +44 (0)71 389 4154

Fifth ASEAN Conference on Energy Technology

April 25 – 27, 1994, Bangkok, Thailand

The conference is organized by the ASEAN Sub-committee on Non-conventional Energy Research (ASEAN SCNCER), National Research Council of Thailand (NRCT) and King Mongkut's Institute of Technology Thonburi (KMITT).

The sustained economic growth in the region is generating a strong demand for energy. Since 1986, the growth in commercial energy demand has been steady, averaging about 8%, and this will continue into the next decade. This rapid growth consequently generates special problems requiring immediate and long-term solutions.

This conference is aimed at disseminating the latest technologies on energy utilization, conversion and management.

Participation from the public and private sectors is expected. The conference will serve as a forum for interaction between researchers, practitioners, equipment manufacturers and suppliers, policy makers, utilities, and end-users.

Abundant opportunities exist for business developments and applications of energy technologies in industry, buildings, agriculture and transportation. In addition, special topics on energy and related environmental issues will be discussed.

Suggested topics are:

- Energy Conservation and Management,
- Renewable Energy,
- Energy Policy, and
- Environmental Issues Related to Energy Utilization.

For details contact:

Prof. Prida Wibulswas
5th ASEAN Conference on Energy Technology
c/o School of Energy and Materials
King Mongkut's Institute of Technology Thonburi (KMITT)
Bangmod, Rasburana
Bangkok 10140
Thailand
Tel: (66-2) 427 8094
Fax: (66-2) 427 9062/8077

Optical Materials Technology for Energy Efficiency and Solar Energy Conversion XIII

April 18 – 22, 1994, Freiburg, Germany

This International Symposium is sponsored by the International Society for Optical Engineering and the European Optical Society.

Topics include:

- Chromogenics for Smart Windows
- Selective Materials
- Solar Concentrators, Reflectors, and Antireflection Coatings
- Transparent Insulation and Super Window Materials
- Photovoltaics, Photochemistry, and Photoelectrochemistry, and
- Sol-Gel Technology.

For details contact:

Volker Wittwer
Fraunhofer-Institut für Solare Energiesysteme
Oltmannsstraße 5
D-79100 Freiburg
Germany
Tel: 49 761 4588 140
Fax: 49 761 4588 100

Book Review

Thailand Improved Charcoal Bucket Stove: Technology and Dissemination

A. Koopmans
Published by
Regional Energy Resources Information Center (RERIC)
Asian Institute of Technology (AIT)
in cooperation with
CUC-AIT Partnership Project and
FAO Regional Wood Energy Development Programme in Asia, Bangkok
ISBN 974-8209-85-7, 1993, v+58 p.

In response to a growing concern about the increasing scarcity and prices of fuelwood and charcoal in Thailand, the Forest Products Research Division of the Royal Forest Department in cooperation with the National Energy Administration (NEA) and with technical assistance from the USAID, Thailand embarked on a project to improve the efficiency of the traditional biomass/wood stove in 1982. Among others, an improved charcoal bucket stove (ICBS) was developed which consumed less fuel, cooked faster and at the same time could accommodate a full range of pot sizes commonly encountered in the household. After considerable testing in the laboratory and in actual household use, thousands of ICBS's were constructed and disseminated, while manufacturers, both formal and informal, were trained by NEA and encouraged to produce them for sale.

This "Technology and Dissemination Booklet" was prepared by Mr. Auke Koopmans in close cooperation with Dr. Aroon Chomcharn, Wood Energy Conversion Specialist of the FAO Regional Wood Energy Development Programme in Asia. The booklet provides technical details concerning the manufacture of the stove. It also describes the dissemination program undertaken in Thailand and the difficul-

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Book Review

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ties encountered and successes achieved. The technical problems relating to production of the ICBS were solved more easily and more completely than problems relating to the sustainability of dissemination strategies and quality control.

The book consists of five chapters. Chapter 1 contains the background information on the energy consumption and the domestic sector in Thailand, the history of the traditional bucket stove, and on research and development efforts on improved bucket stoves in Thailand. The technical development of the ICBS is presented in Chapter 2, which includes the design approach and process, internal and external parameters, the design of the ICBS, and combustion characteristics of the ICBS versus the TBS.

The step by step technologies related to the ICBS production are provided in Chapter 3 in the following sequence: clay selection, clay preparation, forming of the bucket stove, drying of the stove body, forming of the grate, firing of the ceramic parts of the stove, and stove fabrication.

Chapter 4 presents the techno-economic analysis and comparison of two small units for ICBS production: A manual clay mixing system in one unit versus a clay mixer with a small diesel engine in the other. Chapter 5 discusses the present status of ICBS production and dissemination efforts in Thailand.

Details on clay testing and testing procedures are given in Annex 1, which discusses its visual inspection, plasticity/bending test, drying sensitivity and drying shrinkage, firing trial, firing shrinkage and water absorption, slaking properties, the clay/non-clay ratio test in the laboratory and its determination in natural clay. Annex 2 shows detailed technical drawings of ICBS stove parts and the bucket.

The book can be useful for officials, extension workers and manufacturers who are engaged in disseminating, designing and manufacturing energy saving stoves, especially in developing countries.

The book is available from RERIC/AIT, G.P.O. Box 2754, Bangkok 10501, Thailand. Prices: Air mail = US$30.00 per copy for USA, Canada, Japan, Australia, New Zealand and Middle East; Air mail = US$20.00 per copy for Developing Countries; B 200.00 per copy for Thailand.

UNESCO International Directory

The third edition of the "UNESCO International Directory of New and Renewable Energy Information Sources and Research Centres" has just been published by James & James Science Publishers, London. This publication is the printed version of UNESCO's ENERGY database, which is part of UNESCO's Energy Information Programme. The objective of the programme is to improve the flow of information on new and renewable energies through the establishment of regional networks and the co-ordination of existing information systems and services.

The Directory, containing a total of 3,863 entries, and the computerised database, from which it has been generated are intended to facilitate information availability and transfer by providing information on national governmental organizations, research centres, information centres, professional/trade associations, networks, training and education institutions, databases/databanks, journals and reference publications from 172 countries.

The ENERGY database covers new and renewable sources of energy, energy conservation, policy and planning. Its language is English (names and titles are also given in the original language). The software used is CDS/ISIS. The database is updated daily with an average increase of 500 records per year. On-line searches are undertaken upon request, free of charge. The ENERGY database is also available on diskettes as well as on UNESCO's CD-ROM among other databases featured on this CD. Audiovisual aids, Experts and UNESCO Energy Knowledge Bank are being developed for expansion of the database's scope.

For information on the database contact:
Energy information
Engineering and Technology Division
UNESCO
1, rue Miollis
75732 Paris Cedex 15
France
Tel: (+33–1) 4568 3941
Fax: (+33–1) 4065 9535

For purchase of CD-ROM contact:
Any Sales agent of UNESCO publications, or
UNESCO Publishing (UPO/V)
UNESCO
1, rue Miollis
75732 Paris Cedex 15
France
Tel: (+33–1) 4568 2222
Fax: (+33–1) 4273 3007
Price: $ 200 or FF 1,100

For purchase of printed and diskette versions contact:
James & James Science Publishers
5 Castle Road
London NW1 8PR
United Kingdom
Tel: (+44–71) 284 3833
Fax: (+44–71) 284 3737

Prices:
Printed version: $ 135 or £ 75
Diskette version: $ 180 or £ 120

Publications Received

ENERGY

* *Energy in Europe: Annual Energy Review*, prepared by J. Carvalho Neto, N. Deimezis, M. Lecloux and J. Traynor, Directorate General for Energy (DG XVII), Commission of the European Communities (CEC), Brussels, Belgium, 1993, 183 p.

* *Electric Power Generation Markets in India and Pakistan*, prepared by RCG/Hagler, Bailly Inc., Office of Energy and Infrastructure, U.S. Agency for International Development (USAID), Arlington, Virginia, USA, 1992, iv+86 p.

* *1991-1992 Report on Activities of the Cooperative Programme on Energy and Development (COPED)*, Directorate General for Energy (DG XVII), Commission of the European Communities, 1993, 24 p.

* *Product Information Sheets 1993/1994*, produced by the WHO Expanded Programme on Immunization (EPI), in collaboration with the Programme for Acute Respiratory Infections (ARI), the Global Blood Safety Initiative (GBSI) and UNICEF/Copenhagen, published by World Health Organization (WHO)/ United Nations Children's Fund (UNICEF), Geneva, Switzerland, 1993, 205 p.

ENERGY CONSERVATION

* *Energy Conservation in Rubber Smoking Industry*, by Suteera Prasertan, the final report of a subproject of ECI-5 Energy Conservation in Industries, ASEAN-Australia Energy Cooperation Programme (AAECP) Phase II, Department of Mechanical Engineering, Prince of Songkla University, Hat Yai, Thailand, July 1993, xi+107 p.

* *ECI-5 Energy Conservation in Iron/Steel Industry*, by Bundit Fungtammasan and Pornchai Chongchitpaisarn, Technical Report, ASEAN-Australia Phase II Programme on Energy Conservation in Industries, Faculty of Engineering, King Mongkut's Institute of Technology, Bangkok, Thailand, September 1993, vi+88 p.+App.

COOKSTOVES

* *Chinese Fuel Saving Stoves: A Compendium*, prepared by Chinese Academy of Agricultural Engineering Research and Planning (CAAERP), Beijing, Field Document No. 40, Regional Wood Energy Development Programme in Asia (GCP/RAS/131/NET), Food and Agriculture Organization of the United Nations (FAO), Bangkok, Thailand, July 1993, iii+55 p.

* *Indian Improved Cookstoves: A Compendium*, prepared by Improved Chulha Division, Ministry of Non-Conventional Energy Sources, Government of India and Indian Institute of Technology, Delhi, Field Document No. 41, Regional Wood Energy Development Programme in Asia (GCP/RAS/131/NET), Food and Agriculture Organization of the United Nations (FAO), Bangkok, Thailand, July 1993, iii+104 p.

FUELWOOD

* *Patterns of Commercial Woodfuel Supply, Distribution and Use in the City and Province of Cebu, Philippines*, prepared by T.G. Bensel and E.M. Remedio, Field Document No. 42, Regional Wood Energy Development Programme in Asia (FAO), Bangkok, Thailand, July 1993, xii+123 p.

Diary of Events

- **17 – 20 January, 1994, Orlando, FL, USA**

4th International Symposium on Distribution Automation and Demand Side Management

For details contact:
DA/DSM 94
PO Box 2750
Tulsa
OK 74101-2750
USA

- **19 January – 18 February, 1994, Madras, India**

Workshop on Solar Energy Utilisation

For details contact:
Dr T.R. Jagadeesan
Anna University
Madras 600 025
India
Tel: 91 44 2351 723
Fax: 91 44 2350 397

- **23 – 26 January, 1994, Dubai, UAE**

Middle East Electricity '94

For details contact:
F & E Fairs and Exhibitions Ltd
Suite 12, Accurist House
44 Baker street
London W1M 1DH
United Kingdom

- **25 – 27 January, 1994, Naxxar, Malta**

The Mediterranean Oil and Gas Exhibition and Conference

For details contact:
Conference Organizer
Spearhead Exhibitions Ltd
Rowe House, 55-59 Fife Road
Kingston upon Thames
Surrey KT1 1TA
United Kingdom

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Diary of Events

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- **30 January – 3 February, 1994, New York, NY, USA**

1994 Power Engineering Society Winter Meeting

For details contact:
Mr F.E. Schink
14 Middlebury Land
Cramford NJ 07016-1622
USA

- **9 – 11 February, 1994, Tampa, FL, USA**

Innovative Electricity Pricing

For details contact:
Pam Turner
Conference Coordinator
Electric Power Research Institute
3412 Hillview Avenue
PO Box 10412, Palo Alto
CA 94303-9743
USA
Tel: +1 415 855 2010
Fax: +1 415 855 2041

- **28 February – 3 March, 1994, Barbados**

Conference on Solar Applications for Tropical Island States

For details contact:
Prof O. Headley
Dept of Chemistry, The University of the West Indies
Cave Hill Campus
St. Michael
Barbados
Tel: 809 425 1310
Fax: 809 425 1327

- **21 – 24 March, 1994, Clearwater, FL, USA**

19th International Conference on Coal Utilization and Fuel Systems

For details contact:
Barbara Sakkestad
Conference Committee
1156 Fifteenth Street
N.W. Suite 525
Washington DC 20005
USA
Tel: 202 296 1133
Fax: 202 223 3504

- **24 – 26 March, 1994, Washington DC, USA**

The 1994 Third Annual MEMS Professional Program and Meeting: The Energy and Mineral Markets of Tomorrow

For details contact:
Mineral Economics and Management Society
PO Box 721, Houghton
Michigan 49931
USA
Tel: (906) 487 2771
Fax: (906) 487 2944

- **5 – 9 April, 1994, Lisbon, Portugal**

2nd European Congress on Economics and Management of Energy in Industry – Ten Years On

For details contact:
ECEMEI
c/o Prof Albino Reis
Rua Gago Countinho
185-187 - 4435 Rio Tinto
Portugal
Tel: 351 2973 0747
Fax: 351 2973 0746

- **10 – 15 April, 1994, Chicago, IL, USA**

1994 IEEE/PES Transmission and Distribution Conference and Exhibition

For details contact:
Mr J.J. Viera
Commonwealth Edison
PO Box 767
IL 60690
Chicago
USA

- **17 – 21 April, 1994, Atlanta, GA, USA**

Environmental Issues in the Petroleum and Petrochemical Industries

For details contact:
Dr Chen-Hwa Chiu
F&PD Meeting Coordinator
Bechtal Corporation
PO Box 2166, Houston
TX 77252-2166
USA

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Library and Regional Documentation Center, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The "RERIC News" is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership along with the other four regular publications namely: RERIC International Energy Journal (formerly: Renewable Energy Review Journal); RERIC Holdings List; Abstracts of AIT Reports and Publications on Energy; and RERIC Membership Directory. For further details contact:

Regional Energy Resources Information Center
Asian Institute of Technology
G.P.O. Box 2754
Bangkok 10501, Thailand
Telex: 84276 TH
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Fax (66-2) 5245870

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ISSN 0125-1775

Vol. 17 No. 1 March 1994

Workshop on Global Warming Issues in Asia

8-10 September 1993
Asian Institute of Technology
Bangkok, Thailand

Global Warming, which refers to a gradual warming of the world due to emissions of "greenhouse" gases from human activities, particularly the burning of fossil fuels, has been emerging as a serious threat to the environment in recent years.

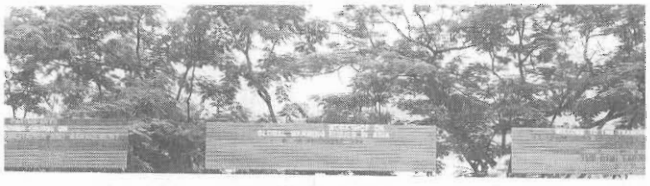
It is now widely believed that average world surface temperature has already risen by about 0.5°C since 1990 and is likely to increase by up to 5°C over the next 100 years. The rise in temperature will cause rise in sea-levels due to expansion of the ocean water and melting of glaciers as well as polar ice caps. Sea-levels appear to have already risen by about 15 cm since the beginning of this century.

Rise of sea-levels would result in flooding and increased ground water salinity in coastal areas. Shifting climatic zones including changes in rainfall patterns and soil moisture are also expected, which in turn would affect water resources and agricultural productivity. It is generally believed that the developing countries will be more adversely affected by Global Warming.

In spite of the emerging threat of Global Warming, which is likely to be the most pressing international environmental issue of the next century, there is little public awareness and debate on the subject in the developing countries of Asia. Most developed countries on the other hand appear to have by now set up special units to address the implications of Global Warming.

The Asian Institute of Technology organized a Workshop on Global Warming Issues in Asia during 8-10 September, 1993. The workshop organizing committee was headed by Dr. S.C. Bhattacharya and Mr. Hans Schroder. The workshop brought together researchers of diverse expertise from different Asian countries as well as recognized experts from outside the continent and provided a forum for deliberations on different facets of Global Warming. Dr. D. Kirk Dawson, Director General, Canadian Climate Centre, Ontario delivered the keynote address.

The workshop received support from a number of important donor agencies, including ASEAN Canada Fund, Swedish Agency for Research Cooperation with Developing Countries (SAREC), Agence de l'Environnement et de la Maîtrise de l'Energie (ADEME), Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH and Swiss Development Cooperation. The workshop was initiated by a grant from CIDA/AIT-Canadian Universities Consortium Partnership Project and has also received support from the British Council, Danish International Development Agency, ADB/AIT ENSIC Project and Clean Energy Research Institute of USA.



INNERTAP

Incorporates news from the Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

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Supplement: Small Scale Wind Energy Systems

Fourth International Conference on Small Engines and Their Fuels

Chiang Mai, Thailand, 21–24 September 1993

Sponsored by IT Power Ltd, Energy for Sustainable Development Ltd, The Institute of Energy and the British Council.

Members of international and local conference organizing committees.

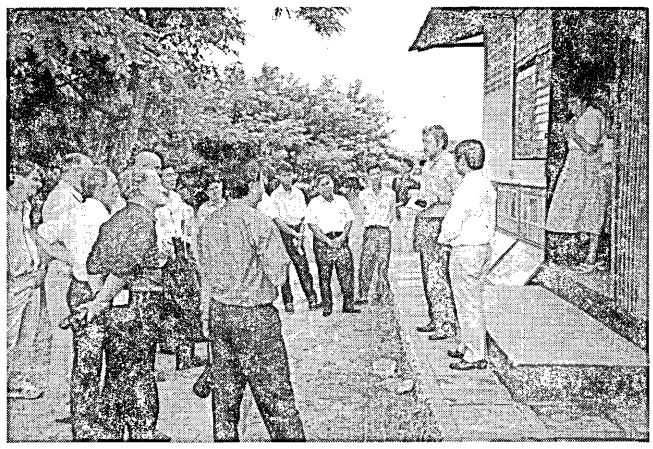
Chiang Mai was the beautiful setting chosen as the first non-UK venue for the fourth International Conference on Small Engines and Their Fuels. The conference organisers took this bold step with the aim of attracting new participants who might find it difficult to obtain funds to travel to Europe. They were rewarded, not only with a congenial location but with 50 delegates, which included many new faces amongst the regular stalwarts. Delegates represented a wide variety of organisations: universities, governments, consultancy companies, development organisations, and non-governmental organisations. South-East Asia was particularly well represented.

The theme of the conference was the contribution of small engines (<100 kW) and their fuels to the energy supply of remote rural communities especially in developing countries. Small engines play an important role in providing energy for these communities' needs, such as electricity, transport, irrigation and other agricultural tasks. The intention was to provide a forum for experts and professionals to share their theoretical and field experiences, as well as to disseminate information on state-of-the-art research and development on small engines using both conventional and alternative fuels. Social, environmental and economic issues were covered as well as the technical aspects of engine and fuel development.

Over 35 papers were presented, with a good mix of both theoretical and practical aspects of internal and external combustion engines. The environment is high on everyone's agenda nowadays, so it was no surprise that emission control received much attention. Considerable interest was generated by Daniel Lumbroso from the French Institute of Petroleum, with his fuel-injected two stroke engine for use in two wheeled vehicles aimed at giving low emissions with mechanical simplicity at a low cost. (Delegates who passed through Bangkok know that this is an area which needs attention if urban air quality is to be improved.)

Stirling engine enthusiasts were treated to a new four cylinder double acting engine, which can be scaled across a range of engine sizes. The designer, Donald Clucas, from the University of Canterbury, in New Zealand, provided a beautifully engineered working model to demonstrate his novel low-cost wobble yoke mechanism, intended to simplify the design by eliminating the need for a number of components including gears, which should lead to a reduction in production costs.

On the alternative fuels side, the vegetable oil from Jatropha curcas (also known as physic nut or black soap) received attention from a number of contributors. The papers included, as well as engine test results, an analysis of the economics of production in Thailand (Wasan Jompakdee from Chiang Mai University and Peter Dunn from the University of Reading) and a system for fuel production and utilisation at village level in Mali (Reinhard Henning, GTZ). The two sets of authors presented conflicting evidence on the toxicity of the oil and agreed on the need for further research. Field experience with bio-diesel was reported by Paul Shepherd on the use of this biomass derived fuel in the public bus network in Reading, UK. Operating experience has been satisfactory although cold start problems have been reported with one type of engine. Exhaust smell is commented upon – not always negatively – and this is currently under investigation, as are the higher particulate emissions compared to diesel.

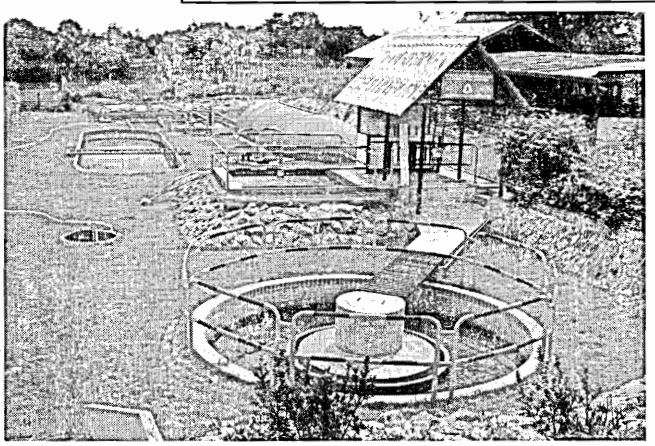


Visit to GTZ Biogas Programme, Chiang Mai.

The local committee (Department of Mechanical Engineering, University of Chiang Mai) ensured the participants saw some of the delightful surrounding countryside by organising a field visit to a biogas installation. The digester was located at a pig farm for treating the effluent from 28,000 pigs, with the main objective of reducing the

smell. The biogas produced is then used for keeping the young pigs warm and the liquid residue is used as fish food and fertilizer. A truly integrated system!

In the week prior to the conference, a workshop on alternative fuels and engines was held at the University of Chiang Mai. It was designed to meet the needs of anyone involved in exploring the technical and economic feasibility of projects based on alternative fuels. Biomass resources, their production and utilisation in continuous combustion applications and in engines were reviewed. The environmental implications of fuel production and utilisation were also covered. Contributors to the workshop came from the Department of Mechanical Engineering, University of Chiang Mai, the universities of Reading and Surrey in the UK, the University of Canterbury in New Zealand, the University of Twente in the Netherlands, and the Thai-German Special Energy Programme. The workshop was sponsored by the British Council and the Petroleum Institute of Thailand.



Upflow Anaerobic Sludge Blanket Anaerobic Digestion pilot plant, Thai-German Biogas programme.

The next conference is to be held in April 1995 at Reading, UK. Further details, as well as the proceedings of this and previous conferences, can be obtained from:

Dr. G. Rice, Chairman
Small Engines Conference
University of Reading
Dept. of Engineering
PO Box 225
Whiteknights
READING RG6 2AY
UNITED KINGDOM
Tel : +44 734 318561
Fax : +44 734 313327

(Contributed by Joy Clancy, Technology and Development Group, University of Twente, The Netherlands, 13 January 1994)

PV-powered Submersible Pump

Raising water from a narrow-bore well by solar energy is an attractive option in many remote locations. However, few solar-powered pumps can raise water from depths lower than about 10m economically.

SHURflo Ltd has developed a new solar submersible pump for operation in standard 100mm diameter boreholes over a wide range of depths down to 70m.

Powered by two 48 watt solar panels the pump produces a flow of 220 to 320 litres of water per hour enough for watering livestock or crop spraying on many farms, or to supply the needs of a holiday home or a small hotel.

Because the pump is specially designed for use in boreholes, the manufacturers have been able to provide a combination of features which no other solar submersible pump offers.

For example, it has an internal bypass which prevents hydraulic overload if the pump is too deeply submerged or the outlet line is blocked. Moreover, running the pump dry will not damage it, and it will prime itself from the dry condition whenever water is available.

The unit has an impact-resistant outer case moulded in high-strength engineering plastics for corrosion resistance and protection against mechanical damage.

For more information contact:
SHURflo Ltd
The Old Forge, 38 West Street
Reigate, Surrey RH2 9BX
United Kingdom

(Source: Extracted from "Solar-powered Submersible Pump", *Energy Digest*, Vol. 22, No. 5, pp. 27-28)

Wave Energy Pilot Plant

Funding is being sought to build a European shoreline oscillating water column wave energy pilot plant with an installed capacity of 600 kW. The unit will be built and tested on the Isle of Islay in the United Kingdom, close to the 75 kW unit developed by Queen's University.

The main objective is to provide a multi water column R&D facility free from commercial constraints for academic and industrial research teams in the European Community. It will provide an essential intermediate step in which the mechanical electrical equipment can be fully developed in an accessible environment before building plant offshore.

The plant will comprise two concrete water columns located in a man-made recess in the coastline and a tapered entrance harbour to maximize wave excitation.

The 51 months construction period splits into 3 phases. In month 24 the 75 kW turbine generator will be installed to provide initial electrical production. In phase 3, three 200 kW Wells turbine generators will be installed and connected to the electrical grid through an adaptable control system.

The pilot plant will produce electric power for 0.06 Ecu/kWh with considerable potential for cost reductions. Commercial wave stations could be deployed along the Western coast of Europe and its islands to tap an abundant renewable energy source.

(Source: Extracted from "A European wave energy pilot plant on Islay (U.K.)", *Solar Europe*, No. 5-6, October 1993, p. 8)

Photovoltaics Development

Despite many applications throughout the developing and industrialized world, the photovoltaic (PV) market is still only a fraction of what it could be, mainly due to the high capital cost of PV power systems. But this situation is changing as advances in technology and manufacturing methods take place, increasing efficiencies and decreasing costs.

Technical Performance

Recent work on crystalline silicon technology has focused upon improved anti-reflection coatings, front-electrode design and surface texturing to improve light-capture. Cells composed of monocrystalline silicon yield the highest efficiencies, and the best commercial modules presently have efficiencies of around 17 to 18% (e.g. the Saturn module from BP Solar, UK).

Of the thin-film technologies, amorphous silicon is the only one in full commercial production. Amorphous silicon tends to suffer a degradation of efficiency over time. Typical stabilized module efficiencies are only around 3 to 4% at present. Several companies are also researching thin-film cells composed of exotic materials, the two main candidates being cadmium telluride (CdTe) and copper indium diselenide (CIS). The efficiencies of CdTe and CIS modules are greater than those of amorphous silicon and they do not suffer performance degradation.

Among the more novel research currently taking place is the development by Texas Instruments (US) of a PV cell based on sub-millimetre silicon spheres embedded in an aluminum foil. Initial trials have returned an average cell efficiency of over 10%.

Costs and Prices

The critical factor affecting the situations in which PV is economic, is the unit price (i.e. the cost per Wp). Figure 1 illustrates very well the complementary trends of PV module price and module efficiency from 1978 to 1992.

Advances in the design of the manufacturing machinery and the methods employed have brought cuts in production costs. For instance, modern production lines (using wire saws) are more efficient in the way they slice silicon ingots into wafers, wasting less of the ingot and producing thinner wafers. As production volumes have gradually increased, certain savings have also been made possible by virtue of mass-production techniques.

Development of the thin-film materials is a promising area for future cost reductions. Although efficiencies are much lower than for crystalline silicon, the tiny quantities of raw materials used should ultimately result in lower production costs.

PV Module Production

The three main regions in which PV is produced are Europe, the US and Japan, with companies from those areas accounting between them for 91% of world production. The remaining 9% is produced in the developing world, mainly India, China and Brazil. The breakdown of the world PV production into MWp and percentage share is shown in Table 1.

Table 1. PV module production in 1992 by regional companies.

Region	MWp	% share	% growth
Europe	16.6	28.1	23
US	18.2	30.7	6
Japan	18.8	31.8	-5
India	2.3	3.9	
China	1.0	1.7	19
Brazil	0.3	0.5	
Others	2.0	3.3	
Total	59.1	100	

Overall, the world market has continued to grow with total shipments of 59.1 MWp in 1992. Since 1988 the global PV market growth rate has been between 15 and 20% per annum, but 1992 showed shipments up only 7.3% on 1991.

Applications

The applications of PV can be roughly divided into 5 broad catego-

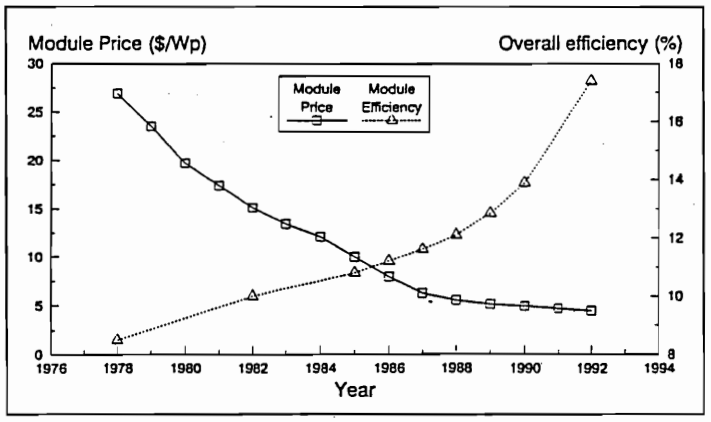


Fig. 1. PV module price and efficiency history.

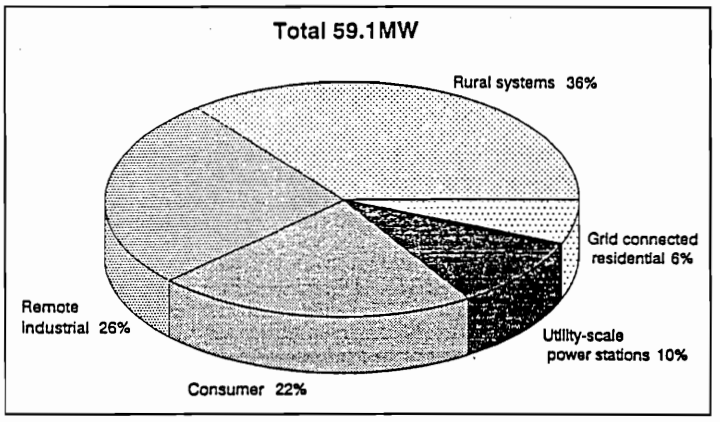


Fig. 2. PV module distination market by application.

ries as follows:

- Utility power plant (>50 kWp);
- Grid residential (1 kWp–20 kWp): solar roof, solar facade;
- Rural systems (100 Wp–10 kWp): pumping, lighting, vaccine storage, village power;
- Remote industrial (10 Wp–10 kWp): telecommunication, signalling, cathodic protection, monitoring; and
- Consumer (0–50 Wp): calculators, watches, novelties, battery chargers, and walkway lights.

The estimated breakdown of the 1992 module destination market into these categories is illustrated in Figure 2. The major sectors in order of size are rural systems, remote industrial applications and consumer products.

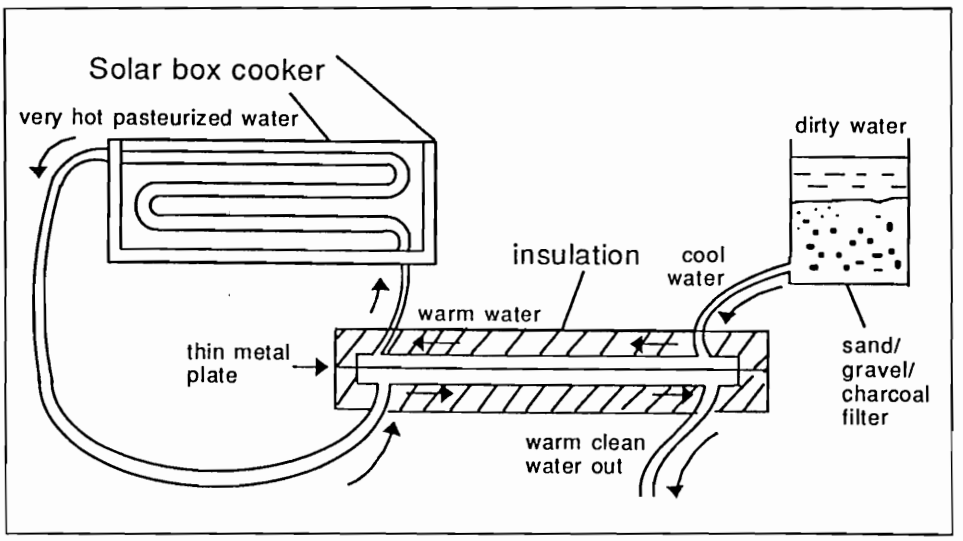
Prospects for PV Development

Crystalline silicon is well established as the conventional technology, and although efficiencies are gradually moving upwards, this technology is probably nearing its practical ceiling. There are also limits to the improvements that can be made in manufacturing and mass-production techniques with conventional sliced wafers.

However, the next decade will see a considerable diversification of PV technologies on the market as many of the current R&D projects come to fruition. In terms of silicon technology, there is the 'ribbon' process under development by Mobil Solar, which consists of a thin film of crystalline silicon grown on a metal foil backing. Texas Instruments are close to production of their spherical-silicon cells. Both of these methods will allow easy mass-production as they avoid the problems of cutting and using discrete wafers. Almost all of the other newcomer technologies will be based around thin-film technology. This will include CdTe, CIS and stabilized multi-junction amorphous silicon.

In the future, rural electrification and health projects will increasingly use PV systems, not just as an alternative to grid extension, but as an economic and effective means of supplying electricity to those people in rural areas that will never be connected to the grid.

(Source: Extracted from "The Photovoltaic Industry Today and Prospects, 1995 to 2005" by R. Barlow & A. Derrick, *Solar Energy and Health* (Working Papers), World Solar Summit, 5-9 September 1993, WHO 1993, pp. 33-59)



Heat-Recovering Solar Water Pasteurizer

Solar Cookers International (SCI) has been promoting the fact that water can be pasteurized by heating covered containers of water inside a solar box cooker. A water pasteurization indicator shows when the water has been heated to pasteurization temperatures, to 65°C or 149°F. It is not necessary to boil water as many people believe.

This simple but not very efficient technique yields at most about 8 liters of water per day in a standard Kerr-Cole solar box. A more efficient technique from PAX World Foundation uses 60 feet of black tubing inside the same solar box cooker, with a commercially-available thermostatic valve which allows water to flow when it reaches 82°C (well above pasteurizing temperatures). The PAX model can produce as much as 20 liters per day.

The heat in the outgoing, pasteurized water is thrown away in both the above techniques. Recently Dale Andreatta, P.E., and colleagues in the Department of Mechanical Engineering at the University of California at Berkeley have designed a device to recycle that heat. A device has been added to the PAX unit to transfer heat of the outgoing hot water to preheat the water going into the solar box. This decreases by about 75% the amount of solar energy required to heat incoming water to pasteurization temperatures and increases the amount of pasteurized water fourfold to about 80 liters per day.

The use of a device to recycle the heat of the outgoing water may have many other applications.

Solar water pasteurization holds great promise in the fight against water-borne diseases, especially in the third world where drinking water is often contaminated with germs and viruses. For example, it is estimated that nearly 10,000 children die each day from dehydration caused by diarrhea.

For more information contact:
PAX World Service, 1111 16th St. NW
Washington, DC, 20036, USA
Tel: (202) 293-7290
Fax: (202) 293-7023

(Source: Extracted from "New Water Pasteurization Advances", *Solar Cookers International Newsletter*, Winter/Spring 1994, p. 6)

PV Pumping Systems Monitoring in Sahel

One of the world's biggest PV projects is being implemented in the Sahel Region in West Africa by CILSS (Permanent Interstates Committee for the Fight Against Drought in the Sahel Region), an organization of 9 African member states (Burkina-Faso, Cape-Verde, Chad, Gambia, Guinea-Bissau, Mali, Mauritania, Niger and Senegal). The programme is financed by the Commission of the European Communities, DG VIII, 6th FED, and includes the procurement and installation of more than 1300 PV systems (PV pumping systems and community systems for lighting, refrigeration and battery charging), supplied by different European manufacturers. A total PV capacity of 1.6 MW is going to be installed.

As part of this project, an intensive monitoring programme is performed on representative PV pumping systems in four Sahelian countries. Standards and operative procedures for a specific monitoring approach at remote sites will be developed. The monitoring task is co-financed by CEC/DG XII and CILSS/FED. The programme is carried out by WIP, Renewable Energies Division, Germany. Performance partner is Hyperion, Ireland.

The monitoring comprises the acquisition, recording, evaluation and assessment of climatological, electrical and hydraulic data (e.g., irradiation, PV generator current and voltage, water flow rate).

On the basis of the data gathered a data bank with real site performance data will be created. The assessment results serve as a basis for technical recommendations for future improvements on the component and system level useful for PV pumping system designers and manufacturers.

(Source: Extracted from "Monitoring of PV pumping systems in West Africa", *Solar Europe*, No. 5-6, October 1993, pp. 26-27)

Huge Wind Potential – Cuba

Cuba is looking to wind power from Spain to help alleviate its chronic power shortages. Despite its long-term energy policy dismissing wind power as an ineffective option, Cuba has planned a Spanish-built, 1 MW wind farm outside Havana and is hoping to build several more along its windswept, 1500 km Atlantic coastline.

"Cuba has never seriously contemplated wind farms, but new developments in wind technology would seem to make this option a very viable one for our nation", says Jorge Santamarina Guerra of Cuba's Energy Council. Wind power has been given development priority because of the relatively short time span it takes to build wind plants.

At present, Cuba receives only 50% of the previous oil import total of 13 million tonnes supplied annually by the Soviet Union prior to 1989. Today it has to rely on an inadequate supply of hydroelectric power and sugar cane residuals to make up the rest of its energy requirements which are largely thermal-generated.

The wind farm at Santa Cruz del Norte is being built by Ecotècnia – a Spanish wind turbine manufacturer. The farm, comprising four 250 kW turbines, is scheduled to be operational in June. It will meet the power needs of a town 40 kilometres north west of the capital. The investment is estimated to be $ 0.5 million.

It's just the beginning, says Santamarina Guerra. Cuba has enormous potential for wind power development. Five different possible sites for wind farms have been identified along the north Atlantic coastline, some as wide as 100 km.

(Source: Extracted from "Cuba discovers huge potential", *Windpower Monthly*, Vol. 10, No. 3, March 1994, pp. 30-31)

New Technology to Expand Use of Solar Power

A US joint government-industry project has produced a new type of solar energy gathering material that could significantly reduce the cost of solar power. The technology resulted from a three-year, $6.26-million effort by United Solar Systems Corp, a joint effort of Canon Inc, the business machines and camera manufacturer, and Energy Conversion Devices of Troy, Michigan.

The project produced a solar energy gathering film, called thin-film photovoltaic technology, that is 100 times thinner than the conventional wafered silicon solar technology now used for street lights, calculators and other products. The new film uses much less material because it is so thin, thus, cutting production costs. The film can be spread on large sheets of low-cost material such as glass or stainless steel.

The US Energy Department considers the new material as a way to boost use of solar energy to cut emissions of greenhouse gases.

The solar panels will be manufactured at a new plant in Newport News, Virginia. The thin film solar panels can be made into roofing shingles that could supply all the daytime electricity needs of a south-facing house.

At present, according to the Energy Department, electricity from conventional silicon technology costs between 25 and 50 cents per kilowatt hour, but the new technology should cut the costs to 16 cents, and eventually to 12 cents.

(Source: Extracted from "US develops new technology to expand use of solar power", *Bangkok Post* (Business Post), Thursday, 20 January 1994, p. 21)

Women Develop a 450 kW Wind Power Plant, Germany

Windfang Women's Cooperative Association was founded in Hamburg in May, 1992. In German, 'windfang' means 'wind break' and is close to 'windfang': 'tomboy'. The very first project of these women, most of whom work in the energy sector, is the construction of a 450 kW windpower plant in northern Germany.

The site is located in an area of Schleswig-Holstein with strong winds. The capital invested is DM 1.1 million (approx. US$ 700,000). It is to be financed through cooperative shares priced at DM 3,000 (US$ 2,000). This pricing of the shares at DM 3,000 each is meant to keep administrative work to a minimum, while financially less well-off women can join the association by buying single shares jointly with other women. The output of the plant, just short of 1 million kWh per year, will be sufficient for over 300 economically run households (e.g. those of association members). Each shareholder will be able to say of herself that her use of electricity is ecologically faultless. Whoever consumes electricity will also feel responsible for the ecologically sound provision of their energy – holding a share in a windpower plant should be just as much a matter of course as owning an electrical appliance.

The women's cooperative association is planning its project in working groups: technology, ecology, economic viability, and public relations.

Windfang works slowly, but thoroughly:

- The decision on the legal form of the group was the subject of a seminar attended by a larger number of women interested in windpower. The decisive reason for forming a cooperative association was that this form of organisation offers both rights of participation in the decision making process as well as financial security through an annual audit.
- The choice of windpower plant was made by the ecology and technology working groups after several months of investigation: five potential suppliers were interviewed about their plant technology and their works were visited and they were also questioned about the environmental soundness of their products (production methods, the environmental aspects, etc.). Two types of plants were found to be positive in economic terms. The decisive point in the final choice was noise: only one of the manufacturers could guarantee low noise levels.

So far all work has been carried out on a voluntary basis. Is this another case of women doing unpaid work? The women involved look upon it as a qualification and entertain the expectation that later projects will not only bring dividends for shareholders but that their professional work can then be adequately remunerated.

Besides, energy consultancy for women is also being considered – the specialist potential of the cooperative leaves hardly anything to be desired. The guiding principle in all projects carried out by Windfang is openness and frankness in technical, financial and structural matters.

(Source: Extracted from "WINDFANG: the Windcatchers – Women in Germany Raise the Winds" by Christiane Delfs, *AT Forum*, No. 3, 12/1993, pp. 6-7)

Wind Power for Telecommunications in China

Westwind Turbines of Australia has signed a contract with telecommunication company NEC Australia for the supply, supervision and installation of its turbines in China. According to the contract, a 3100 km fibre optic telecommunications link across China will be powered by 15, 2.5 kW wind turbines of Westwind. They will be spaced along the fibre optic link being laid from Yining near the Russian border to Lanzhou, south of Beijing. The cable passes through some of the world's harshest terrain and the wind turbines will have to operate over a wide range of desert temperatures, from over 40°C in summer to minus 40°C in winter. The conditions are so extreme that installation of the machines can only take place at certain times of the year.

The remote location of many of the repeater stations along the link has resulted in the use of wind and solar power at many sites. Applications in telecommunications are considered by Westwind Turbines as a growing market for its products. This project is part of the Chinese government's five year plan to install 12,000 km of telecommunications cable and the new cable may be extended to form the main telecommunications link between China and Europe.

(Source: Extracted from "Remote Link Contract in China" by Steve Dear, *Windpower Monthly*, Vol. 10, No. 1, January 1994, p. 16)

Power from Sugar Cane

An agreement reached by the Brazilian government and a group of 150 ethanol distillers could boost sugar cane-based power generation. The state's sugar-power capacity is expected to increase from 200 MW to 3,000 MW within 15 years.

If all goes well, investment in the new generating capacity will be raised by the ethanol producers. The agreement calls for a fifth of the state's electricity to be produced by burning sugar cane pulp. The price would be comparable with that of hydro-electric power. The initiative will save the estimated $8 billion capital cost of building a proposed hydro-power facility of similar capacity.

Recent advances in the design of gas turbines and the conversion of solid fuels into gases have made the agreement possible. It could turn the sugar industry into a net producer of

Cont. P. 9

Refuse-Derived Fuel

Refuse-derived fuel (RDF) is made by refining municipal solid waste in a series of mechanical sorting and shredding stages to separate the combustible portion of the waste. Either a loose fuel, known as fluff, floc or coarse RDF (c-RDF), or a densified pellet or briquette (d-RDF) is produced.

Studies on the calorific value of waste with different levels of materials recycling demonstrate that removing the non-combustibles like glass and metals, and removing clean combustibles like office paper still leaves a waste with sufficient energy value to make RDF production viable.

Waste management options include landfilling, waste-to-energy or mass incineration, recycling and refuse-derived fuel production.

On-site Combustion

Interest in on-site combustion and power generation has greatly increased in recent years. On-site combustion development goes hand-in-hand with mounting interest in coarse RDF production.

The major advantage of c-RDF over d-RDF is that the reduced refining and processing impacts favourably on capital and operating costs, and uses less energy for production. Where on-site combustion is to be used, the need for densifying the RDF for ease of transport is removed. And c-RDF can avoid a need for drying the fuel product, a stage necessary for pelletisation. Since the drying stage is a potential source of odour, as well as a further energy demand, this is another plus point.

Process description

The refuse is discharged either onto a tipping floor or into a bunker with an overhead grabber. Generally the tipping floor method is preferred as it is less costly, allows better removal of unwanted items such as gas canisters and reduces waste compaction. Subsequently the material is passed through a cylindrical screen (trommel) which sorts it into fine material (fines), heavy (stones and bricks) and oversized materials (large sheets of plastic, etc.) from the small, lighter pieces like paper and plastic film which will form the fuel product. The fine fraction, containing the smaller high moisture content organics and ash, is either landfilled or diverted for composting or anaerobic digestion, the latter offering additional energy recovery. The oversized fraction can be shredded and partially returned to the fuel stream or landfilled, depending on its composition, while the fuel fraction is conveyed to a shredder. Ferrous and non-ferrous metals can be separated either before or after shredding. Further separation takes place in an air classifier, although this would not be essential for c-RDF manufacture.

For d-RDF, the light fuel fraction is subjected to secondary shredding, then dried and pelletised. In some plants high powered screw presses are used to dry and briquette the fuel in a single unit. A magnetic separator is installed as a final 'road block' to prevent metals damaging the densifiers.

Case Studies

Byker, Newcastle, UK

One hundred thousand tonnes of waste are processed annually for Newcastle City Council. Around 60% of input material is rejected, 4% is recovered as ferrous scrap and 36% as fuel. All of the RDF pellets are combusted in an adjacent boiler house, where three boilers have a total capacity of 21 MW, and generate up to 3.5 MW of electricity as well as providing around 30 million Btu of heat per hour to the Byker district heating scheme. The Byker plant, which has been operating for fourteen years, is regarded a reliable and robust example of processing plants of this nature.

Isle of Wight, UK

The Isle of Wight has difficulty in disposing of its refuse, especially during the summer months when tourism considerable increases the population. Commissioned in 1989 the island's RDF plant processes 50,000 tonnes of refuse and produces 15,000 tonnes of d-RDF each year. An on-site power generation system has been installed to utilise all the RDF produced in the facility.

Udine, Italy

The 210 tonne per day Udine plant in Northern Italy, commissioned in early 1992, serves an area with a population of 280,000. The organic fraction after treatment on a vibrating screen for the removal of inert materials, is mixed with green wastes and sewage sludge in conditioning drums prior to being composted in windrows. A methane-fired drying unit reduces the moisture content of the light combustible fraction up to 20%.

Conclusion

Recovering the energy from the non-recyclable portion of household and commercial waste offers a flexible complement to material recycling and reduces the need for landfill. Energy produced from waste replaces energy that would otherwise have been generated from fossil fuels, so offers a net environmental benefit.

(Extracted from "Refuse-Derived Fuel", *Warmer Bulletin*, No. 39, November 1993)

Comparison of Fuel Properties

Property	d-RDF	c-RDF	Coal	Peat
Bulk Density (kg/m³)	400	75	1000	300
Calorific Value (MJ/kg)	16	14	27	10
Moisture Content (%wt)	10	28	14	55
Ash Content (%wt)	15	12	6.5	3.5
Volatile Matter (%wt)	68	66	33	67
Chlorine (%wt)	0.7	0.7	0.3	0.0
Sulfur (%wt)	0.3	0.3	1.5	0.3

2000m Geothermal Well in Tibet

Prospectors in Tibet have drilled a geothermal well 2000m deep and found water with a temperature of 260°C. The well located in the Yangbajain geothermal field, 90 km from Lhasa, is the deepest of its kind in China and the hottest. A second well in the same field, 1000 m deep has yielded water at 200°C.

So far, 40 geothermal fields have been found in China and 3000 wells are currently in production. The country's exploitable geothermal reserves are estimated to be equivalent to 200 billion tons of coal.

Tibet leads China in the exploitation of renewable energy. The capital, Lhasa, draws 40% of its power from a 25 MW geothermal plant. Besides, the plateau has a hydropower potential of 220 GW and its solar resources are claimed to be second only to the Sahara desert, with 2300–3000 hours sunlight each year.

At present, the region has small hydropower plants with a total capacity of 50 MW. A large pumped storage plant is also under construction, at Yamzho Yumco.

Tibet has three solar power plants and 24 satellite earth stations which are powered from solar cells. Wind power development is also growing across the Tibetan plateau.

(Source: Extracted from "Prospectors sink 2000 m geothermal well", *Modern Power Systems*, Vol. 14, No. 1, January 1994, p. 12)

First OTEC Project

A memorandum of understanding was signed in early February by Sea Solar with the Tamil Nadu state government, to bring a $250m 100 MW ocean thermal energy conversion (OTEC) project on line. It is described as the first such project in the world.

The temperature difference between the surface water of the ocean and water at 1,000 metres depth will be exploited. It will be used to heat the water through refrigeration which will produce high pressure vapour to drive a turbine. The plant will be mounted on a ship, to be constructed in the US and towed to the site off Kulashekharapatnam, 10 km south of Tiruchndur.

The technology is patented by US Prof. M. Anderson who spent years on intensive research to make this technology a reality. Temperature gradients available in the Indian ocean and the Pacific make them the ideal locations for such power plants. Other OTEC projects can be set up in coastal Gujarat and Andhra Pradesh if this project turns out successful.

The Tamil Nadu project can be expanded to 600 MW capacity later. The cost of electricity generated by this plant will be at about 7 cents/kWh (Rs2.20). A spin-off benefit will be the daily production of six tonnes of desalinated water. Mineral water to be pumped from the ocean depth will also have the potential for aquaculture and fish farming.

The Ministry of Non-conventional Energy Sources has also received a proposal from Sea Power of Sweden for setting up a 1 MW floating wave power vessel plant in the Andaman and Nicobar islands.

(Source: Extracted from "First-ever OTEC Scheme Set for Tamil Nadu SEB", *Power in Asia*, 7 February 1994, Issue No. 144, pp. 10-11)

Power from Sugar Cane

From P. 7

cheap, environmentally-benign energy.

Ethanol produced from crushed sugar cane fuels one third of Brazil's 13 million cars. Dry pulp or bagasse – a byproduct of the process is burned to generate electricity.

Using conventional technology, a moderately efficient sugar cane processing plant can generate about 20 kWh of electricity per tonne of cane, roughly enough to run the factory. By introducing a combined bagasse gasifier and steam-injected gas turbine new technology can increase that energy yield 23 times, to 460 kWh.

A spin-off from expensive research in military aircraft technology has made steam-injected gas turbines commercially available for power generation. The modern steam-injected gas turbine captures its own high-temperature exhaust, uses it to form steam and injects the steam back into the combustion chamber with the gaseous fuel, thereby increasing both efficiency and electricity output.

Biomass can be gasified by the same process as coal gasification which has received a significant investment of utilities and government energy departments; and researchers claim that biomass will be one-fifth cheaper to handle than coal.

The accord should see environmentally-acceptable power supplied to a rapidly-growing region, while its labour-intensive sugar cane industry should be revitalised, cutting rural unemployment.

An efficient bagasse-based technology is especially appropriate for many developing countries. According to the estimate of researchers at Princeton University's Center for Energy and Environmental Studies, this technology could increase the potential power capacity from bagasse in 70 sugar-producing developing countries to about 50,000 MW, more than a quarter of their current utility-generated electricity capacity. Bagasse-fired power could amount to as much as these countries' entire oil-fired electricity production.

Use of renewable energy resources instead of coal or petroleum could help countries to improve their balance of payments and reduce emissions from fossil fuels. The idea is that the same amount of carbon dioxide as is produced during combustion will be absorbed by the following year's growing crop of sugar cane.

(Extracted from "Sao Paulo Sugar Power", *Petroleum Economist*, Vol. 60, No. 11, pp. 42-43)

Conventionally Fuelled Engines Versus Renewable Energy Equipment

The Power Guide: An international catalogue on small-scale energy equipment, published by Intermediate Technology is intended to be a guide to renewable and small-scale energy equipment (up to 250 kW) for the developing world. The Power Guide catalogues small-scale energy equipment and provides information on hundreds of products from almost 500 manufacturers and suppliers in over 40 countries throughout the world. It will help those looking at energy choices to select the most appropriate energy source and conversion technology, and find out where to obtain the necessary equipment. In one of its introduction sections, the guide highlights the advantages and disadvantages of conventionally fuelled engines versus renewable energy equipment.

The main disadvantages of conventional power systems are:

- dependence on a regular supply of fuel, spare parts and lubricating oil;
- inability to provide continuous power at levels below about 2 kW;
- inability to provide even intermittent power economically below about 0.5 kW;
- noise and pollution;
- high operation and maintenance costs; and
- a need for relatively frequent human intervention (unless complex and expensive automatic control equipment is provided).

The first problem, relating to the difficulty in providing reliable fuel, consumables and spare parts in remote areas, is often one of the primary restrictions on the spread of conventional power units beyond the limits of the all-weather road network. The difficulty in matching internal combustion engines with electrical (or other) loads below about 2 kW is also a major problem. Today there is an increasing need to power much smaller electrical loads such as lights, TVs and video players, small refrigeration units, telecommunications equipment, small power tools, and so on, most of which individually need power in the range from 1 to 200 W.

Matching a generating set to a load that is too small is not only uneconomic (as small engines are inefficient at part load) but it can cause damage and premature failure of the engine in some cases as a result of poor combustion and excessive carbonization of the cylinders.

Therefore, in some respects, generating sets are inappropriate and inconvenient for the multitude of small electrical and other applications that are already needed or which can be envisaged to improve life in remote areas. However, small internal combustion engines do have a number of major advantages in appropriate applications, in that they are:

- of low capital cost in relation to the power they can deliver (so they represent the least-capital-cost method of providing power in most situations off the grid);
- able to be started quickly and reach full power very rapidly, so they offer power on demand with great flexibility;
- small and light in relation to their power rating and therefore more portable than other power sources in terms of power/weight or power/size ratios; and
- almost universally used, so sources of supply are common and the skills to operate, maintain and repair them effectively are widely available.

The so-called 'renewable energy technologies' are to some extent the opposite of conventional internal combustion engines in the sense that their disadvantages are generally the reverse of the advantages given above, and vice versa. In general, the renewables suffer from:

- having high capital costs;
- being inflexible in operation in terms of meeting variations in power demand (unless batteries or other energy storage is provided to meet any mismatch between energy supply and demand);
- being relatively large in relation to their power rating (so less suitable for portable applications); and
- being unfamiliar technology, where procurement, operation, repair and maintenance often demand knowledge and skills that are not easily found.

To some extent the disadvantages of the renewables are slowly being reduced, if not removed, as their cost-effectiveness (in real terms), efficiency and flexibility slowly improve with technical development and growing production and use. At the same time their familiarity is also slowly increasing.

In conclusion, the main advantages of the renewables relate to their ability to provide firm, reliable power at very low power levels with minimal human intervention. Moreover, many renewable technologies have hardly any requirement for supplies of fuel or other consumables, and negligible day-to-day running costs. Other factors, such as reduced or zero environmental pollution and quiet operation, tend to be attractive spin-off benefits of renewable technologies rather than direct reasons for using them.

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SMALL SCALE WIND ENERGY SYSTEMS

Published with financial support from the Netherlands Minister for Development Cooperation
Editors: Goezinne & Veldkamp, Renewable Energy Consultants

EDITORIAL

From time to time we are approached by people who want to reinvent the wheel by design a windmill on their own. Our sound advise is: don't do it! The best thing to do is to buy a reliable windmill.

However, if you do insist on making a windmill yourself be sure to make use of the knowledge and experience incorporated in the current designs, do not make the same errors again in your machine.

I leave it to your imagination which ways there are to obtain such knowledge. One way is shown to you here.

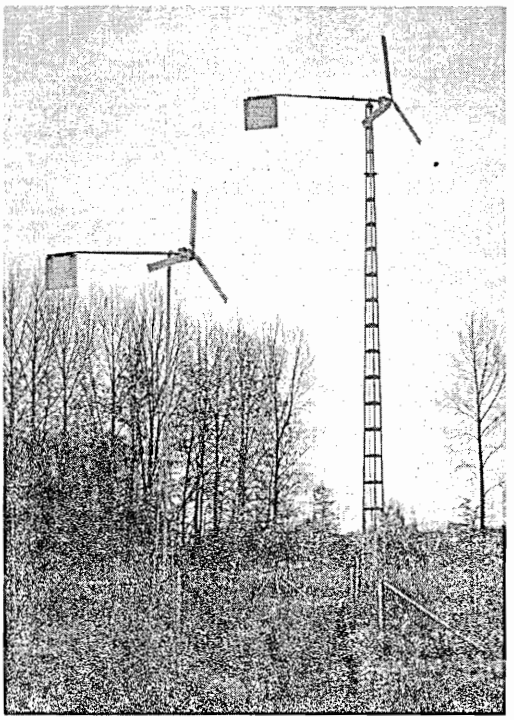
Frank Goezinne/G&V

Pwani Quietly Catch the Market – Kenya

Pwani is a small but industrious company on the coast of Kenya. It started in 1972, and in the early eighties it began production of windpumps. Significantly, the company did not receive international development aid, and is a good example of local entrepreneurial skill. It is fair to say that the quality of the early machines was fairly low and a survey report of 1982 shows that less than 50% of the systems were operating. However, a commitment to their product has seen the company, and its engineering, mature. In the late eighties it did have some involvement with GTZ the German aid agency, in the production of handpumps (Afridev), increasingly quality control on the windpumps, and in the form of a credit scheme for farmers. The credit scheme offered farmers 100,000 KSh (US$2700) for a well and a windpump, with a 30% down payment coming from the farmer. Pwani installed 36 windpumps under this scheme before it ended in 1989.

The Pwani company has produced over 160 windpumps mainly 14 feet (approx. 4m) in rotor diameter. This compares with Kijito Windpumps, the other principal windpump producer in Kenya, who have sold over 220 windpumps. There are, however, some interesting differences between the two windpump companies. Unlike Kijito which as a company serves the whole country and can work in the harsh conditions of the Turkana desert, Pwani has adopted a cluster approach. Along the coast of Kenya there are strips of farm land where grid electricity is not available. This farm land is occupied by either new settlers or "holiday" homes. The farmers are interested in

Cont. P. 2



The VIRYA-2 and VIRYA-3.3

Manufacturing Your Own Wind Generator

If you think of making wind generators yourself here is some interesting news.

Detailed building plans and manuals (in English) for two small electricity generating windmills are provided by the Dutch company KRAGTEN DESIGN.

The two mills, type VIRYA-2 and VIRYA-3.3, have rotor diameters of 2 and 3.3 metres and rated powers of 120 and 800 Watts,

Cont. P. 2

Pwani Quietly Catch the Market – Kenya

From P.1

cattle,poultry, and domestic water, and in many cases irrigation of citrus and other fruit trees (Bananas, Mangos, Papaya). Regarding the "holiday" homes, there are numerous people currently working in the city who purchase a plot of land and build a house. This house is used at weekends, and is intended to be a retirement refuge. By selling mainly to this private market, Pwani also distinguishes itself from Kijito, whose client constituency is more dominated by development agencies.

To this private market, Pwani sells a package which can be drilling of a borehole plus handpump, or borehole plus windpump. The water is at about 30m and the wind regime is reasonable and predictable as it is so near the coast. Diurnal effects are strong and push the potential of the wind regime higher than its 3 to 4m/s average would suggest. The drilling costs about 160,000 Kenya Shillings (US$4,300). Many clients start with a handpump and then after some generation of income from the resulting fruit produce they upgrade to a windpump. A medium Pwani windpump costs 85,000 KSh (US$2350) inclusive of the 9m tower and pump.

High cost or High quality – can we have both?

Mr Sodha, the founder and managing director of this family business, feels that the price is too high and is looking to build a cheaper machine. The existing machines are based on fabricating a modified copy of an old Australian or American multiblade. The success of Pwani with this copy flies in the face of some "experts" who have said that such a copying exercise cannot be made to work. One of the reasons Pwani have been successful is their policy clustering and ensuring they sell windpumps only to the truly interested. A neglected windpump breaks down quickly, and so Mr Sodha asks that farmers show their commitment to the concept by placing the windpump where there are few trees.

S.J. Batchelor/Gamos Ltd, UK

Electricity Sets It Alizes, Mauritania

An introduction to the Alizes programme was given in these pages in the near past. To reiterate, Alizes is the name of a project run in by a partnership of the Hydraulic and Energy Ministry, CNEA (National desk for alternative energies) Mauritania, and French NGO the Institut Technologique Dello and Espace Eolienne Regional. The government has policies to give access of clean potable water to all its people, and to promote and give value to renewable energy and local resources. In response to these mandates the Alizes programme was started in May 1990.

With its emphasis on water, Alizes has developed an interesting strategy. One of its most important features is the idea of clustering. It expects to install just over one hundred windpumps in a limited area. In this way the infrastructure to operate and maintain the

Cont. P. 3

Manufacturing Your Own Wind Generator

From P. 1

respectively (VIRYA stands for 'Energy' in Sanskrit).

Both mills have generators made from standard rotary current motors with 220/380 V windings. The standard motors are partly modified by providing them with a permanent magnet armature to avoid the use of brushes and to obtain better performance.

The rotor is directly mounted on the generator shaft. As the rotor speed is much lower than the original (220/380 V) motor speed the machines generate 24 Volts DC.

As the machine is designed to be manufactured in developing countries (possibly with exception of the generator) basic materials like mild steel and wood (blades) are used.

The machines hardly require attention as the mill is provided with an automatic so called "hinged side vane safety system" which turns the head out of the wind at high wind speeds, see photograph.

Maintenance costs are kept to a minimum: both mills have maintenance free head bearings and non-guyed towers which can be erected and lowered easily because of hinges at the tower foot.

The designs have evolved from extensive field tests with several prototypes of the mills for more than ten years.

The building plan consists of assembly drawings of the whole mill plus the detail drawings of all separate parts. In the manual several aspects are explained in detail, e.g. safety system, manufacturing of parts, mounting and installation, maintenance, electronics and testing.

The prices for the drawings and manual, including mailing costs but excluding VAT or import duties, are for the VIRYA-2 Fl 260 (around US$ 140) and for the VIRYA-3.3 Fl 360. There are no licence costs for serial manufacture.

For an information leaflet and order form write or fax to: KRAGTEN DESIGN, Populierenlaan 51, 5492 SG St. Oedenrode, The Netherlands, fax +31 4138 75770.

Frank Goezinne/G&V
The Netherlands

Electricity Sets It Alizes, Mauritania

From P. 2

windpumps can be justified and ultimately will be self supporting. Towards this end, the Alizes project will assist in the private local manufacture of windpumps, help set up the organisation of a regional maintenance network and encourage the participation of the purchasers from the very start of the process of windpump purchase.

Alizes chose the area of south Trarza in the South West of Mauritania. This was due to the good average wind speed (trade winds), the fact that there were a number of wells in the area with a depth not exceeding 30m, and the numerous rural population with a relative ease of access to the project area. The area can be thought of as a half circle of about 100km around Rosso the regional capital.

In addition to water, the Alizes programme hopes to promote renewable energy more generally. The most natural starting place to follow on the wind/water work, is wind/electricity. The programme has installed 3 wind generator systems so far. They have chosen to purchase and install LMW machines, in the 1kW to 2.5kW range. They each have very different uses.

The first, an LMW 2000, is pumping water! It draws water over a 15m head and delivers it over 3km from the Senegal river. This delivers clear water in an area where the boreholes only yield salty unpotable water. The system is also used in a limited way for charging batteries for the local population.

The second machine is more dedicated to home electricity, and serves 20 houses with enough power for lighting and radio. This delivers an effective half kilowatt, and it has been found that it gives about 9kWh during a 24hr period.

The third system is more unusual. It drives a refrigerator for commercial fish and meat production. The location with its annual average temperature of 37 degrees Celsius, and April to June monthly averages being above 40, makes food preservation difficult. The main products of the area are fish from the river, and meat from the nomadic pastoralists. The refrigeration system therefore opens up significant marketing possibilities. Wind/refrigeration utilises the wind energy well in that the cold store provides a buffer to absorb the fluctuations in the wind regime.

Small Generators and Windpumps

In addition to the LMW systems, the programme has been discussing with Marlech about supply and possible local construction of their small machines. The region has a strong steady wind most of the year. In the first half of the year, the winds are driven by the Trade Winds averaging at about 4.5m/s, while the latter half of the year the average drops to about 3m/s as the monsoon comes in. Very suitable for this type of small wind generation.

Regarding the 100 windpumps; in the update filed last year June 93, it was reported that 62 windpumps have been installed. This is well on target for the planned 101 windpumps in five years, despite the difficult political circumstances of Mauritania. The costs were reported as US$9400 where some 15% was to improve the existing well, 35% for tanks, fences and taps. Only 38% was for the actual windpump, with a further 12% for the installation and guarantees. It was decided that the village would contribute 15% of the total cost and that payment had to be made first before an order was considered valid. The first round of talks with 30 villages yielded 26 requests. The requests were filled by a small enterprise in Nouakchott, the Ste Deyloul. This enterprise, ten persons, was chosen because it was interested in renewables and had the capacity to manage spares, maintenance and sales. Deyloul has a commercial contract with Alizes, to first import windpumps from Oasis and then gradually learn to manufacture various parts. After the first 30 windpumps were installed on existing wells, other villages were offered the possibility but had to pay for the well in addition to the 15%. An interesting feature of the financing is that for an extra US$400 per year, the village can have an ongoing total guarantee. Mr Jacques Monvois said that up to 75% of purchasers choose this option!

It was noted that an important factor is the right of Deyloul to sell windpumps privately outside the programme. It is this that makes the result of 62 windpumps in three years exciting. Of the 62 only 50 are within the programme, a further 12 are private sales! This is a good sign that the technology has broken through and could become part of the local market.

Water Output

Some preliminary results in terms of water output are available. There has been an opportunity to measure the actual output of the systems. For a 25m head the daily output for a 4.5m/s average windspeed was predicted to be 15 cubic metres. The actual results are close. The first measurements were taken from a system with a 10m head. The first measuring period of 4.5m/s only yielded 13.5 cubic metres, but a second period with only a 4.1m/s average gave 16.5 cubic metres. Other studies conducted by IT Power and the former CWD have shown that there is always a wide variation in output given a daily average, and so the different results are not surprising. Also it has been shown that the yield of a multi-blade windpump tends to depend more on the pump diameter than minor differences in head. In this case standard pump sizes meant the pump was slightly under size for the head, and could be comparable to the 25m predicted output. Hence the results are within the range predicted by the theoretical model.

Cont. P. 4

Indonesia Looks at Small Wind Systems for Households

In Indonesia, very probably plans to install thousands of small, autonomous wind energy conversion systems with battery back up, will be carried out. Paul Hensing, a Dutch renewable energy consultant, negotiates with the Indonesian firm P.T. Saruntawaya Baru about the implementation of the project. A pilot project in Dajapara, on the north coast of Java, has shown that continuous supply of households with electricity is feasible with small windturbines with a rated power of 250 W or more. The project will be executed on the basis of extensive technology transfer. The vast majority of the components will be produced in Indonesia and the assembly of the turbines also will be done locally. Possibly, the World Bank will be involved in the project.

Indonesia counts 18,000 islands of which many are scarcely populated. But even on the main island Java there are vast rural areas without a grid infrastructure. Indonesia is a country with a fast growing economy with a strong emphasis on investment in new industries. As a consequence of the limited financial possibilities and the requirements of industrial development, the construction of new grids and new central generating stations for rural regions are not the first priority of the government. Apart from that, the rapidly increasing demand for energy will cause serious environmental damage if this demand is met by the construction of large conventional generating stations, burning fossil fuels. The government therefore prefers the use of renewable energy sources to generate electricity for domestic use in non urban areas.

Until recently, the supply of electricity in such areas was ensured by diesel/battery systems. But most of these systems have come to the end of their lifetime. They cause air pollution and there are sometimes logistic problems with the supply of diesel oil. Moreover, also in rural areas, the demand is increasing and the capacity of the diesel systems is not sufficient anymore.

The plans of Hensing, Saruntawaya Baru and Dutch wind turbine manufacturer LMW aim at the founding of an Indonesian industry, manufacturing LMW's stand alone turbines and its components in licence, initially producing at least 5000 a year of them.

Hensing: "Although the average wind speeds in Java are not very favourable, we have very good experiences with the pilot project in Djapara where a number of 250 W and some larger systems have been tried out. We were able to ensure continuous supply to the households that were connected to the turbines. The turbines we use start producing at very low wind speeds and they have worked satisfactorily in the Indonesian circumstances. The project aims at selling turbine/battery systems to households for their individual electricity demand. An average household can meet its demands for lighting and small domestic appliances, television and audio sets, small equipment, etc. All the components and the assembly as well as the batteries can be manufactured locally. There will be one exception to this: the rotor blades will have to be imported. However, there is quite some experience and know how in the field of manufacturing polyester products in Indonesia. Once the local industry has acquired the specific know how of manufacturing high quality rotor blades, the production of this main component also can be transferred to Indonesia."

Hensing expects that in the future, when photovoltaic systems have been developed further, hybrid photovoltaic/wind systems with battery backup will take a fair share of the Indonesian energy supply. Hensing expects that a final positive decision on the plans to start local quantity production of LMW's wind/battery systems and to install them by thousands, will be made soon.

Frans Janse, The Netherlands

Electricity Sets It Alizes, Mauritania

From P. 3

Measuring has not been an easy task for the field workers. Anemometers have proven unreliable in the harsh climatic conditions. Also villagers often stop the windpump when there is too much water! The demand for water is steadily growing as irrigated gardens are developed, and so the problems of them switching the system off should be resolved over time. Experience showed that the villagers were inclined to act too quickly to shut down the windpump, and to confuse the two positions on the brake. One position furls the windpump to stop water flow, but a second position locks the rotor to make it safe for maintenance and repair. The villagers all too easily locked the rotor and so a screw was installed in the brake bracket to prevent this.

Simon Batchelor/Gamos Ltd, UK

Citation is encouraged on the condition that the source is indicated.
Reactions or other contributions are welcomed. Please write to:
Goezinne & Veldkamp, P.O. Box 775, 7500 AT Enschede, The Netherlands.
Fax: +31 53 32 70 27. Tel: +31 53 32 70 27. Telex: 44846 bchs nl.

Responsibility for the articles rests solely with the authors. Contributions should preferably not be longer than 300 words. For longer articles please contact the editors. The editors reserve the right to shorten reactions and articles.

Energy Efficiency Centres in Developing Countries

Five pilot centres to promote energy efficiency in developing countries were formed during 1990-1993 period under a four year partnership between Batelle/Pacific Northwest Laboratories and World Wildlife Fund (WWF).

Energy efficiency centres in China, Russia, Poland, Bulgaria and the Czech Republic are flourishing and they are expected to become self-supporting after three years, says William Chandler of Batelle/Pacific Northwest Laboratories. A similar centre has also been planned for Ukraine.

Initial funding for the centres has come from the US Agency for International Development, Department of Energy, Environmental Protection Agency, and such private foundations as MacArthur, C.S. Mott, Honeywell, and Goldsmith. In addition, DOE's Lawrence Berkeley Laboratory joined in founding the Beijing centre.

The use of local experts in these centres has produced benefits for the host countries "for one-tenth the typical cost of foreign aid", says Chandler, "we have created a new approach to international cooperation". These centres will continue to provide policy advice and business services long after all the US government contractors have gone home or moved on to greener pastures.

The energy efficiency centre in Beijing will deliver mutual benefits for China and the United States because China is a big market for advanced US technology and providing US energy saving devices to Chinese factories and homes will save money and reduce air pollution, says director Zhou Dadi.

China is aware of the possibility of increased environmental pollution as it develops economically and living standards of its people rise, he says. Therefore, the improvement of energy efficiency right from the beginning is important for China so that it will not repeat the mistakes of more advanced nations.

Coal accounts for 75% of Chinese energy needs and clean coal technology is therefore crucial to the country's air pollution abatement.

The Beijing centre formed three months ago will help introduce high-efficiency electric motors and boilers, and will train Chinese utilities to adopt US-style integrated resources planning.

The WWF is seeking $100,000 to further support the Beijing centre, said William Eichbaum – vice president of the WWF.

The centre in Warsaw, Poland, has drafted an electric utility reform legislation modeled after energy efficiency programmes in California and northeastern US states. The legislation would enable utilities to make money by helping their customers save energy.

Energy efficiency legislation has also been drafted by the centre in Moscow and submitted for consideration by the government.

The centre in Prague, operational since 1990, has attracted $30 million in contracts from one US firm.

These centres operate as non-governmental, not-for-profit organisations before becoming self-supporting.

(Source: Extracted from "Developing countries promote energy efficiency", *The Pakistan Times*, Monday, February 7, 1994, p. 8)

Australia's Award for Energy Efficient Building

Australia's 1993 national Energy Award for buildings went to architect Garry Baverstock, the designer of an energy efficient office building in Perth, the Solar Energy Information Centre. He is also director of the centre.

After the building was built in 1989, annual expenditure on electricity for the 923 m² building has been less than half that of conventional buildings. From May 1992 to April 1993 electricity cost was A$10.80 per m² compared to an estimated A$22 to A$28 per m² for a conventional building.

The construction of the building costed A$1.1 million. A conventional building would have cost a similar amount.

Environmental features in the building are:

- The use of polystyrene roof panels to reduce the amount of steel in the structure.
- Solar air heating rather than reverse cycle or gas appliances.
- Elimination of the use of CFCs in cooling systems by using an indirect evaporative cooler and the ventilation of cooler air through the building each night.
- The use of a 100% fresh air cooling system to improve the health of occupants.
- Maximum use of daylight through skylights fitted with slat shades to reduce the ingress of heat in summer.
- Low wattage fluorescent lighting in corridors.

The building is controlled by a computer programmed to respond to temperature changes according to season and to open venting and air cooling systems automatically.

(Source: Extracted from "Australia's Annual Energy Awards", *Solar Progress*, Vol. 14, No. 4, p. 27)

Superconducting Magnetic Energy Storage Plan

Anchorage Municipal Light & Power, USA has planned to form a venture with Babcock & Wilcox Co. to develop and construct a commercial superconducting magnetic energy storage (SMES) system. Though relatively small, the 30 MW SMES, costing $25 million, will be large enough to greatly improve stability and reliability of the Alaskan City's power system, which is subject to frequent outages, and it will also save money.

B&W's Nuclear Fuel Division, Lynchburg, VA, has been involved in SMES technology for six years and was a major supplier of magnets to the Superconducting Supercollider Labo-

Cont. P. 13

Environmental Impacts of Wind Energy Applications

The environmental impacts of conventional fossil fuel powered generation, such as acid rain, global warming and the depletion of finite fuel resources, are well publicised and have led to increased interest in the use of sustainable, renewable sources of energy. In comparison to other renewable sources power generated from wind is one of the lowest costs. Hereafter we consider positive as well as negative environmental effects of wind power development.

Environmental and Other Benefits

Wind power offers several important environmental benefits:

- There are no carbon dioxide (CO_2) emissions to contribute to global warming and increase the greenhouse effect.
- There are no sulphur and nitrogen oxide (SO_x and NO_x) emissions to contribute to acid rain.

In addition:

- There are no radiation hazards.
- Fuel is free, incurs no transport costs and produces no waste.
- There are no thermal emissions (i.e. heat loss) into the atmosphere.
- Wind turbines have a good safety record and are simple and clean to decommission.
- Use of wind energy saves the consumption of precious finite fossil fuels.

Environmental Impacts

Potential adverse effects of wind power generation on the environment include visual impact, noise, electromagnetic interference, power transmission, and impact on ecology.

Visual Impact

For good wind speeds, wind farms need to be sited on high, exposed land and so the turbines, together with the power transmission lines from the site, can cause some visual intrusion. The assessment of the visual impact of wind turbines is a subjective process and there is a delicate balance to be struck between some loss of landscape value and the environmental benefits of the technology. A wind turbine is not a particularly large structure, typically having a tower height of 30m and a rotor of 30–35m diameter. However, for example, wind farms proposed for the United Kingdom typically consist of 10–30 machines distributed over several square kilometres of high, open land and there is possible conflict with landscape values.

Noise

Noise emissions from wind turbines are of a relatively low level compared with other every day activities. They have been likened to the swishing sound caused by branches of trees during a brisk wind. However, because of the nature of sites required for wind farms, wind turbines will often be located in areas of low background noise level where even the relatively low noise contributions from the turbines may be detectable. Even in these circumstances, it is only likely that the wind turbine noise will be detectable for limited periods of time during low wind speed operations, since at higher wind speeds the ambient noise level due to wind noise from trees and buildings increases sufficiently to mask the turbine noise. Careful design, siting and operation should ensure that wind turbine noise is not nuisance. Noise considerations may limit the number of turbines which may be sited in a specific area.

Electromagnetic Interference

Interference with television reception is not usually a problem and any necessary remedial action is simple and cheap. Other impacts, such as interference with public service transmissions (e.g. microwave links), are very site-specific. Sites likely to cause problems in this area would be avoided.

Power Transmission

The choice of power transmission route through scenic areas may also prove to be sensitive but there are well-established procedures for handling this issue, based on many years of experience from the assessment of power line planning applications.

Ecology

There are a few concerns about the effects of wind turbines on the local ecology. These usually focus on loss of land usage, fragile ecosystems (such as peat land flora) and the potential effect on birds. However, the amount of land used in constructing a wind farm is only a few square metres per machine and the effect on natural habitat and farming activities is minimal. Fragile land is under threat during construction of the wind farm and adverse affects can usually be mitigated through good construction practice. Birds could be affected either through displacement from existing habitat or through impact with rotating blades, but experience to date show that the effect of wind turbines on bird life is small.

For further information on wind energy applications and the environmental impacts contact:

Renewable Energy Enquiries Bureau
ETSU, Harwell
Oxfordshire OX11 ORA
United Kingdom
Tel: 0235 432450

(Source: Extracted from "The Wind Farms Project", *Department of Trade and Industry Information Bulletin*, United Kingdom, Issue 4, Summer 1993)

Switch over to CNG Cars to Save Environment, Pakistan

Though diesel is thought to be one of the cheapest, most readily available fuels, compressed natural gas (CNG) is another clean economical, alternative transport fuel, now available in Pakistan.

Realising the importance of CNG, the Pakistani Government has already awarded licenses to about 29 private parties to set up CNG plants and stations all over the country. Presently CNG stations, under the HDIP (the Hydrocarbon Development Institute of Pakistan), are working at Islamabad and Karachi and have so far converted about 1500 cars and 10 diesel buses. The station at Lahore is under construction and will be ready by the end of 1994. Two stations under the private sector will soon be set up at Karachi by Caltex and Ecotec Pakistan, while another one is likely to be set up in Islamabad in the future.

"With growing awareness and concern about the environment, it is time that people now switch over to CNG as an alternative fuel. It is free of sulphur and lead, produces 90% less carbon monoxide in exhaust emissions, has no fumes and above all is economically cheap", says Hilal Raza, Director-General of the HDIP.

Converting a petrol car to a diesel one costs somewhere from about Rs 20,000 to 40,000 (US$ 1 = Rs 30), depending on the make of car, engine, etc., whereas conversion of a car to run on CNG costs around Rs 11,000. A major advantage is that a car with a CNG kit can still run on petrol by simply turning a knob on the dash board. Converting a car to CNG is not so complicated. The CNG cylinder is permanently fitted, normally in the boot of the car while the kit is installed in the engine compartment. Refuelling is easy and simple. Just drop in at the CNG station and gas is refilled through a flexible pipe.

CNG is different from LPG (liquefied petroleum gas). LPG is a mixture of propane and butane and is in liquid form, while CNG is composed mainly of methane and is in gaseous form. The kits used for both types of fuels are also different and cannot be used interchangeably.

"CNG kits do not have any mechanical parts, requiring least maintenance and have a long life. The absence of lead keeps the spark plugs clean and decreases the rate of wear of an engine as it does not wash away the lubricating oil from the pistons like petrol", says engineer Shakeel.

Referring to the safety factor, the DG HDIP claims that "CNG is categorised far safer than petrol. It is lighter than air and disperses easily, its self-ignition temperature is 700°C against 455°C of petroleum and its cylinders are made of a special single piece of steel alloy and tested at far greater pressure than is filled."

Cylinders of various sizes have been adapted to fit in cars of different sizes and are available in capacities of 9, 11 and 13 liters. According to the HDIP estimates a 1300-cc car can travel about 152 km in one-fill costing Rs 62. Whereas the same 13 liters of petrol will cost about Rs 182. Thus one can save about Rs 120 on every fill of gas.

(Source: Extracted from "Save Environment: Switch Over to CNG Cars", *The Pakistan Times*, Saturday, February 5, 1994, p.8)

Superconducting Magnetic Energy Storage Plan

From P. 11

ratory. Paul Ayres of the division says: "We see a very big market in the mid-sized unit once we get the first one established...And the unit is portable. A utility can move it or sell it to another utility". If a utility wants greater storage capacity, it would order multiple units.

The manufacturer-utility partners made a joint proposal to the Department of Defence's Technology Reinvestment Program, and in October received an $8.5 million grant. The partners will about split the remaining cost.

The SMES unit will be delivered by rail and barge to Anchorage. It is expected to be 70 ft long by 14 ft in diameter and be on line by late 1997. Ayres anticipates power recovery of 90%. That figure is not much affected by the time of storing electricity, converted to DC current. Power usage in refrigerating the coil with liquid helium at a temperature of 4°C above absolute zero – about 269°C – is not critical, he says. "The determining factor is going twice through the AC-DC conditioning cycle."

With the SMES unit, Anchorage will save about $2 million a year on fuel costs because it will be able to rely more on hydropower and put some combustion turbines on cold standby. It also will reduce the frequency of outages for its 30,000 customers, whose peak demand reaches about 140 MW in the winter. Hydro is not a good back-up for turbines because it takes too long to come on line, sometimes resulting in unwanted load shedding.

(Source: Extracted from "Magnetic Storage Planned", *Engineering News-Record*, Vol. 231, No. 21, pp. 9, 12)

GEF Supports NGO-Activities to Combat Global Warming

The Global Environment Fund (GEF) supports NGO-activities to combat global environmental problems through a new small grants window managed by United Nations Development Program (UNDP). This program consists of country programs and an inter-country component. With the inter-country part of the program it will be possible to fund international NGO-activities.

A total of 7 million US$ was made available for the small grants window by May 1993. The goals of the supported activities must be within the goals of GEF: securing biodiversity, combating climate change and ozone-depletion.

Country-programs

In each country involved a Na-

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GEF Supports NGO-Activities to Combat Global Warming

From P. 13

tional Coordinator is employed and a National Select Committee appointed for selecting the projects to support. For each country a sum of US$ 200,000 is initially allocated. The country fund will be replenished when the initial allocation is used and the program evaluation is positive.

Eligible activities to combat global warming include:

- afforestation/reforestation activities, especially community based fuel wood plantations;
- improved land-management practices, e.g. combatting bush fires, introducing alternatives to "slash and burn" practices;
- household energy efficiency programs, e.g. using fuel wood more efficiently, introducing fuel-efficient, low-emission cookstoves, solar cooking;
- development of alternative sources of energy in rural areas;
- biogas demonstration programs;
- community-based marketing and delivery systems of energy efficient products for household use;
- institutional support to deliver renewable energy systems to rural areas;
- small-scale building projects with innovative technology, e.g. insulation, that conserves energy;
- community-based activities to combat urban greenhouse gases from factories and vehicles, e.g. promotion of public transport;
- public awareness, education and information activities that increase people's understanding of environmental problems and remedies;
- policy and advocacy activities supporting community efforts and/or government policies to conserve the global environment.

Of the first 36 projects approved, one is supporting dissemination of fuel efficient stoves and a number are supporting afforestation/reforestation. The funding for each project is between 3,000 and 50,000 US$ with the majority around 25,000 US$.

For further information contact:

UNDP
One United Nations Plaza
Rooms 2050–2052
New York, N.Y. 10017
USA
Tel: +1-212-906 6076
Fax: +1-212-906 5313

(Source: Extracted from "Global Environment Fund: NGO Small-Grants Window", *Hydronet*, 3/93, p.13)

Fifth AIT–WHO Training Course on Solar Refrigerator Repair and Maintenance

May 30 - June 10, 1994
Asian Institute of Technology, Bangkok, Thailand

The course is organized by the Energy Technology Program, Asian Institute of Technology (AIT) in collaboration with the Expanded Program on Immunization (EPI) of the World Health Organization (WHO).

Course Outline

This two week course is designed to provide intermediate training in solar photovoltaic (PV) technology with emphasis on refrigeration for vaccine storage. It is specifically designed for persons with some prior PV experience or basic electrical training who have a current work requirement for planning, installing, maintaining or supervising programs relating to rural based solar photovoltaic systems for refrigerated vaccine storage.

Persons successfully completing the course will have basic competence in small PV system and solar refrigerator design, installation, and maintenance.

Course Design

The course emphasizes hands-on work supported by sufficient theoretical study to enable a full understanding of the practical components of the course. In general, mornings will be a combination of lecture in theory plus demonstrations illustrating the lecture. Afternoon work will be all practical work with participants working in small groups of three to five, each group having their own instructor. Practical work will consist of experiments with actual components to show their operation and failure modes, actual installation of solar equipment, troubleshooting practice and repair of faulty units.

By limiting the course to twenty participants, attention can be paid to each individual participant's needs. Each day, participants are evaluated and examined regarding that day's work, and additional material and assistance are provided to participants in areas where inadequate understanding exists.

Instructors on the course include AIT technical staff and external instructors from overseas having long, practical experience in photovoltaics and solar refrigeration. Field trips to other sites near Bangkok will be arranged.

Pre-requisites

Candidates should have an understanding of basic electricity and should have job responsibilities relating to the supervision, installation, repair or maintenance of solar PV systems.

This course emphasizes the solar and electrical components of PV refrigeration systems. It does not include comprehensive training in the mechanical repair of refrigerators and additional trades training in compression refrigeration maintenance and repair is strongly recommended if participants work will include the repair of the mechanical components of refrigerators.

Language

Candidates should have the ability to understand, speak and write the English language.

Application

The number of participants is limited to 20. Acceptance will be

on a '**first come first served**' basis, hence applicants should send applications as soon as possible.

Requests for additional information or application forms should be mailed or faxed to:

The Secretary
Energy Technology Program
Asian Institute of Technology
GPO Box 2754, Bangkok 10501
Thailand
Fax: (662) 524 5439 or 516 2126
Tel: (662) 516 0110-29 Ext. 5440
Tlx: 84276 AIT TH
Cable: AIT Bangkok

Fourth International Symposium on Renewable Energy Education

December 12-14, 1994
Asian Institute of Technology
Bangkok, Thailand

Currently, concerns are growing worldwide regarding the environmental consequences of heavy dependence on fossil and nuclear energy sources, particularly global warming, urban air pollution, oil spills, acid rain and nuclear risks. As a result, a consensus is gradually emerging that renewable energy needs to be promoted in order to meet these imposing threats especially global warming.

Promoting renewable energy education is vital and necessarily a prerequisite for effective promotion of renewable energy. Although renewable energy teaching has been gradually and slowly taking roots ever since the oil crisis of 1973, the approach to renewable programs and postgraduate programs is far from established at present.

The International Association for Solar Energy Education (IASEE), which is the Working Group of the International Solar Energy Society on Education, plans to organise the fourth International Symposium on Renewable Energy Education (ISREE-4) at the Asian Institute of Technology, Bangkok, Thailand, during 12-14 December 1994. It is expected that ISREE-4 will be a meeting ground of leading renewable energy experts/educators/teachers as well as government officials/ advisors involved in educational policy making from different parts of the globe and provide a forum for deliberations on all aspects of renewable energy education at different levels. Overall, it is expected that ISREE-4 will be an important event that will contribute to setting the course of renewable energy education into the 21st century.

The organizing committee of ISREE-4 invites papers for the symposium from all countries. Authors are required to submit an abstract not exceeding two pages of A4 size. The abstract should contain author's full name and address for correspondence, and fax number as well as e-mail address, if available. Instructions for preparing the full paper will be sent at the time of notification of acceptance.

The abstracts should be sent to Dr. S.C. Bhattacharya, Chairman Organizing Committee, ISREE-4, Energy Technology Program, Asian Institute of Technology, G.P.O. Box 2754, Bangkok-10501, Thailand, before 15 August, 1994.

Publications Received

ENERGY

* *Annual Review of Energy and the Environment*, volume 18, 1993, edited by R.H. Socolow, D. Anderson and J. Harte, Annual Reviews Inc., Palo Alto, California, USA, 1993, ISBN: 0-8243-2318-1, ix+692 p.
* *Electric Utilities Data Book for the Asian and Pacific Region*, prepared by the Tata Energy Research Institute (TERI), New Delhi, published by Asian Development Bank, 1993, xiv+461 p.
* *Energy Systems in Kenya*: Focus on Rural Electrification, by Dominic Walubengo and Adelheid Onyango, KENGO Regional Wood Energy Programme for Africa, Nairobi, Kenya, 1992, ISBN: 9966-841-08-3, 57 p.
* *Household Energy in Sudan*, by Ga'afar El Faki Ali and Ahmed Hassan Hood, KENGO Regional Wood Energy Programme for Africa, Nairobi, Kenya, 1992, ISBN: 9966-841-03-2, 38 p.

RENEWABLE ENERGY

* *Fundamentals of Remote Area Power Supply Systems: A Text for Tertiary Students*, by A. Akbarzadeh, published by Energy Victoria, Melbourne, Australia, 1992, ISBN 0-7206-3139-7, vi+95 p.+App.
* *The Power Guide*, second edition, published by Intermediate Technology Publications in association with the Technology and Development Group, University of Twente, London, the United Kingdom, 1994, ISBN 1-85339-192-1, xv+280 p.

BIOMASS ENERGY

* *Techno-economic Assessment of Selected Biomass Liquefaction Processes*, by David Beckman, Douglas C. Elliott, Börje Gevert, Christina Hörnell, Björn Kjellström, Anders Östman, Yrjö Solantausta and Virve Tulenheimo, Technical Research Centre of Finland, Espoo, Finland, 1990, ISBN: 952-38-3719-X, 161 p.+App.
* *Regional Training Course on Biomass Energy Development: Management of Community Biomass Energy Programmes, 1991 Course Proceedings*, edited by Muiruri J. Kimani, KENGO Regional Wood Energy Programme for Africa, Nairobi and Nakuru, Kenya, 1992, ISBN: 9966-841-12-1, viii+116 p.

WIND ENERGY

* *Small-scale Wind Energy Conversion Systems*, prepared by K.S. Fernando, Economic and Social Commission for Asia and the Pacific, United Nations, 1993, vii+51 p.+App.

Training Courses/Conferences

Indo–Italian Workshop on Renewable Energy Technologies

April 8-10, 1994, New Delhi, India

The workshop is organised by the Centre for Energy Studies, Indian Institute of Technology. Topics include: energy options in India & Italy, solar energy, solar passive technologies, wind energy, biomass and biogas, micro-hydel energy, ocean energy, and energy conservation & management.

For further information contact:
Prof H.P. Garg
Organising Secretary and Head
Centre for Energy Studies
Indian Institute of Technology
Hauz Khas, New Delhi-110 016
India
Tel: 666 979 Ext. 5001 & 5019
Fax: 9111 686 2037
Tlx: 31-61460 IIT IN or 31-73087 IIT IN

Windpower '94

May 9-13, 1994, Minneapolis, MN, USA

The conference is sponsored by the American Wind Energy Association. General topics to be featured at WINDPOWER '94 include utility wind programs, legislative and regulatory issues, wind resource assessment, international project development, environmental compatibility, economics of wind energy, technology development and project performance.

For further information contact:
Linda Redmon, AWEA Meetings Coordinator
777 N. Capitol Street, NE
Suite 805, Washington, DC 20002
USA
Tel: +1 202 408 8988
Fax: +1 202 408 8536

International Training Course on Rural Energy Sources

June 1 - July 15, 1994, Chengdu, P.R. China

The course is organised by the Chengdu Xingguang Development Corp. for Appropriate Science and Technology (DCAST) and the Chengdu Biogas Research and Design Institute (BRDI).

Contents include:
- Scientific principles of rural energy sources;
- Technical feasibility of rural energy sources;
- Biogas technology (fermentation, design & extension);
- Solar energy (solar application, collector design);
- Mini-hydropower (classification, design & extension), and
- Technical study tours.

For further information contact:
Mr Song Yuhua, Director of DCAST
No. 17, Yulin East St.
Chengdu 610041
P.R. China
Tel: 5541 487
Fax: 581 849
Tlx: 60109 JJHCN

Available also from DCAST is the book **Biogas Technology in China**, China Agricultural Publishing House, ISBN 7-109-X/S.174, October 1991, 259 p. Contents of the book include: Biogas fermentation, biogas digesters, biogas conveyance, application of biogas, comprehensive utilization of biogas fertilizer, and biogas in cities and towns. Price: US$ 35, air mailing included.

Second World Conference on Solar Cookers – Use and Technology

July 12-15, 1994, Heredia, Costra Rica

The conference is partially sponsored by the Universidad Nacional, Heredia, Costa Rica and the Solar Box Cookers International (SBCI), USA.

Topics include:
- Solar cooker theoretical models, computer simulation, technology, adaptations for diverse applications
- Cultural, nutritional and economic issues of solar cooking
- Dissemination strategies
- Varied use of solar cookers
- Testing of solar cookers, etc.

For further information contact:
Dr Shyam S. Nandwani, Coordinator
Sección de Energía Solar, Departamento de Física
Universidad Nacional, P.O. Box 728
Heredia, Costa Rica (CA)
Tel: (506) 37-6363, ext. 2482, 2344
Fax: (506) 37-4111, 37-6427, 37-7032
E-mail: SNANDWAN@UCRVM2

Asia Energy Efficiency '94 Conference

September 22-23, 1994, Singapore

The conference provides a forum for professionals to demonstrate and discuss the state-of-the-art in energy

efficient motors, lighting, cooling systems, automated controls, energy storage, and technical progress in the utilization of renewable energy sources. As this event coincides with the ENEX-ASIA '94 and GlobalTRONICS '94 exhibitions, participants in the conference can maximize their mutual benefit by exchanging expertise with leading experts and professionals.

For details contact:
Ms. Irene Low
Conference Manager
Reed Exhibitions (S) Pte Ltd
1 Maritime Square #12-01
World Trade Centre
Singapore 0409

International Training Course on Energy Management in Small and Medium Scale Industries

October 10 - November 11, 1994
Maastricht and Enschede, The Netherlands

This annual five-week course will be offered for the 8th time by the Technology and Development Group of the University of Twente (TDG/UT) and the Maastricht School of Management (RVB/MSM). The course is sponsored by the Ministry of Development Cooperation of The Netherlands.

The course programme consists of lectures, case studies, exercises, group discussions and industrial visits with respect to the following subjects:

- Management of small and medium scale industries (SMI): leadership and motivation in industrial context, developmental, social and environmental functions, human resource management, internal efficiency and competitiveness, strategic management, markets, communication and extension;
- Economic issues: factor costs, energy costs and price structures, business opportunities and threats, budgeting, costing, financing, cost control;
- Project management: identification and formulation, feasibility analysis, appraisal, decision making, implementation;
- Energy supply: fuels and electricity, conversions, cogeneration, fuel substitution, renewable energy sources, technology options, costs;
- Energy assessment: auditing, data interpretation, control, conservation opportunities, energy demand management, energy housekeeping;
- Energy policies: policy instruments, energy substitution and conservation, energy balances, industrialisation, public and private sector, environmental and demographical factors, sector-, national-, and international policy levels, socio-economic development and energy strategies.

Another annual programme is the international training workshops on Energy and Environment for Sustainable Development, May/June/July 1994. This programme is organised by the Technology and Development Group of the University of Twente, in close cooperation with the International Institute for Aerospace Survey and Earth Sciences (ITC), at Enschede, The Netherlands.

For further information contact:
Mrs. Ir.G.L. Stassen-te-Velde
Technology and Development Group
University of Twente
PO Box 217, 7500 AE Enschede
Netherlands
Tel: +31 5389 3539/3545
Fax: +31 5334 0822
Tlx: 44200 thtes nl

European Conference on Energy Performance and Indoor Climate in Buildings

November 24-26, 1994, Lyon, France

The three days programme for this conference will comprise full session, invited papers, poster session and industrial sessions.

Topics include:

- Design tools,
- Simulation and prediction,
- Thermal performance of buildings,
- Ventilation,
- Indoor air quality,
- Urban climatology,
- Shading,
- Summer comfort,
- Daylighting and energy,
- Test methods,
- Monitoring,
- Control strategies,
- Innovative building components: solar performance, heating, cooling,
- Natural and innovative cooling techniques,
- New materials,
- Standardization and regulation,
- Political, economical and social aspects, and
- Educational aspects.

For further information contact:
Dr G. Guarracino (E.C.EPIC in Buildings)
Laboratoire Sciences Habitat, Dpt.G.C.B., CNRS
Ecole Nationale des Travaux Publics de l'Etat
Rue Maurice Audin
69518 Vaulx-en-Velin
France
Tel: 33 7204 7031
Fax: 33 7204 7041
Tlx: ENTPE 370511 F

Book Review

Small-scale Wind Energy Conversion Systems

Prepared by K.S. Fernando
Economic and Social Commission for Asia and the Pacific (ESCAP)
United Nations, New York
1993, vii+51 p.+App.

This publication is part of a project on regional cooperation in wind energy technology, funded by the Government of Australia and implemented by the Economic and Social Commission for Asia and the Pacific (ESCAP).

In particular, considerable advances in wind energy technology during the last decade make it the most mature and cost effective renewable energy technology which could compete with most conventional sources of energy when viewed within the framework of environmental least-cost analysis.

In the developing country perspective, a clear role for renewable energy is seen in the supply of energy to rural areas where the demand and geographical characteristics make the extension of centralised energy supply systems uneconomical. An example of such a situation is the extension of the national electricity grid to remote areas where the electricity demand is mainly characterised by household lighting. Due to extremely low load factor resulting from such a demand and the scattered nature of dwellings in villages, the extension of grid to such areas often turns out to be uneconomical. But still, the social and political concerns about the expansion of rural electrification cannot be overlooked.

This publication reviews the state-of-the-art of wind energy resources assessment and the technology status of wind energy conversion systems (WECs) in the developing countries of the ESCAP region. The national and international roles in the promotion of development of wind energy technology in the region are also discussed. The study is focused on the application of small scale wind-electric systems for provision of basic electricity needs of rural households in countries in Asia and the Pacific.

In chapter A, the general atmospheric circulation is briefly introduced with a view to explain the origin of the wind system. An attempt is then made to present main features of the regional wind climate in the Asian and Pacific region as well as the circumstances leading the formation of localised winds. Finally, wind characteristics and issues related to wind resources assessment are discussed. Chapter B is devoted to the introduction of basic theoretical aspects of harnessing wind energy followed by an overview of the technology and its performance.

Application of wind electric systems for rural electrification is discussed in Chapter C, starting with a review of rural electrification issues in regional countries. It is then followed by a review of national wind energy programmes. The chapter concludes with a case study in which a complete analysis of a wind powered rural electrification scheme is presented. Other possible energy supply options for the same situation as in the case study are then analyzed along with a cost comparison.

Issues concerning the promotion of wind energy applications in regional countries and scope for regional cooperation are discussed in Chapter D. The study concludes with a series of recommendations for accelerating the development and utilisation of wind energy technology in countries in the ESCAP region.

Fundamentals of Remote Area Power Supply Systems: A Text for Tertiary Students

A. Akbarzadeh
Energy Victoria
Melbourne, Australia
ISBN 0-7306-3139-7, 1992, 95 p.+app.

During the past three decades, the attraction of renewable energies has experienced many ups and downs almost parallel with the oil price. In spite of hard work, enthusiasm, and the efforts of many alternative thinkers, renewable energies have usually been hammered by the notion that they are not a reliable and economically viable technology.

Remote area applications have provided an opportunity for renewable energies to prove the contrary. It has been demonstrated in numerous locations that renewable energy based systems can economically and reliably provide the needed power in remote areas.

This text book explains the fundamentals of remote area power supply systems which are primarily based on renewable energy. The book is aimed at tertiary students. At the same time it has been developed so that the material can be understood and followed by readers with knowledge of high school physics.

The book contains the fundamentals of solar and wind energy. It provides tools for estimating the potential and limitations of these renewable energy sources.

It also provides information on equipment and system design for conversion of wind and solar energy to electricity and its storage as a power source in remote areas.

There is an exclusive chapter on the economic analysis of remote area power supply systems which helps the reader to assess the economic viability of different options for power production in remote areas.

The appendix contains useful information on some of the typically available products which can help the reader with a preliminary system design and costing.

Each chapter contains sample problems and step-by-step solutions. Also, at the end of every chapter there are problems which can be assigned to students.

The aim of this book is to provide educational material

on renewable energy based remote area power supply systems in such a way that the reader is able to intelligently design and cost such systems.

Remote Area Power Supplies

Second edition
Energy Victoria and State Electricity Commission of Victoria
Melbourne, Australia
April 1993, 67 p.

Advances in technology and decreasing costs have made remote area power supplies (RAPS) increasingly popular.

This edition of Remote Area Power Supplies provides up-to-date information on different options of generating electricity for homes not connected to the electricity grid.

The book, at first, discusses home design and home energy systems, load management, energy efficient lights and appliances, and system size and costs.

Then, four main alternatives of generating electricity for homes are considered separately, these include photovoltaics, wind turbines, micro-hydro, and diesel and petrol generators. Advantages and disadvantages of each option, its characteristics and requirements are presented.

In the following sections the book deals with batteries and inverters, two important components of most RAPS systems. System controls, purchasing, installation, maintenance of equipment, and safety are also covered.

The book has been written in a short, but rather comprehensive and easily understandable manner. All this makes it very useful for those who deal with RAPS systems for home applications.

These two books are available from Energy Victoria, Level 4, 151 Flinders Street, Melbourne 3000, Victoria, Australia at the following prices:

- Fundamentals of Remote Area Power Supply Systems – AU$ 25.00 per copy,
- Remote Area Power Supplies – AU$ 15.00 per copy.

These prices do not include postage and handling costs.

Diary of Events

- **May 16 – 17, 1994, Kuala Lumpur, Malaysia**

Renewable Energy Asia Pacific '94

For details contact:
Advanstar Communication Asia Limited
23rd Floor, Tai Yau Building
181 Johnson Road
Hong Kong
Tel: +852 832-4998
Fax: +852 575-4611

- **May 19 – 20, 1994, Winchester, United Kingdom**

Waste-to-Energy '94

Conference to discuss the role of waste-to-energy schemes in the framework of future municipal waste management.

For details contact:
ETSU, Harwell, Didcot
Oxfordshire OX11 ORA
United Kingdom
Tel: +44 235 433 602
Fax: +44 235 432 923

- **May 19 – 20, 1994, Antwerp, Belgium**

European Conference on Energy and the Environment

For details contact:
Mrs Marie-Claire Bruyneel
Conference secretariat
WEL, Marketplein 16
B-2110 Wijnegem
Belgium
Tel: +(03) 353 7253
Fax: +(03) 353 8991

- **May 23 – 26, 1994, Brighton, United Kingdom**

INSUCON 1994: Insulation Technology for the 21st Century

For details contact:
Michael Burkert, BEAMA
8 Leicester Street
London WC2H 7BN
United Kingdom
Tel: (+44) 71 872 6243
Fax: (+44) 71 437 4901

- **May 24 – 28, 1994, Baku, Azerbaijan**

International Caspian Oil and Gas Exhibition and Conference

For details contact:
Conference Organizer
Spearhead Exhibitions Ltd
55 Eden Street
Kingston-upon-Thames
Surrey KT1 1BW
United Kingdom

- **May 25 – 27, 1994, Stavanger, Norway**

IAEE International Conference 1994, in close cooperation with World Petroleum Congress

For details contact:
IAEE Norway, Norwegian Association for Energy Economics
PO Box 72
N-1321 Stabekk
Norway
Tel: +47 2 531 034
Fax: +47 2 534 308

- **June 6 – 9, 1994, Milan, Italy**

19th World Gas Conference

For details contact:
Piero Luigi Caribotti
Secretary of the Papers Committee WGC-19, c/o SNAM S.P.A.
Piazza Santa Barbara
7 - INSO 3
20097 San Donato Milanese (MI)
Italy

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Diary of Events
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Tel: +39 2 520 4871
Fax: +39 2 520 4297

- **June 11 – 16, 1994, Snowbird, UT, USA**

14th North American Meeting of the Catalysis Society

For details contact:
Francis V. Hanson
Department of Chemical and Fuels Engineering
University of Utah
3290 MEB, Salt Lake City
UT 84112
USA

- **June 13 – 16, 1994, The Hague, Netherlands**

39th International Gas Turbine & Aeroengine Congress & Exposition (TURBO EXPO '94)

For details contact:
The American Society of Mechanical Engineers
345 East 47th Street
New York, NY 10017
USA

- **June 13 – 16, 1994, Neptun, Romania**

National Energy Conference

Towards a sustainable energy efficiency in Romania.

For details contact:
Dr Jean Constantinescu
Chairman of the Steering Committee CNE'94
Bd Energeticienilor 8
79619 Bucuresti
Romania
Fax: +40 401 321 4465

- **June 14 – 17, 1994, Stirling, United Kingdom**

BWEA 16, British Wind Energy Association Annual Conference 1994

For details contact:
Conference Administrator
Energy Action Scotland
21 West Nile Street
Glasgow G1 2PJ
United Kingdom
Tel: +(041) 226 3064
Fax: (041) 221 2788

- **June 15 – 16, 1994, London, United Kingdom**

Conference on Power Generation and the Environment

For details contact:
Julie Brown/Anne Nolan
Conference Services Department C479
Institution of Mechanical Engineers
1 Birdcage Walk
London SW1H 9JJ
United Kingdom
Tel: (+44) 71 973 1316/1318
Fax: (+44) 71 222 9881

- **June 19 – 24, 1994, Birmingham, United Kingdom**

23rd Triennial Congress of the International Union of Producers and Distributors of Electrical Energy: UNIPEDE

For details contact:
Laurence Bernard
Union Internationale des Producteurs et Distributeurs d'Energie Electrique
28 rue Jacques Ibert
F-75858 Paris cedex 17
France
Tel: (+33) 14042 4707
Fax: (+33) 14042 6052
Tlx: 616 305 F

- **June 20 – 24, 1994, Birmingham, United Kingdom**

ElectroTech '94

For details contact:
ElectroTech Exhibitions Ltd
Wix Will House
West Horsley KT24 6DZ
Surrey
United Kingdom
Tel: (+44) 483 222 888
Fax: (+44) 483 224 321

- **June 21 – 23, 1994, Charlottetown, Canada**

Wind-Diesel Conference

For details contact:
Atlantic Orient
Farrell Farm Road, Route 5
PO Box 1097, Norwich
Vermont
USA
Tel: +802 649 5446
Fax: (802) 649 5405

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Library and Regional Documentation Center, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The "RERIC News" is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership along with the other four regular publications namely: RERIC International Energy Journal (formerly: Renewable Energy Review Journal); RERIC Holdings List; Abstracts of AIT Reports and Publications on Energy; and RERIC Membership Directory. For further details contact:

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Bangkok 10501, Thailand
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RERIC news

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Fifth AIT-WHO Training Course on Solar Refrigeration

30 May – 10 June 1994
Energy Technology Program, Asian Institute of Technology, Bangkok, Thailand

Use of solar photovoltaic (PV) refrigeration systems for storing vaccines in remote rural dispensaries is rapidly increasing due to the promotional efforts of the World Health Organization (WHO) and the United Nations Children Fund (UNICEF). Many other organizations working for the betterment of living standards of people in remote areas are also now employing solar refrigeration systems in their primary health care programs.

Solar PV powered systems are relatively simpler in operation and have lower operating and maintenance costs in comparison with systems powered by diesel generators. In addition, they are noiseless and clean, producing no adverse effects to the environment. When compared with kerosene refrigerators, PV refrigerators are much more reliable and have better temperature regulation, which in turn reduce vaccine losses. However, the initial cost of a PV system is not low. Careful system sizing, proper installation, maintenance and repair are therefore vital to minimizing the life-cycle cost of these systems. This requires engineers and technicians to be fully-trained in these aspects. However, in the developing countries where most of the PV refrigeration systems have been installed, there is a lack of well-trained personnel in this sector.

The Asian Institute of Technology (AIT) was selected by the World Health Organization to establish a training center on solar refrigeration for the engineers and technicians in South-East Asia and the West Pacific. With the support of WHO, a complete training facility for solar photovoltaic refrigeration systems was set up in the Energy Park of the Energy Technology Program of AIT in early 1990. The first training course was held in July 1990. Since then, training courses have been held regularly every year.

Participants and organizers after the opening session in front of the solar demonstration house in the Energy Park, AIT.

The fifth training course was held during 30 May – 10 June 1994, with the participation of 18 engineers and technicians from 10 different countries. The special feature of this course was the increased participation from African countries. This corresponds to the increasing number of solar refrigeration systems in the African region. There were 8 participants from Angola, Tanzania, Mozambique, Zambia and Ghana. Other participants were from Bangladesh, Bhutan, Malaysia,

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INNERTAP

Incorporates news from the Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

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Supplement: Small Scale Wind Energy Systems

Fifth AIT-WHO Training Course on Solar Refrigeration

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Thailand and Kiribati.

A book containing the training material and guidelines for the practical work was introduced for the first time in this course. Its text part is comprised of basic principles of solar photovoltaics and related components of solar PV powered refrigeration systems. The practical section contains very effective practical work for gaining experience in doing repair and maintenance tasks. Some WHO/EPI training materials, which were used in the previous courses, were also provided to the participants and selected practical tasks were performed.

A practical work session on PV panels.

Particular emphasis was placed on the hands-on practical sessions. Two physical models were used to explain the movement of the sun in different seasons, which is very important for the orientation of a solar panel to obtain optimum energy at that location and to avoid shading problems.

A number of practical tasks on PV panels, batteries and PV regulators were assigned to the participants. Four different solar refrigeration systems were used for installation and trouble shooting practice.

The 5th AIT-WHO training course on solar refrigerator repair and maintenance was organized by a committee composed of Prof. E. Karmazsin, Mr. Athula Rajapakse and Mr. Herbert Wade of the Energy Technology Program of AIT, in collaboration with Mr. Garry Presthus of the Expanded Program on Immunization (EPI), WHO, Southeast Asia Regional Office. Financial support for the participants was provided by UNICEF (Angola), WHO (Southeast Asia Regional Office), WHO (Ghana), DANIDA (Tanzania), DANIDA (Mozambique), SNV (Bhutan), BP Solar (Zambia), Forum Secretariat and University of Kebangsaan (Malaysia).

Window Coating Material Controls Insolation

The National Industrial Research Institute of Nagoya of the Agency of Industrial Science and Technology, Japan has developed a window glass coating film that automatically decreases the transmission of sunlight when the room temperature (boundary temperature) achieves a certain level.

Usual window glass transmits 90% of light energy, so when sunlight enters a room it displays a hothouse effect; on the contrary, when the room temperature rises the heat is dissipated outside. There exists a "thermochromic" material with a light permeation ratio or reflection ratio which is reversible, and since the color is changed with the temperature, it is regarded as a light adjusting element.

The new material is produced by doping vanadium dioxide with tungsten. The research team of the institute showed that the critical temperature of materials can be set freely by changing the tungsten addition ratio.

When the temperature rises, the vanadium dioxide crystal undergoes a transition from the semiconductor phase to metal phase at 68°C, resulting in reduced infrared ray permeation due to plasma reflection. It is necessary to lower the phase transition temperature to enable the material to be used as a window coating material.

A multi-target reactive magnetron sputter system was used to vaporize vanadium and tungsten in argon and oxygen to form a 50-100-nm-thick film on a glass substrate. The boundary temperature was set at 25°C, which provides a pleasant room temperature.

The glass remains ordinary at temperatures below the transition temperature, but above this temperature, it automatically displays a light reflection effect. The shielding effect is especially pronounced with infrared radiation, and little change occurs in the range of visible light, so vision through the window is not impaired. By coating the material on window glass surfaces, in summer, suppressing sunlight incidence into rooms decreases the cooling load, and in winter the air heating energy is prevented from being dissipated.

For more information contact:

National Industrial Research Institute of Nagoya, AIST
1-1, Hirate-cho, Kita-ku
Nagoya City, Aichi Pref. 462
Japan
Tel: +81 52 911 2111
Fax: +81 52 916 2802

(Source: Extracted from "Window Coating Material Controlling Incidence Sunlight", *JETRO*, Vol. 21, No. 12, March 1994, pp. 38-39)

PV-powered Radio for Villages

Chengdu TV and Electrical Corporation in the central Chinese city has engaged in a new venture – the mass production of an inexpensive and efficient solar-powered radio. The project, undertaken in collaboration with a private foundation led by Bahá'ís seeks to promote the use of the radio as both an aid to rural development and a solution to the pollution problems that come with batteries.

The key technology in this radio is the special circuitry developed by Dr. K. Dean Stephens, which he says makes the radio more efficient than

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PV-powered Radio for Villages

From P. 2

any solar-powered consumer radio yet produced.

"For the so-called First World, the issue here is environmental impact," said Dr. Stephens. "Batteries in their manufacture require about 80 times the energy they store; and after they are thrown away, they continue to pollute, contaminating the ground for years with heavy metals," he added.

"What we are trying to do is pioneer a technology that is going to be more earth friendly," said Dr. Stephens, who is also director of the Vanguard Trust, a not-for-profit foundation that is coordinating and promoting the project.

"With regard to the developing world, the main point is that the cost of batteries ends up being far greater than the cost of a radio, and they are a great drain on the income of many villagers," Dr. Stephens added. For example, about 10% of a worker's salary in Tanzania would go to buying radio batteries if he replaces them every month.

According to Dr. Stephens, although small solar-powered radios have been produced before, none has risen above novelty status because they were either too expensive or worked only under ideal conditions, such as in bright sunlight.

The totally redesigned circuitry enables the radio to play even in ambient light – sitting beside a window or even next to a gasoline lantern at night. "In the past, you had to practically bake solar radios in the sun to get them to work," said Dr. Stephens.

Trial Production Run

The radio is much less expensive than previously produced solar radios. Low cost is achieved both by the radio's efficient design and the decision to produce it in China, where labor costs are low. The first lot of radios, made in a trial production run of 100 units, are being sold for US$ 25. Later, as production expands, they should sell for less. "Ultimately, the cost will be about US$ 17 a piece, that turns out to be the price of just the solar panel anywhere else," he said.

The high efficiency and low cost have drawn considerable interest of radio broadcasting companies and development agencies. Both the British Broadcasting Corporation (BBC) and Danish national radio corporation (Danicom) are evaluating preliminary models of the radio. Several international development agencies, as well, have ordered radios for testing and trials.

The first production models of the radio, named Vanguardia SR-2 are powered by a series of crystalline silicon solar cells, connected in panel on the back of the radio. The radio is capable of receiving only medium-wave bands. Including FM or shortwave bands would unnecessarily drive the price up, Dr. Stephens said. "We are planning future, multi-band models for other markets," he added.

Innovative Circuit Design

The new circuitry can drive that speaker on just 1/25 watts. That is about ten times the efficiency of most radios, said Dr. Stephens, whose credentials as an electronics pioneer include responsibility for the design of an ultra-compact color television camera for the Apollo space missions to the moon.

"The Chengdu TV and Electrical group has been extremely flexible in working out the final details of the design and manufacturing," said Dr. Stephens.

The Trust was created to develop and promote useful and appropriate technologies for the developing world, and one of its major themes has been to create affordable technology for village-level radio systems.

Village Radio System

"There have been successful experiments at creating village radio systems, and there is a good deal of interest in them among development specialists," said Dr. Stephens. "The idea is to set up a miniature radio station that will allow a village to serve itself with local broadcasts," he continued. The radio can be viewed as a tool for the preservation of various traditions and cultural expressions. And it is also a form of grassroots empowerment in the information era as it puts information directly into the hands of the people.

The Vanguard Trust recently published a small booklet entitled Village Radio Owner's Manual, which outlines both the technology and the organization that can be used to establish a village radio station. The Trust has also experimented extensively with a small-scale solar system designed by Dr. Stephens, to provide light and refrigeration at a Bahá'ís training center in Puerto Rico.

(Source: Extracted from "Promoting Earth-Friendly Radio Receivers", *SOL*, March 1992 – April 1993, pp. 4-5)

SOLARWALL Canada

Conserval Engineering Inc., developers of the SOLARWALL™, has recently completed a study on the benefits of their product for 15 industrial buildings across Canada. Three SOLARWALL™ systems have already been ordered as the result of the study. The potential for sales appears excellent for most of the remaining buildings involved in the study.

The SOLARWALL™ system consists of a perforated, dark metal cladding which is mounted on the outside face of a building wall. Intake fans mounted at the top of the wall system draw fresh air through the panel and into the building. When exposed to the sun, the dark metal cladding heats the incoming air. The temperature of the air delivered to the building can be raised by as much as 20°C on a typical sunny day in winter.

The SOLARWALL™ produces heat and saves energy in four main ways:

- providing solar-heated make-up or ventilation air;
- de-stratifying indoor temperatures by distributing make-up air through perforated ducting near the ceiling;

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Breakthrough in Solar Cell Technology

The researchers at the Centre for Photovoltaic Devices and Systems, the University of New South Wales, have made a breakthrough in solar cell technology, which promises to cut the cost of solar electricity by 80% in 5 to 10 years.

"We have developed a new design strategy which should eventually meet all nations' needs for cheap and environmentally sound energy supplies," said Professor Martin Green, head of the centre.

"The potential has always been there to produce an inexpensive, clean, convenient and inexhaustible supply of energy – and now we know how to do it," Green said.

When used to mass-produce solar cells, the new process could produce solar electricity for less than US$1 per watt, cheaper than the most efficient coal-fired power plants.

So far, solar cell technology has focused on making high-efficient cells by using ever-more expensive pure, high quality silicon semiconductor material.

However, the metal carrying the current in solar cells has always been put on the top surface of the cell, which cuts down the sunlight reaching the silicon in the cell.

The university researchers used lasers to cut grooves in the cell, burying the conducting metal in it. This allows lower-quality – and therefore cheaper silicon solar cells to produce more power than the high-quality, expensive cells. They can use silicon that is 100 times poorer in quality than the top grade material now used in the most efficient cells.

This technique also allows the cells to be only 20 microns thick, compared to the 400-micron thick cells now being used.

"With all the work that photovoltaics researchers have put into the technology over past decades, and the potential the technology has always held, it was inevitable that sooner or later someone would make the breakthrough. The only surprise is that it happened so soon," Green said.

Once the solar cells are mass-produced and widely used, the scientists believe the cost of electricity production could fall to 20 cents per watt.

The technology is patented by Unisearch Ltd, the commercial research and development arm of the University of New South Wales.

(Source: Extracted from "Way found to make cheap solar electricity", AP, Sydney, *Bangkok Post*, Saturday 14 May 1994, p. 6)

SOLARWALL

From P. 3

- recapturing the heat lost through the existing wall, and returning it to the building with the incoming solar-heated air; and
- with de-stratification, reducing the heat lost from roof or wall exhaust fans.

The SOLARWALL™ not only saves energy, but it also improves indoor air quality through increased fresh air ventilation.

Short-term Payback

The study was restricted to industrial buildings. The simple payback period for the buildings studied ranged from 1.2 years to 8.3 years. Of these, 55% showed a payback of under three years while 82% had a payback period of under four years. Even the company with the longest estimated payback is seriously considering investing in the SOLARWALL™ to solve ventilation problems.

The total capital cost of all 15 projects was estimated at nearly $5 million, with an average payback of less than 2.5 years. If all projects were implemented, 6,500,000 GJ would be saved over 20 years, this is equivalent to over $42 million.

The study clearly indicates that sites that require better ventilation are the most likely candidates for a SOLARWALL™. Building operators facing negative pressure problems, poor indoor air quality, or a need for large quantities of make-up air are much more likely to invest in a SOLARWALL™ because it solves these problems as well as cuts energy costs.

(Source: From "SOLARWALL™: A Success with Industry", *SOL*, March 1992 – April 1993, p. 14)

Israeli Wind Turbines for Golan Heights

Ten updated versions of the Austrian designed Floda wind turbine are to be installed on the Golan Heights in Israel early next year.

The 600 kW Floda turbines will be built in Israel at the facilities of TRM Advanced Wind Technologies. The first blades will be manufactured this autumn and the prototype machines will be installed in the first quarter of next year.

The research and development of the improved Floda design – the TRM 645 – will all officially be done in Israel, said Edan Harel of TRM and Mei Golan Wind Energy Ltd. Full production will start in 1995, with a manufacturing capacity of about 120 turbines a year. The 45 m diameter rotor of the TRM 645 is mounted on a 42 m tower with a hub height of 43.5 m. The machine is variable speed and the blades are made of epoxy composite, advanced resin and carbon fibre, a material which is far more resistant to dirt degradation than glass fibre.

Ten Flodas have already been installed on the Golan Heights (in 1992) at Bashanit, and commercial operation began in August 1993. They produced just over 6 million kWh in the (low wind) six-month period from August to January, 1994.

The Israeli Electrical Corp will soon install 5-6 MW of wind, tentatively HMZ turbines from Belgium, on the Golan Heights, said Harel. That's where the main wind resource is in Israel. However, beside the Golan Heights, TRM also hopes to install an additional 20 MW in Galilee and in other parts of the country.

(Source: From "Israeli Machines for Golan Heights", by Ros Davidson, *WINDPOWER MONTHLY*, Vol. 10, No. 6, April 1994, p. 19)

Wind Turbine Research at Sandia Lab

One of the biggest challenges has been increasing the performance and reliability of the wind turbines, particularly the blades.

Much of Sandia's work has focused on the impact of loads caused by wind on the turbine's lifetime. Due to the calculation-intensive nature of the analysis, researchers have relied heavily on computer modelling. The models are then transformed into computer codes that can be used by wind engineers.

FAROW is a code for fatigue and reliability analysis of turbines. LIFE2 is used to predict service lifetimes of wind turbines and can be used in developing inspection schedules for turbine components.

"Sandia has tackled virtually every aspect of turbine performance and reliability," says Henry Dodd, Wind Energy Technology Manager. "However, our fatigue and reliability analysis codes, while not very glamorous or very visible to those outside the industry, are some of our more important contributions."

Wind engineers at Sandia have also investigated the fatigue properties of composite material used to build turbine blades; stress on the joint between blade assemblies and the hub; new joint designs for turbine blades; commercially available nondestructive techniques for the inspection and evaluation of blades of vertical axis wind turbines (VAWT); and the development of expert systems to aid windsmiths in diagnosing turbines that have been taken out service.

The modern egg-beater-shaped VAWT is one of Sandia's viable contributions. In the 1970s, using their extensive experience in aerodynamics and structural dynamics, engineers set out to develop an efficient turbine that industry could manufacture. As a starting point they used the 1920s design of French inventor George Jean Marie Darrieus.

Their first turbine, built on top of an engineer's desk, was 12 inches tall. A larger working model was then built on the rooftop of a Sandia office building.

About two years later, Sandia built a wind turbine with a blade span of 17 meters (the largest VAWT at that time) to show that it was cost-competitive with the more traditional horizontal axis machines.

After improvements were made to the turbine's shape and blades, Alcoa Industries built three VAWTs under a DOE contract. Their successful operation convinced two companies – VAWTPOWER of New Mexico and FloWind, now based in California – to commercialize the design. FloWind had more than 500 VAWTs producing electricity in the mid-1980s. Currently, 98% of those are still operating and 90% still have their original blades.

California wind farms – composed of both horizontal- and vertical-axis turbines – continue to improve their output and currently produce about 2% of the electricity used in the US.

Over the past decade, the research at Sandia has focused on reducing costs and improving the reliability of VAWTs. A 34-metre VAWT built in Bushland, Texas, incorporates component designs that increase wind-to-electricity efficiencies and reduce costs through more reliable operation. Sandia designed and built the 50-metre-tall VAWT to advance the performance and capabilities of VAWT technologies for future commercial applications.

For three years, the egg-beater-shaped turbine has been providing test results in the areas of structural dynamics, aerodynamics, fatigue and controls. An article published on the subject in a trade publication prompted more than 300 inquiries.

"The interest reflects a growing awareness that wind energy has come a long way in the last 10 years," Dodd says. "The reliability and performance problems that gave windpower a negative image in the early years have been addressed and now it's emerging as an economically viable energy option."

Costs of windpower in some parts of the country are approaching five cents a kilowatt-hour. If air pollution and other environmental costs are taken into account, a practice in a growing number of states, wind power becomes competitive with coal power, which has traditionally been the cheapest energy alternative.

(Source: Extracted from "Wind Power's Popularity Soars", *Energy Digest*, Vol. 22, No. 5, 1993, pp.41-42)

Largest Wind Farm in Australia

Australia's largest wind farm, on the southern coast of Western Australia, was officially opened by the State's Energy Minister – Colin Barnett, on 5 March 1994.

The wind farm, located at Ten Mile Lagoon, was established for the remote town of Esperance after five years of successful operation of a smaller demonstration project at the nearby Salmon Beach. The A$ 5.8 million farm, funded by the State Energy Commission of Western Australia, will generate 2 MW of power for Esperance and surrounding areas in conjunction with the local diesel power station. It will provide up to 30% of the region's power needs. Each year it will save A$ 650,000 or 1.9 million litres of fuel (5,000 litres a day), equal to 5,000 tonnes of carbon dioxide.

The cost of the power generated at the farm will be about 8 cents/kWh compared to about 10 cents/kWh of fuel costs for the diesel station.

It is expected to pay for itself within about 12 years.

"The community has increasingly supported the application of renewable energy as a practical power source," said Mr. Barnett. "The success of renewable energy as a prominent power source will hinge on the ability to create an effective long-term market. To achieve that goal, solar power needs to be available at a price which is attractive compared to conventional forms of power generation."

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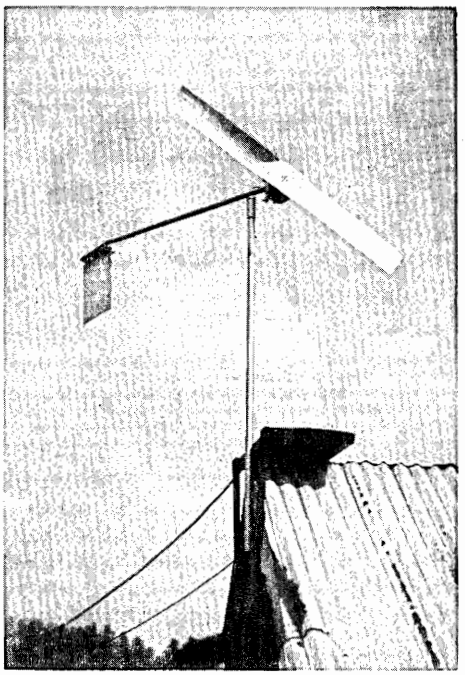
Building Plans for Windmill VIRYA-1.25

Detailed building plans and a manual (in English) for a small electricity generating windmill are supplied by the Dutch company KRAGTEN DESIGN. This mill, type VIRYA-1.25, has a rotor diameter of 1.25 meter and a rated power of 50 Watts (VIRYA is energy in Sanskrit). The starting wind speed is 3 m/s.

The rotor has two blades which are made from one strip of galvanised steel sheet. The mill has a fairly low tip speed ratio (ratio between the tip speed and the wind speed) of five, resulting in a low noise level.

This mill has a generator made from a standard rotary current or asynchronous motor. As a modification, this motor is provided with a permanent magnet armature and a stainless steel shaft. The rotor hub is mounted directly on the tapered shaft end of the generator. The rotor rpm range is much lower than the original motor rpm and therefore, using the standard 220/380 V windings, 24 V DC is generated if the windings are rectified in delta.

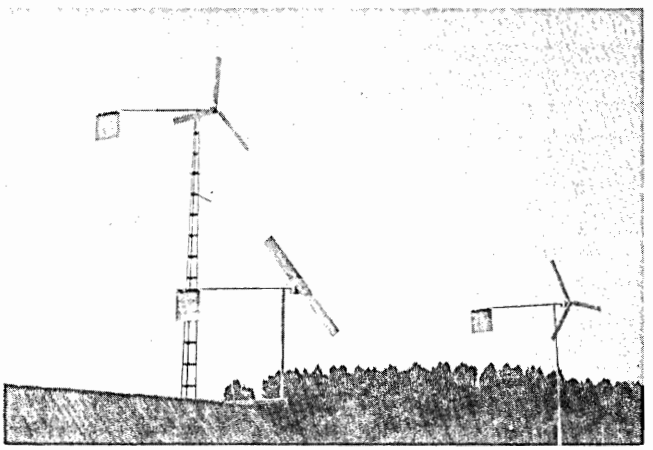


VIRYA-1.25 Windmill.

The mill is provided with a so called "hinged side vane safety system" to prevent too high rotor rpm and thrust at high wind speeds. The rotor axis is placed eccentrically with respect to the tower axis. The vane juts out beside the rotor and the vane blade is connected to the vane arm by means of hinges. At low wind speeds the vane blade hangs in an almost vertical position and the rotor is perpendicular to the wind. For wind speeds higher than about 7 m/s the rotor starts to turn out of the wind gradually. At very high wind speeds the rotor turns about 70 degrees out of the wind and the vane blade is in the almost horizontal position. The behaviour of this safety system is very stable and the rotor speed is limited sharply.

The mill has maintenance-free head bearings and a 1.5 meter long tower which can be mounted against an existing structure.

A building plan consists of assembly drawings of the whole mill, rotor, generator, head and tower, the dump load (limits the maximum charge voltage to 28 V) and the blade press. A building plan contains detailed drawings of all separate parts, lists of parts to be manufactured and lists of standard parts. In the manual several aspects are explained in detail, i.e. safety system, manufacturing of parts, mounting and installation, maintenance, electronics and testing.



From left to right: VIRYA-3.3, VIRYA-1.25 and VIRYA-2 Windmills.

The price for drawings and manual, including mailing costs but excluding VAT or import duties, is dfl 220 (around US$ 120). Apart from the VIRYA-1.25, KRAGTEN DESIGN supplies, have for more than a year now, produced building plans of two bigger, three blade mills, the VIRYA-2 and the VIRYA-3.3. The prices for these building plans are dfl 260 and dfl 360, respectively. No license costs are required for serial manufacture.

For an information leaflet and order form contact:

KRAGTEN DESIGN
Populierenlaan 51
5492 SG St. Oedenrode
The Netherlands
Fax: +31 4138 75770

Largest Wind Farm in Australia

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He said: "This project distinguished itself by being large scale as well as providing a cheaper and environmental friendly alternative."

The wind farms not only serve an important practical and environmental purpose but has been recognised as a major tourist attraction for the region and has showcased Esperance as the wind energy capital of Australia.

The plant comprises nine wind turbines on 30 m towers. The turbines have all been painted white to reduce visual impact, and carry no company logos. Access roads and power lines have been hidden from view, where possible. Erosion control has also been introduced and public access will be limited to selected viewing areas.

Due to its nature and the extensive environmental planning and management carried out to ensure limited disturbance to the local environment, the wind farm has been nominated for the prestigious Banksia Environmental Awards. The awards recognise businesses or organisation which best promote environmental awareness.

(Source: Extracted from "Esperance Wind Farm – Ten Mile Lagoon", *Solar Progress*, Vol. 15, No. 1, p. 33 and "Ten Mile Lagoon Turns to the Wind", *Modern Power Systems*, Vol. 13, Issue 4, April 1994, p. 12)

Biogas Plant for Wildlife Resort – Nepal

Recently, the construction of a 15 m^3 Chinese fixed-dome biogas plant has been completed at Machan Wildlife Resort (MWR) at Chitwan, Nepal. The project has been initiated by Consolidated Management Services (CMS).

In the context of wildlife resorts, this pilot plant is important in several ways. First, wildlife resorts produce a substantial amount of bio-degradable waste, especially in the case of MWR where elephants are present. This waste, if not processed or disposed of properly, will affect the surrounding environment, which in turn could reduce the number of visitors.

Second, most wildlife resorts are located in remote areas and are not connected to the national electricity grid, and fuel transport from a long distance would be costly. So biogas technology could be the answer to environmental and energy problems.

There are eight adult elephants at MWR producing a total of about 160 kg dung per day (20 kg/elephant/day) which can be used to feed the plant. Elephant dung contains a high proportion of fibrous materials with a high carbon-nitrogen ratio of 43. Optimum gas production occurs at around a C/N ratio of 25. The human excreta from the resident employees of MWR and the guests can be used to bring down the ratio of the base feeding material, i.e. elephant dung. Therefore, use of human excreta which contains a low C/N ratio (8 to 10) in conjunction with elephant dung was suggested for the smooth functioning of the biogas plant.

Moreover, 3 latrines used by about 100 staff have also been constructed near the digester site and directly connected with the biogas plant by a 10 cm diameter polythene pipe.

Altogether 30 man-days of masons, 50 man-days of labourers were required to complete the construction work in a period of 15 days.

Feeding of Digester

In the long run, the digester will be fed with elephant dung and human excreta only. But for quick and easy operation, the initial loading of the digester was done as follows.

As mentioned earlier, elephant dung contains a lot of fibrous materials which when diluted with water tend to float to the surface and are not decomposed easily. This can even block the gas outlet pipe. To avoid the problem, the raw dung was diluted with water (1:1 ratio), the fibrous materials were removed and the slurry gained was fed into the digester. First, about 1/5 volume of the digester was filled with this slurry, then a mixture of cow dung and water was added. Latrine wastes were also fed to the digester.

Recently Dr. Amrit B. Karki and Mr. Abinash Pant of CMS paid a visit to Machan Wildlife Resort to inspect the biogas plant. They were able to test the successful production of methane gas (perhaps the first in history from elephant dung) on 30th March 1994. The staff, residents and tourists were excited when they saw the flame.

At present, the gas produced is used to provide fuel mainly for cooking at the staff kitchen and the digested effluent will be transported elsewhere as fertilizer for vegetables and crops. It is conceived that in the future more biogas units will be installed in order to meet most of the energy needs of MWR.

If this project proves successful, other tourist resorts could also be interested in installing biogas plants not only as a tourist attraction but also as a felt-need to economize the fuel, as well as for the protection of the environment.

(Source: Extracted from "Biogas Installation with Elephant Dung at Machan Wildlife Resort – Chitwan, Nepal", by Amrit B. Karki, Krishna M. Gautam and Ajoy Karki, *Biogas*, No. 45, April 1994, pp. 3-4)

Methane Gas from Garbage

Dr. Victor Luis of the University of the Philippines College of Engineering and Agro Technology (UPCEAT) has formulated a method to produce methane gas from garbage. The method is now being studied and improved by the Philippine Council for Industry and Energy Research and Development (PCIERD) of the Department of Science and Technology (DOST). A pilot study has been conducted successfully in Los Banos, Laguna.

Basically, the method consists in piling alternate layers of biodegradable market wastes and soil in pits measuring two meters on each side and four feet in depth. The pits are lined with plastic sheets prior to filling in order to prevent seepage. Cow manure may also be added to the garbage. Tubes lined with holes are thrust vertically into the layered pit. The upper end of each tube is connected to a plastic container where the gas released from the waste is collected.

The methane gas collected in the Los Banos study is of very good quality with high fuel efficiency. If done continuously and on a large scale, the technology can generate enough power to supply energy to entire communities.

The technology is now being applied on a bigger scale at the sanitary landfill station of San Mateo, Rizal. The National Power Corporation (NPC), the Metro Manila Authority (MMA) and the Department of Environment and Natural Resources (DENR) are cooperating with PCIERD in the project.

Like a big version of Los Banos, the alternate piles of garbage and soil are arranged in daily disposal cells which contain each day's entire garbage delivery, explained project manager Alexander Umagat of MMA.

However, the wastes are not sorted as done in Los Banos, and thus still contain non-organic matter like metals and plastic. This could be one of the reasons for the lower amount of meth-

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Delta 16 Sales to Sahel

Canadian company Dutch Industries Ltd of Regina, Saskatchewan has sold a number of its Delta 16 water pumping windmills to the Sahel region of West Africa.

"Delta 16 units have been operating successfully for more than a year in Niger and Mali. They were used to replace other windmills that had failed in other projects", says Dutch Industries wind engineer Philip Vander Ziel.

The University of Waterloo in Ontario and Dutch Industries have cooperated in establishing water pumping systems for irrigation in Mali and Niger. The project involves mapping and predicting wind resources; simulation of wind pump and irrigation systems; investigating the social, economic, political and environmental impact of wind pumping systems; constructing and maintaining such systems; and training residents in their use.

In Sahel there are more than 60,000 water points, many of which are tapped manually. This is considered by the project leaders as a large potential market for wind energy technology.

The Delta 16 was developed by John Kentfield at the University of Calgary. It is of horizontal axis type with 32 vanes on a distinctive, octagonal perimeter bladed rotor, 4.9 metres in diameter.

From 30 metres depth, the Delta 16 can typically draw 36.4 cubic metres of water daily in winds averaging 17 kph. It can also draw water from deeper wells, and can start up at very low wind speeds owing to a concrete counterbalance.

(Source: Extracted from "Canadian Sales to West Africa", by David Bright & Stephen Salaff, *WINDPOWER MONTHLY*, Vol. 10, No. 4, April 1994, p. 28)

Micro-hydro Replaces Diesel on Kapiti Island

Department of Conservation ranger Peter Daniel is elated to have quiet, 24 hour power from a micro-hydro system after 17 years of turning on and off noisy diesel generators each day. For the first time on Kapiti Island, New Zealand, the lights don't have to go off at night, electric clocks can be used, a video can be set to automatically tape the news.

Ebbett Automation Ltd, design and build contractor, has recently commissioned the system. During the conceptual design micro-hydro was found to be the most cost effective system for the site. Undersea cable connection to the mainland grid would cost over $NZ 700,000. Since the ranger station is located on the lee side of the island wind energy was not competitive. Similarly, the topography and heavy bush of the island were not favourable for photovoltaics.

The system uses 'state-of-the-art' technology for a standard 'off the shelf' 3 phase motor, to be a self-exited generator. An innovative new controller was specially designed to enable the generator to charge a battery bank. A 10 kVA Siemens inverter then produces standard 230V power from the batteries. Load peaks are handled by the inverter/battery combination and the micro-hydro is relatively small, trickling away at 3 to 3.6 litres per second, 24 hours per day, to restore battery energy.

The peak current requirements of the boat winch were a major problem and the overall concept was only possible with the help of GEC NZ Ltd with a special variable speed drive system that reduced the motor start surge to within the inverter rating and gave the extra advantage of speed control of the winch during boat launching.

Tamar of Australia supplied micro-hydro components to Ebbett's specifications. A custom built programmable logic control system monitors battery and load condition and either dumps excess energy into a heater element or starts a small generator to top up any shortfall. Everything is fully automatic.

The project was originally initiated by the Energy Management Division of the Ministry of Commerce and is now being monitored by the Energy Efficiency and Conservation Authority.

Savings on running expenses are estimated at approximately $NZ 7,000 per annum and the capital recovered within 10 years. To supplement the existing installation a second system is intended to be installed on another stream. Meanwhile, the natural tranquillity of the environment has been returned to the wildlife in the bird sanctuary of Kapiti Island.

Further information can be obtained from:

Graeme Ebbett
Ebbett Automation Ltd
70-72 Victoria Street
Petone (Wellington)
New Zealand
Tel: (04) 568 6377
Fax: (04) 588 2374

Methane Gas from Garbage

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ane obtained at the site, noted Umagat. The PCIERD team is studying various factors affecting the quantity and quality of gas to make necessary adjustments in the method and equipment to improve the methane output. The team also wants to make sure that any effluent from the process is environmentally safe before its disposal.

Methane extraction is necessary for safety purposes because retention of methane in the garbage can cause spontaneous explosions and fires.

The plan is to use the gas for running a generator supplying power to the nearby communities, or to hold in tanks for domestic cooking. The remaining wastes after methane extraction can be used as fertilizer.

Once the minor loopholes of the process have been remedied, PCIERD plans to apply the process in other places, especially in key cities where garbage volumes are large and demand for energy is high.

(Source: Extracted from "Energy from Garbage", *Energy Alternatives*, Vol. XI, No. 1, 1993, p. 3)

Large-scale Biomass Gasification Test

Since 1991 Tampella Power has run coal gasification tests with the goal of commercialising pressurized gasification at a 15 MW pilot plant in Tampere, Finland. Enviropower, a joint venture company of Tampella Power and Vattenfall AB (formerly the Swedish State Power Board), has recently completed an extensive biomass gasification test programme at this plant. A total of 3,000 tons of mixed Finnish wood chips was converted into product gas in a series of large-scale tests.

The success of these tests is very important because multi-fuel gasification significantly boosts the potential and competitive advantage of biomass. The tests show that the same technology used for coal can also be applied for alternative fuels, making future coal gasification plants more competitive.

Technology

A gasification technology based on the U-Gas gasification process developed in the US by the Institute of Gas Technology (IGT) has been used. Since 1989 Enviropower has further developed the technology to be suitable for all solid fuels including coal and biomass.

The process was developed as a single stage air-blown gasification process to produce low- to medium-calorific value gas from a variety of feedstocks. These include high ash, high sulphur coals. It is designed to provide economical handling of large volumes of gas; high carbon conversion of coal to gas without producing tar or oil by-products; and have minimal environmental effects.

The process is based on a combination of fluidized bed gasification and ash agglomeration in a single stage reactor. The pilot plant at Tampere has a maximum thermal input of 15 MW and can operate at up to 30 bar and 1100°C.

The plant was commissioned in 1991 and used for coal gasification tests. In late 1992, a new fuel feed line was set up and other modifications were made to allow testing with biomass, while the coal testing capacity remained unchanged.

This pilot plant contains all the necessary modules for research, component testing and completion of the development of the new gasification process for IGCC application. These include: solids feed system, gasifier, ash removal system, product gas cooling, hot gas clean-up, product gas combustion and waste heat recovery boiler, and process control.

Test Results

In general, the tests showed that the process was very suitable for biomass. Optimized process performance was demonstrated with commercial type biomass. The operation of the process was shown to be stable under full-scale plant conditions, i.e. 20 bar, 850°C. The biomass system operated without problems. Fuel was fed through at a capacity of 100 t/day.

The product gas from the biomass, with lower heating value of more than 5 MJ/Nm^3, was shown suitable for gas turbines. The gasification process achieved a fuel conversion efficiency of over 99% with very low heavy tar formation.

The operation of the ceramic filter was shown stable. The dust content of the product gas after filtration was less than 5 mg/m^3, while the alkaline content was well below the requirement for gas turbines, typically 0.1 ppm.

The successful tests are important to countries like Finland and Sweden which have an abundance of biomass. During the next 25 years, the total Swedish power generating potential for new biomass plants is 5 TWh each year in the municipal cogeneration sector and 1-2 TWh in the industrial cogeneration sector.

The technology has also been selected for demonstration in round 4 of the US Clean Coal Programme run by the US Department of Energy.

Enviropower is also planning to build a biomass-based power plant in Finland. The cost of setting up this demonstration plant with a capacity of 50-100 MW will be about $100 million. (Source: Extracted from "Biomass Looks Good for Gasification Process", *Modern Power Systems*, Vol. 13, Issue 4, April 1994, pp. 61,63,65)

Low-head Hydro – Peru

Intermediate Technology (IT) Peru has built a prototype 'low-head' turbine that can bring affordable power to remote areas.

The power generated by a micro-hydro unit depends on the volume and velocity of the running water, and on the 'head' – the height the water falls from to the turbine.

Micro-hydro has delivered electric power to remote communities all over the world. However, most units are high or medium head, requiring the water to fall from 6 metres or more. This is found only in particularly hilly or mountainous areas.

Existing low-head turbines are too expensive for poor communities.

The prototype, built by a small workshop in Lima, was finished in October and has since been going through laboratory tests. It can produce 13 kW of power from a head of four metres and a flow of just half a cubic metre per second.

The next stage is to install and test it at a field site in Cajamarca, where most of IT Peru's current hydro work is concentrated.

The low-head turbine is the result of three years' work, since IT's international hydro team began investigating alternative approaches in 1990. Detailed design work began in 1992.

The IT design could be an effective way of bringing power to remote rural communities. IT Peru is already looking at the potential for low head turbines in the Amazon region of South America. IT Sri Lanka also wants to use low-head units in the country's dry zones.

(Source: From "Low-head hydro brings more power to the people", *IT News*, March 1994, p.2.)

Energy Crops Perspective in UK

Anyone boarding a bus in Reading recently may have been involved in a demonstration scheme to evaluate the potential of transport biofuels in the UK. The scheme comprises three buses running on biodiesel produced from oilseed rape, the bright yellow crop that is now such a familiar springtime sight in many parts of the country.

The project aims to assess the extent that biodiesel, with its low sulphur content, could lessen the effects of exhaust emissions in the town centre, and to monitor the performance of buses using the fuel on both urban and rural roads. Initial results have been good, with local opinion especially supportive.

The scheme reflects the interest, currently stirring, in the energy potential of a whole range of agricultural crops. Not surprisingly, much of the attention originates from farmers themselves.

In some countries, like Austria, France and Italy, biodiesel and bioethanol (made by fermenting the sugars and starches found in crops such as wheat, barley and sugar beet) are already having an impact in the transport sector. The motivations are strong: Austria, for example, found it cheaper to subsidise biodiesel production than cereal exports.

In the UK market, for biodiesel to be competitive with fossil diesel, a subsidy of at least 15 p/litre would be required. In reality, liquid biofuels could be competitive only if the price of conventional fuels were two to three times as much or biodiesel were to be exempt from excise duty.

Although niche markets such as inner city transport and inland waterways have been identified, biodiesel may not be a cost-effective solution to the relevant environmental concern.

However, energy crops' potential extends much further than liquid fuels. If the market for wood fuel develops, the day may come when farmers grow short rotation arable coppice on set-aside land purely for combustion in biomass power stations. In addition to coppicing of willow or poplar, there are other potential crops such as miscanthus. This woody, bamboo-like grass is already produced in the UK as an ornamental plant, and is now being considered from an energy perspective.

Miscanthus turns light to energy through photosynthesis extremely effectively, leading to rapid growth and good yields of dry matter.

A perennial, miscanthus is generally planted in April and gathered the following February or March using a forage harvester. In some other countries, yields from the second year of cropping onwards, average 15-25 tonnes per hectare per year, enough to meet the energy needs of one to three average households.

However, the future of energy crops will depend on work to establish the economics and environmental impact of production, conversion and use. The Department of Trade and Industry has analysed the potential of a number of such crops and is seeking to demonstrate the commercial viability of the more promising. Field trials on miscanthus and a range of other species are under way, as are other trials sponsored by the Ministry of Agriculture. The results will help define the circumstances under which energy crops can be competitive in the fuel market.

(Source: Extracted from "Crops to Energy" by Barry Hague, *Review*, Issue 21, December 1993, pp. 12–13)

Renewable Energy in India

Along with its vast territory and huge population, India has one of the largest and most active renewable energy programmes in the developing world.

India's programme for the development and utilisation of renewable energy is being implemented by the Ministry of Power and Non-Conventional Energy Sources through its Department of Non-conventional Energy Sources (DNES). Progress has been impressive since DNES formation in 1982. For example, 15 wind farms have been built (with a capacity of over 40 MW), about 4,000 windpumps installed, 50,000 photovoltaic systems mounted, and about 250,000 solar cookers sold.

For centuries solar energy has been used for traditional activities such as for crop drying and salt production. In the 1950s scientists at the National Physical Laboratory in New Delhi started to study solar energy for new applications. Solar water heaters have now been used for domestic, community and industrial applications. A 50 kW solar thermal power plant in Haryana and a 20 kW plant in Andhra Pradesh have been built. A 30 MW plant has been proposed for Rajasthan.

India is the largest producer of PV modules in the developing world, with more than 3 MWp production in 1992. There are now more than 40,000 lighting systems, almost 2,000 water pumps, 1,000 community systems and 100 rural educational TV receivers powered by PV, as well as vaccine refrigerators, telecommunication repeaters and navigational aids. A tender for 20,000 PV power packs for rural telephones was issued.

In 1986, the first generation of wind farms was installed in the western coastal region of Gujurat by Gujurat Windfarms Ltd, a consortium of Western India Erectors and Gujurat Industrial Investment Corporation. In 1992, the first indigenous wind turbines (manufactured by Bharat Heavy Electricals Limited) were installed in Tuna, Gujurat. The cost of wind generated power is believed to be competitive with that produced by new thermal power plants.

In the country there are now about 20 manufacturers of windpumps. Most of the 5,000 or so units manufactured to date are shallow-well pumps. However, more recently, deep-well pumps for village water supply have been developed.

Hydro power is another important renewable energy resource in India. The exploitable hydro potential is 80,000 MW, of which 5,000 MW is at sites of less than 10 MW. So far only less than 500 MW of small hydro power has been harnessed. Major efforts thus

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SMALL SCALE WIND ENERGY SYSTEMS

Published with financial support from the Netherlands Ministry for Development Cooperation
Editors: Goezinne & Veldkamp, Renewable Energy Consultants

EDITORIAL

This time there is some good news and some bad news. The bad news is that the well known Colombian windmill producer Las Gaviotas has stopped its activities. However, there is also good news: firstly the Mauritania windpump project seems to be doing well; secondly, maybe new wind energy activities are under way in a joint British-Dutch effort. Finally there are interesting possibilities in Vietnam.

Dick Veldkamp/G&V

Windpumps in Developing Countries, a Market Overview

In October 1993, a study of the windpump market in 22 selected countries for the Dutch Ministry of Development Cooperation (DGIS) was completed (*see also RN 16-2 of June 1993*). The main objective of this study was **to obtain a picture of the windpump market in developing countries, with special emphasis on second generation (modern) windpumps.** Manufacturers and end-users (considered to be the main actors in the market) were the focus of the study. The main question was whether there actually is a market for windpumps. The study concluded that there is indeed a worldwide market. However it is small and fragmented.

The windpump product family may be split into three basic types:

- First generation, classical 'American' windpumps;
- Second generation, modern lightweight windpumps;
- Low cost, artisanal windpumps.

First generation windpumps are still being produced in industrialised countries such as the USA, Australia, South Africa, Spain and France. FIASA in Argentina alone produces more than 3000 units per year. The home market is however gradually declining. The predominant windpump type in the developing countries is the second generation windpump, but low cost windpumps are made in many countries as well.

Sales figures of last 5 years indicate 4600 units per year worldwide. This is based on first hand information gathered from manufacturers, by questionnaires (30% response) and country visits. Real sales figures will therefore be higher. About 20% of these sales were in developing countries.

In developing countries the manufacturing companies are small and lack finance as well as the necessary technical and marketing skills. Many windpump models in production are unsuitable for the market segment presently served, while the manufacturer is not aware of more suitable models available elsewhere in the world. Most manufacturers therefore have only small established markets with sales of less than 100 per year. The models in production often need to be developed further. This is mostly done by trial and error.

The basic needs of the manufacturers are: firstly (and foremost!) capital, secondly the establishment of networks and bases to support maintenance activities and sales; thirdly assistance for the selection and development of windpumps; and fourthly technical assistance to improve production engineering and quality control.

There are many potential applications for windpumps. The table (on p. 2) shows the market segments found, with different applications and corresponding user categories. Potential users need in general access to finance, information on suitable water lifting technologies (to help them make a choice), and training in operation and maintenance. In general, awareness of windpumping applications is low, both with potential end-users and also with financing institutes.

There is a number of barriers hampering market development. Some of these are outside users and manufacturers control, such as subsidy on electricity and fossil fuels. Market stagnation and even decline is often the result of the absence of a maintenance infrastructure. Furthermore, there are no institutions which promote windpumping on an international scale, and therefore no relevant worldwide information data base exists on windpumping at some central institute. However, many of these drawbacks for market development, such as lack of capital, awareness and maintenance infrastructure, are not inherent to windpumping, but apply to most renewable energy technologies. This was confirmed by various speakers at the 12th European Photovoltaic Solar Energy Conference at Amsterdam.

One of the most positive findings of the study was the economic feasibility of windpumping. The unit water costs for

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Windpumps in Developing Countries

From P. 1

APPLICATION	USERS	COUNTRIES	COMMENTS
Large cattle Farms	Wealthy farmers	Worldwide	Established markets for 1st generation windpumps.
Irrigation	Farmers, usually with a few ha.	Worldwide	For high value crops. Low cost and second generation windpumps are best.
Agro-forestry/ afforestation	Innovators and Wealthy farmers	Cape Verde, India	Very small market at present. 2nd generation and low cost windpumps best suited.
Low Head	Individuals Communal	Thailand, Vietnam, China	For salt pans, shrimp/fish raising. Low cost designs used, some attempts with second generation designs.
Homesteads and Small Farms	Farmers and rural families	Worldwide	Often mixed domestic, livestock and irrigation. 1st and second generation suitable.
Domestic Water for Community Use	Villages, Small communities around missions, hospitals	Worldwide	Social/institutional implications. Often externally funded. 1st and 2nd generation suitable.
Nomadic Livestock	Nomadic people	Colombia, Kenya, Sahel	Use for people and animals. Environmental/social effects are important. 1st generation preferred.
Community Agriculture	Small groups in rural areas	Sahel	Cultivation of high nutritious vegetables for own in village use. 2nd generation windpumps suitable.

some of the second generation windpumps were among the lowest, compared with other pumping means such as diesel pumps and PV-pumps. The main bottleneck remains the high investment costs in most cases, the reason why low cost windpumps are still being produced. This, despite the fact (which was also confirmed by the study), that unit water costs for low cost windpumps were higher than for good second generation machines, due to the high maintenance costs.

There are of course various approaches possible to stimulate the windpump market in developing countries. A direct approach could be to help manufacturers with tailor-made assistance, with priority on accessability of finance. An indirect approach which might have more effect in the long term could be to create a windpump branch support institute such as the proposed 'Wind Energy for Rural Areas – International Association' (WERA-IA) which should get the mandate to assist the windpumping market in relieving actual needs, such as marketing, creating credit schemes, human resource development, information gathering and supply etc. Finances for both approaches should be supplied by international donor agencies, as well as by members of the organisation itself.

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British/Dutch Collaboration in Water Pumping Windmill Technology

Since the end of the organisation CWD (Consultancy Services Wind Energy, Developing Countries) in 1990 there has been a reduction in worldwide activities focused on water pumping windmill technology. However, development of the CWD technology has continued through collaboration between ECN (The Netherlands Energy Research Foundation) and UCL (University College London) in the UK. More recently UCL and Reading University have begun a major project funded by the UK Science and Engineering Research Council (SERC) looking at the reliability of water pumping windmills. This project has prompted the setting up of a test site at Silsoe College near Bedford in England. The Manager for both the test site and the SERC project is Dr Neil Bishop.

Dr Bishop, who currently sits on the British Wind Energy Association Technical Programs Committee, was a member of the group led by Halcrow Gilbert and Associates who undertook the study entitled Technical Review of CWD Hardware and the follow-up study Technical Goals for the Continued Development of CWD Hardware. CWD's aim was to produce lightweight, simple and efficient machines suitable for production in developing countries. This focused their efforts on gearless, low solidity and hence fast running machines. It also resulted in designs which were dynamically responsive. The ECN/UCL collaboration focused on this dynamic response. This has been followed by a more substantial 3 year project run jointly by UCL and Reading University (in collaboration with ECN). Although the project is only half way through it has already produced a suite of theoretical dynamic models for estimating the response of the CWD2740 and CWD2000 machines for any given input wind fields. Work which is currently in progress includes pump system modelling, being led by John Burton at Reading University, and reliability improvement devices.

Experimental verification is being undertaken at the Silsoe test site. Three test beds are available, two with bore holes (at 25 m and 43 m respectively) and one with a surface tank. The location of the site is reasonable for testing, being of undulating hills with a mean wind speed of 5.0 m/s. A monitoring station on the site is capable of storing both performance data (output, wind speed, direction, etc.) and structural responses (rotor speed, yaw position, tower and blade stresses, etc.). A computer based system is used to acquire, analyse and store

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Gaviotas to Stop Windpump Production

One of the world's most innovative and successful producers of windpumps has ceased making windpump systems. Colombia based Gaviotas were the producers of a popular small windpump, with a rotor diameter of 2 m. The small double acting windpump was recognised as one of the few really successful designs to have been commercialised in the last 15 years.

The windpump has been on sale since 1979 and about 8000 systems have been sold in Colombia and worldwide. It was mainly popular with small landholders to pump from shallow wells on to vegetable plots. It had many novel features which made it particularly useful in the tropical low wind regions: a downwind rotor for self orientation without safety mechanism; a direct transmission with a differential pump. The differential effect was achieved by having a PVC hollow pump rod, with half the area of the pump cylinder. This causes the pump to push water on both the up and down stroke. This effectively smoothens the torque experienced by the rotor with the associated gains in output, with a very low starting wind speed. The maximum pumping head was 25 m: this is ideal for the smallholder with a shallow well.

Why stop production in spite of success?

Economics seems to be the answer. Production of a cheap item means that the profit per item is small. The Gaviotas Centre has grown, and with growth is has expanded into new technologies and has been forced to rationalise.

The Centre was developing a 3.1 m version of its popular windpump, however this is thought to have been stopped along with the main production. The new system was to be for higher wind areas, but the Centre had problems translating its design to withstand 20 m/s wind speeds. At such a wind speed, with a 10 bladed 3.1 m rotor diameter, the machine runs at 120-150 rpm, and the associated high velocities and accelerations induce large forces in the pump rod. A new furling system was being developed and possible introduction of a gearbox to reduce speed excitation. This development may be dropped along with the main production of the smaller 2 m windpump.

The end of windpumps in Colombia?

By no means! The Jober windpump, manufactured by Jober Industry, combines the rotor design of the Gaviotas with the pump design of another Colombian windpump: the Gavilan. The Gavilan developed about the same time as the Gaviotas, but went out of production several years ago. The unusual feature of the Jober (and Gavilan) pump is the presence of a spring to assist the return stroke. This lower spring keeps the pump in tension, thus avoiding the inherent difficulties of fast running reciprocating pumps (in the case of the Gavilan, the system used a cable for its pump rod, thus also avoiding the problems of alignment with the tower which was to be made by the purchaser from two wooden legs). In the Jober the system is counterbalanced with another spring at the top to keep the starting torque as low as possible. About 500 Jober pumps have been installed and they look set to pick up a large part of the market created by the cessation of Gaviotas windpump production.

In addition to the novel 'modern' windpumps mentioned above, Colombia also hosts the Indusierra. This is an adapted copy of an American multiblade. The system is sold in rotor diameters of between 2 m and 5 m, with a back gear of 3:1 to avoid running the pump at high speeds. It is slightly more expensive than its lighter counterparts the Jober and Gaviotas, but nevertheless is bound get some of the market slack left by Gaviotas.

And who knows? Perhaps more budding entrepreneurs will pick up where Gaviotas is leaving off. Dr Alvaro Pinilla at the Universidad de los Andes has estimates that there are about 5000 workshops in Bogotá alone which have the capability to make a modern windpump. He also estimates that the market could be as large as 30,000 units in the next few years for systems able to pump up to 50 m.

Anyway, Gaviotas production will be missed as an example to other countries, and we are waiting for other entrepreneurs to fill the gap in Colombia. (Grateful acknowledgement to Dr. Pinilla for technical information).

Simon Batchelor/Gamos

British/Dutch Collaboration in Water Pumping Windmill Technology

From P. 2

the results. Electricity for powering the equipment is produced using a combination of wind electric machines and solar power generators. Currently four machines are being tested, these being the CWD2000, CWD2740 and Gaviotas direct drive machines and a new machine designed by IT Power which utilises a novel gearbox and pitch control of the rotor blades. It is hoped that the site can become an established location for wind pumping test work.

Although research and development activities in wind pumping have been low over the last few years, interest from developing countries has remained high. Because of this, and utilising existing British/Dutch collaborative links, a seminar has now been arranged at Silsoe College on 11th July 1994. The aim of the seminar is to discuss avenues for future international collaboration in the field of water pumping windmill technology. So after a relatively quiet period of several years, the future for water pumping windmill development now looks quite hopeful.

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The Potential of Vietnam

Vietnam is much in the news lately, for its revolution in its economy and the potential for the future. In this go-ahead environment will there be any market for small wind turbines? This is the first of a two articles which explores the potential of Vietnam for small scale wind power (pumps and small generators).

The best place to start with any country survey is in its wind, water and human resources.

Wind regime

Like many countries, Vietnam has limited accurate wind data. Recent studies on the wind regime are considered an intellectual asset by the government of Vietnam and 'will be released only as part of an ongoing wind energy programme' (says a senior government official). Of course we can look at the old data; some wind data of dubious quality is available. From that data we may say that the country generally has low winds in the region of 2 to 3 m/s annual mean. As with Thailand's coastal region, Vietnam's long coastline has low mean wind speeds. However, we can also surmise that strong diurnal effects probably give rise to strong winds at certain times of the day. This makes wind pumping a viable practicality.

Water

Much of Vietnam is serviced by shallow wells less than 10 m deep. Although at first site these 3,000,000 wells look to be a potential market for windpumps, there are limitations. They often yield a limited quantity of water which is of generally poor quality, not meeting WHO health standards. Government estimates are that about 59% of these wells require major repair. So if a windpump were to be applied to open wells, it would need to be linked to a wells rehabilitation program. Since 1982 there are also about 82,000 drilled tubewells under the UNICEF programme. These all have handpumps, with 120-300 people per water point. As there are 140,000 new tubewells planned for the next five years maybe a few windpumps could be installed on them, if the socio-economic circumstances were favourable. Apart from this there is considerable emphasis on rain catchment in most other rural development programmes, so limited market there.

Human resources

Vietnam has a long history of traditional wooden windpumps in the South and Coast. These were used for salt pans. The low head allowed the use of a simple paddle pump. In the main they were troublesome and only a few of these pumps continue today. In the late 1970s, research began on a more durable multiblade windpump. This work resulted in a machine based on an old Jeep (4 wheel drive military vehicle) gearbox, running a series of paddle pumps (after the war old jeeps were in abundance). This was always considered to be a novel and interesting use of old war materials. It has been estimated that 300-400 systems were installed. However recent estimates by the Head of Institute of Renewable Energy (Vietnam) suggest that less than 50 are still in operation now.

One would have thought in Vietnam's 'isolated' state there would be an emphasis on decentralised and renewable energy plants. To a certain extent this has been the case but the discussion and action on wind has been limited. Despite a general commitment to renewables from the government and support from UNDP, most activities in energy have focused on improved stoves and biogas. Some small scale research has been conducted in institutes, but there are no firm plans for wide scale dissemination.

There are three institutes who have had some exposure to wind energy technology. The Institute of Energy (who is to develop wind technology for the nation), and Hanoi and Ho Chi Minh Polytechnics. The latter has a specific Centre for Thermal Equipment and Renewable Energy which started research in 1977. In 1990 it set up the Centre for Water Supply and Environmental Sanitation.

The problem has been that research has tended to be uncoordinated (true for wind research the world over!) Officials readily admit to failure of prototypes. In addition Vietnam suffers from the age old divide between academia and the industrial world. Once a prototype has been developed there is no network for installation and maintenance. So the 300 windpumps for salt pans have gradually failed due to the overall impact of inadequate socio-economic conditions. Perhaps the bottom line is that in the recent past there has been no infrastructure for commercialisation. This may well change with the changes currently happening in the market economy.

Supply or demand

The above has looked at the supply side of wind energy in Vietnam: the wind regime, the water resource and the institutions for building machinery combine together to provide a potential for wind energy. But in many cases it is not the supply side which is critical, but rather the demand. Are the right socio-economic factors in place to create a demand for windpumps? The second article in this series (next issue) will look at the demand side, the wind energy market in Vietnam.

Simon Batchelor/Gamos

Citation is encouraged on the condition that the source is indicated.
Reactions or other contributions are welcomed. Please write to:
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Responsibility for the articles rests solely with the authors. Contributions should preferably not be longer than 300 words. For longer articles please contact the editors. The editors reserve the right to shorten reactions and articles.

Funding Renewable Power Generation – Philippines

The Department of Energy's (DOE) Renewable Energy Power Program (REPP) has secured a fund of 750 million pesos to finance projects that generate power from renewable sources. The money comes from five government financing institutions.

With the fund, the DOE-REPP hopes to encourage power generation from renewable and indigenous energy sources, provide a favorable market environment which can attract local and foreign investors, and realize DOE's target of generating an additional 50 MW of renewable power by 1996.

Besides, supplementing this amount is a grant of $ 3.75 million from the United States Agency for International Development (USAID) to be administered by non-governmental organizations. DOE is also looking into a $ 25 million loan for mini-hydro and biomass projects which was offered by China during President Fidel Ramos' visit to that country.

Proposals are invited for projects which can generate at least 500 kW of power from renewable sources, especially mini-hydro and biomass. DOE will guarantee the purchase of the power generated if the project proponent wants to sell it to the power grid of the National Power Corporation (NPC). DOE will also provide technical and marketing support to the project through the NPC and the National Electrification Administration (NEA).

A proposal should contain information on: the availability of energy resources; the presence of transmission lines or substation requirements for power distribution; and feasibility studies on the socio-economic and financial aspects of the project.

The proposal must also establish the proponent's technical and financial capability to undertake the project, and the technologies to be used must have been successfully piloted before commercialization.

Operation of a proposed power plant should promote the public interest. For instance, its construction and operation should not close existing passageways, natural forest reserves, water outlets and sources.

The loan applied for should not be more than 75% of the total project cost. The terms of payment should not exceed a maximum of 20 years, which includes a maximum grace period of five years for the repayment of the principal.

Proposals will be evaluated and approved by a committee composed of a representative of DOE as chairman, and representatives from the NPC, NEA, the five government financing institutions, the Philippine Council for Industry and Energy Research and Development (PCIERD) and the Philippine National Oil Company-Energy Research and Development Center (PNOC-ERDC) as members.

To monitor project progress, the DOE will require quarterly status reports from the third month after the contract comes into effect. With assistance from NPC, NEA, PCIERD or PNOC-ERDC, the DOE will also conduct regular supervision visits to the plants to assess project status and ensure compliance with the conditions of the contract. If necessary, it will recommend appropriate measures to remedy problems and improve project performance.

To date, a proposal for the Langonan Mini-hydro Project in Puerto Princesa, Palawan, has been evaluated. The NPC and DOE have endorsed feasibility studies for this 6.8 MW project under a build-operate-transfer scheme.

By encouraging and assisting renewable power generation projects, the program promotes the application of viable nonconventional energy technologies and encourages the use of environmentally benign energy sources.

(Source: Extracted from "Renewable Energy Generation Gets Multi-million Peso Funding", *Energy Alternatives*, Vol. IX, No. 2, 1993, pp. 1,8)

Renewable Energy in India

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are expected in this area.

India has been at the forefront of biomass technology, with several companies manufacturing biomass gasifiers for powering modified internal combustion engines. External combustion engines (Stirling engines) were developed and demonstrated by a Madras-based company. India is also well known for its National Biogas Programme.

Opportunities and confidence in the renewable energy market are growing. The Government of India has requested US$ 115 million from the International Development Association and a further US$ 26 million from the UN/World Bank Global Environment Facility, to finance small-scale energy schemes and apply to project components of the India Renewable Resources Development Project. This should result in the installation of a further 2.5 MW of PV, 100 MW of small-scale hydro and 85 MW of wind farms.

(Source: Extracted from "India", by Roy Barlow and Tony Derrick, *Review*, Issue 21, December 1993, pp. 28-29)

Small-scale Applications of Renewables in UK

Beside the renewables' potential in the large-scale production of electricity and heat, many diverse applications of renewable energy are found on a much more modest level in the United Kingdom.

There were many thousands of water- and wind-driven corn mills operating in the UK in the 19th century. And today, small-scale renewable power systems are again in the resurgence, which in part is linked to leisure and recreational activities.

One example is Marlec Ltd of Corby, Northamptonshire, which has been producing small-scale low-energy products for many years. The wind chargers of the company are well known and popular: over 20,000 units have been sold and successful exports have made Marlec a world leader in the field. The chargers are inexpensive, ranging from £300 to just over £400.

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Project on Dissemination and Implementation of Renewables in Africa

The Renewable Energy Technologies (RETs) Research for Dissemination and Implementation project, started in January 1994, is an initiative of the Stockholm Environmental Institute (SEI), African Energy Policy Research Network (AFREPREN) and the Foundation for Woodstove Dissemination (FWD).

The project objective is to gain a better understanding of factors determining the success or failure of RETs dissemination projects through the examination of non-technological barriers.

Sub-Saharan Africa has substantial renewable energy resources which include biomass, solar, hydro and wind. Biomass accounts for about 73% of total energy used in most Sub-Saharan African countries. Suitable renewable energy technologies have been developed and are mature enough to be applied on the continent.

Despite recognition that renewables are an important source of energy for Sub-Saharan Africa, RETs have not attracted the required level of investment, nor has the desired level of dissemination been realised. Although national and international resources allocated to developing, adapting and disseminating RETs in the last two decades were substantial, the total amount is still insignificant (6%) compared to resources spent on fossil fuels.

Although there has been little success, isolated cases of RETs dissemination have been recorded in some Eastern and Southern African countries. Typical examples include dissemination of the Kenyan ceramic jiko (KCJ), an improved charcoal stove in Kenya; solar water heaters (SWH) in Botswana; photovoltaics (PVs) in Kenya, Botswana and Zimbabwe; ethanol in Zimbabwe; and biogas in Burundi.

Dissemination of RETs in Eastern and Southern Africa

Country	RET	Number disseminated
Kenya	KCJ	over 500,000
Kenya	PVs	over 8,000*
Botswana	SWH	8,500
Zimbabwe	ethanol	40,000,000 litres**

* Total number of modules sold
** Annual production of ethanol

The factors behind the limited success of RETs dissemination include:

- high initial investment costs coupled with absence of supporting financial instruments;
- poor baseline information;
- excessive emphasis on the household sector; and
- inadequate development of local capacity.

These factors and many more have yet to be evaluated comprehensively. This analysis will enable key RETs actors such as policy makers, entrepreneurs, NGOs and aid agencies to respond effectively to the pressing need for effective RETs dissemination.

To address the above issues, the Renewable Energy Technologies Research for Dissemination and Implementation project will:

- document the status of RETs dissemination;
- compile a regional directory of experts and organisations involved in RETs dissemination;
- conduct case studies in six countries on RETs dissemination;
- and explore non-technological factors that affect the dissemi-

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Small-scale Applications of Renewables in UK

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They are easily installed, requiring a pole 1.5m high to hold the unit with the blades and tail.

Basically, the units are applicable to situations where grid connection or other alternatives would be expensive or impractical. Typical users are caravanners and those with portable homes, weekend cottages or boats. The units can charge one or more batteries, producing enough power for lighting, radio, portable TV, water pump and refrigerator.

Minimal maintenance and great reliability seem to be the common experience. Chargers can be left running while the owners are absent, although a shunt regulator is recommended to prevent overcharging.

Marlec also supplies solar panels which are usually used to charge 12 V batteries for a wide variety of uses from telecommunications and navigation systems, to caravans, holiday cottages and boats. The panels range from 5W to 60W and they can be connected in parallel to give higher currents or in series to produce higher voltages. These panels, costing up to £380, are easily installed and require virtually no maintenance, except occasional cleaning.

These panels can be combined with the wind chargers to provide a more consistent power since winds are usually stronger in winter while there are longer hours of sun in summer.

Such a hybrid power system is being tested at the UK's first solar-wind-power telephone kiosk. If successful this will be the answer to lighting phone boxes in remote areas where supplying mains electricity is costly. To increase the efficiency, the kiosk is fitted with a photosensitive device which activates the light at dusk and turns it off at dawn.

In the UK, photovoltaics is also used for lighthouses and marine navigation lights. In agriculture solar cells now power remote outbuildings, keep tractor batteries charged, and provide power for electric fences and infrared security sensors, which give a warning radio signal when activated.

The number of users of such low-energy generators is increasing. An impressive list includes the Royal Navy, Trinity House, Harbour and Port Authorities, the Nature Conservancy Council and many research stations, as well as round-the-world yachtsmen.

Technology has advanced greatly since the 19th century but renewable energy sources, it would seem, are still much valued for the contribution they can make to the quality of life.

(Source: From "Thinking Small", by Peter Heslop, *Review*, Issue 21, December 1993, pp. 3-4)

An International Collaborative Project on Acid Rain and Emissions Reduction in Asia

The projected growth of energy consumption in Asia combined with the utilization of indigenous coal will result in increased emissions of acidifying compounds, particularly sulfur dioxide. If the present trend continues, sulfur dioxide emissions for Asia will exceed the emissions from North America and Europe combined by the year 2010.

A substantial portion of sulfur emissions is transported by winds up to thousands of kilometers from their source so that countries not only receive acid deposition from the neighboring countries but also export acidifying compounds. These depositions affect agriculture and forest productivity, water resources as well as man-made structures.

In response to the growing threat of acid rain in Asia, a group of researchers from Asia, Europe and USA initiated a regional project to study the problem of sulfur deposition in 1991. The Asian Development Bank and the World Bank have provided funds to conduct the project as a major international and interdisciplinary effort.

The main goal of this collaborative project is to develop an integrated model (RAINS-ASIA) for policy analysis of the acid rain problem in Asia. RAINS-ASIA comprises three modules (sub models): Energy and Emissions (ENEM) module, Atmospheric Transport and Deposition (ATMOS) module and Impact Assessment (IMPACT) module.

The ENEM module deals with sectoral energy consumption for 92 sub-country regions of Asia, of which approximately 30 are large metropolitan areas. In the module, fuel used can be disaggregated into 15 types. Energy Consumption data for the base year (1990), as well as historical years (1980-1989) are being collected for the module. Projected energy consumption figures for selected years up to 2020 are also being collected. The ENEM module will also generate energy scenarios for each country and region in Asia.

The ATMOS module deals with atmospheric transport and deposition of compounds. The projections for the acid deposition patterns for future emission scenarios are based on a transfer matrix for long-range transport/deposition modelling. The emission scenarios calculated in the ENEM module are taken as inputs and transformed into deposition patterns.

The IMPACT module assesses the environmental effects of sulfur dioxide emissions. The module incorporates critical loads (maximum allowable deposition levels) for 14 different ecosystems. The critical loads have been computed using a model combined with an assessment of the relative sensitivity of various ecosystems to acidification. The module is capable of identifying areas in Asia which have an increased risk of damage from acid rain and sulfur deposition.

RAINS-ASIA is a micro-computer based model. The model will allow users to describe emissions in current and future years on regional, country or sub-country basis, follow these emissions through the acid deposition processes, and assess the potential impacts of those emissions to critical ecosystems. The model will also allow for assessment of various control strategies to achieve long-term environmental objectives.

Asian focal centers have been established to help coordinate the project activities. Over 50 Asian institutions are involved in this project.

Apart from data collection for the ENEM module of RAINS-ASIA model, the project activities at AIT include monitoring of sulfur dioxide concentration at 50 selected sites in Asian countries and national institution buildings in Asia. The monitoring results can be used to verify the predictions of the RAINS-ASIA model in the future. SO_2 monitoring will be carried out over a period of 12 months through the active collaboration of the University of Iowa, USA, Swedish Environmental Research Institute, Sweden and the country focal centers for SO_2 monitoring.

As part of the ADB funded project activity, a symposium on the integrated RAINS-ASIA model is being planned towards the end of 1994.

The Asian Institute of Technology (AIT) is responsible for the overall management of the project entitled "Acid Rain and Emissions Reduction in Asia" funded by ADB and for the establishment of an energy and environment emissions database. AIT is also collaborating with some of the institutions in Europe and USA currently involved in the World Bank funded projects on Acid Rain and Emissions Reduction in Asia namely, Resource Management Associates (RMA) of Madison, USA, International Institute of Applied System Analysis (IIASA) of Laxenburg, Austria, the University of Iowa (UOI), Iowa, USA, and National Institute of Public Health and Environmental Protection (RIVM), The Netherlands.

For further information on the activities of the project, please contact:

Dr. S. C. Bhattacharya or
Dr. Ram M. Shrestha
Energy Technology Program
Asian Institute of Technology
G.P.O. Box 2754
Bangkok 10501
Thailand
Fax: (66-2) 524 5439

Project on Dissemination and Implementation of Renewables in Africa

From P. 12

nation of RETs in Eastern and Southern Africa.

For more information on the project contact Semida Silveira at SEI Stockholm or:

Patience Turyareeba
AFREPREN/FWD
Box 30979, Nairobi, Kenya
Tel: 254-2-566032
Fax: 254-2-564164/566231/740524
E-mail: karekezi@elci.gn.apc.org
Tlx: 25516 FWDNET KE 22912 PBLC NRB

(Source: Extracted from "Renewable Energy Technologies – Research for Dissemination and Implementation" by Stephen Karekezi and Patience Turyareeba, *Renewable Energy for Development*, Vol. 7, No. 1, May 1994, p. 6)

Laos Hydropower for Thailand

Laos is one of the most rapidly developing hydropower players in South-East Asia. Endowed with abundant water resources, Laos stands as an ideal source of energy to meet Thailand's power needs. The country currently has 195 MW of installed capacity and exports about 90% of power output to Thailand.

With a population of 4.4 million and a total GDP of US$ 1 billion/year Laos is one of the poorest countries in the world. The key to a dramatic leap in the country's prosperity lies in the Mekong River.

Hydropower is already one of the country's biggest foreign exchange earners, although hydro sales earnings fell 11% to US$ 17 M last year, mainly due to low reservoir storage levels.

According to the Asian Development Bank, Laos accounts for 18,000 MW out of the overall hydropower potential of 58,000 MW of the Mekong and its tributaries. The ADB is studying a cross-border power grid, mainly focused on Thailand, as a market for Lao, Burmese and Chinese power.

The Laotian government has recently signed agreements to develop major hydropower projects on the Nam Theun River, a tributary of the Mekong. The first, the Theun-Hinboun project, is a trans-basin run-of-river development.

The partners selected by the Laotian government are Nordic Hydropower AB (25%), which is owned by Skatkraft SF of Norway (50%), Vattenfall AB of Sweden (40%) and Nordic Power Invest of Sweden (10%), representing the power utilities of the Nordic countries and MDX Power Co of Thailand (20%).

The joint venture company to be established in Laos will be known as the Theun-Hinboun Power Company Ltd. It will implement, own and operate the project under a 30-year concession granted by the government.

The site of the proposed project is about 100 km upstream of the confluence with the Mekong, in the border area between Bolikhamsay and Khammouane provinces. In this area, a narrow mountain ridge separates the Nam Theun basin from the lower Nam Hinboun basin, offering the opportunity to exploit the difference in elevation of about 240 m for power generation, through a trans-basin diversion.

The generating capacity will be 210 MW.

The 230 kV transmission line to the Thai border at Thakhek is about 100 km long. In Thailand, about 95 km of transmission line will be required to connect to the main grid at Sakhon Nakhon. Average annual electricity generation is estimated at 1,600 GWh (87% plant factor) before implementation of any upstream diversion and 1,325 GWh at 72% plant factor (17% reduction), in the event that the proposed 600 MW Nam Theun 2 hydropower project is commissioned upstream.

It is claimed that the project will have limited adverse environmental impacts. There will be no resettlement or loss of cultural heritage as far as the local population is concerned.

From the Thai point of view, emissions from thermal power generation in a plant of equivalent capacity will be avoided. The only identified adverse impact is the reduction of flow downstream of the diversion dam.

Construction is expected to take about three years. Assuming that the civil works contractor can be mobilised at the end of 1994, the project may commence commercial operation on August 1, 1997.

Total implementation costs are estimated at US$ 280 M. The project will be financed by US$ 110 M equity (40%) and US$ 170 M export credits and commercial loans. The Asian Development Bank will provide US$ 60 M towards the government's equity.

The second project, Nam Theun 2, is being carried out by an Australian-French-Thai consortium led by Transfield Corporate, in collaboration with EDF and Italian Thai Development, a major player in the construction field in South-East Asia.

Nam Theun 2 is situated 250 km east of the capital, Vientiane, in Khammoune Province. It has provoked some opposition from environmentalists, as it will involve flooding the Nakai Plateau and exposing the hinterland to further encroachment. However, it could bring Laos around US$ 350 M/year in foreign exchange from Thailand.

The project will be largely financed by the Thai finance house, Phatra Thanakit, on the basis that most of the power generated will be exported to Thailand.

The French partner, EDF, will operate the power plant for 20 years, before handing it over to the Laotian government. Transfield's implementation of a CSIRO-developed strategy, designed to maintain biodiversity of the environmentally sensitive area, will result in considerable capital and ongoing management costs. However, financial consultants believe the site could produce power for as little as 1.8 US cents/kWh.

The construction of 600 MW power station is planned to commence in 1995 and expected to finish in 1998. There will be four turbines of 150 MW each.

Work has already begun on the Hauay Ho hydropower project, involving the construction of a 150 MW hydropower dam on the Ho river in Champassak province. The 85 m high, 700 m long dam itself will have a gross head of 780 m, the deepest in Asia, and a reservoir of 30 km^2.

The dam is a joint US$ 156 M project between the Laotian government and South Korean construction company, Daewoo Corp, under a build-operate-transfer scheme (BOT). Under the scheme, Daewoo will recover its costs by operating the dam for 30 years, after which the facility will be transferred to the Laotian government.

(Source: Extracted from "Laos Hydro to Power Thai Economy", *International Water Power & Dam Construction*, Vol. 45, No. 8, March 1994, pp. 18-20)

Unisearch in Energy

Unisearch is the commercial company of the University of New South Wales (UNSW), Australia. Unisearch is an active supplier of energy related services to both industry and government in Australia and the Asian Pacific region.

Services available range from the development of new 'green' technologies to consulting in efficient energy management and from product testing to strategies in energy economics. Energy related environmental problems are another area in which Unisearch offers expertise to clients.

Since 1992 UNSW academic consultants working through Unisearch's Consulting and Research Division have been assessing proposals for the Australian International Development Assistance Bureau (AIDAB) relating to development projects in Asia and the Pacific by Australian companies requiring soft loan support under the Development Import Finance Facility (DIFF) scheme. To date more than 40 projects have been assessed by Unisearch with a total project value in excess of 1.5 billion dollars.

Henan Coal Gasification Project

The largest DIFF project that Unisearch has assessed to date is for the construction of a gasification plant. The plant will accommodate the conversion of low grade coal to town gas and fuel oil recovery near the city of Yima in Henan Province, China. The gas will supply four cities along a 200 km trunk route: Yima, Zhengzhou, Luoyang and Sanmenxia, and will involve the construction of a gas pipeline and the connection of approximately 800,000 households in those cities.

The objective of the project is to provide a cleaner source of energy for domestic applications, primarily cooking with some space heating. It is anticipated that when the proposed plant comes on line in 36 months time, there will be a significant improvement in both indoor and outdoor air quality of the four cities as gas replaces coal which is now widely used for cooking.

The total value of the plant is approximately US$ 232 million. The estimated contract value for Australian supplied boilers, gasifiers, by product recovery technology and associated engineering and technical services is US$ 60 million.

The implementing agency for the product is the Henan Provincial Government and the end-user, the Yima Coal Mining Bureau which is said to be the largest coal producer in China. The project assessment was led by Professor Tony Owen (Economics) assisted by Mr John Sands (External Environmental Consultant) and Professor Geoffrey Sergeant (Fuel Technology). The assessment has involved two field missions to China in February and August 1993.

Australia will benefit from the sale of the proposed equipment and services and the ongoing sale of similar equipment to other coal gasification projects in China.

Vanadium Redox Battery Technology

The Unisearch and UNSW initiatives in the vanadium redox battery technology took a further step forward in 1993 with the signing of agreements with Mitsubishi Petrochemical Co and its subsidiary – Kashima-Kita Electric Power Corporation.

The agreement will fund three years of research by UNSW's Vanadium Battery Group under the continued direction of Professor Maria Skyllas-Kazacos into upgrading battery performance and reducing costs. The target application is load levelling in the large scale production and delivery of electricity.

Current cost analyses by Unisearch and others show that bulk electricity can be stored more economically by vanadium batteries than by present load levelling techniques such as hydro-pumping.

The agreement will bring the expertise of the UNSW team in research and development of the battery including electrolytes, electrodes, membrane materials and cell design together with the manufacturing, commercial and market expertise of the Mitsubishi team. This should lead to the early commercialisation of the battery for load levelling applications. (Source: Extracted from "Unisearch in Energy" by Wal Lamberth, *Annual Report 1993*, Energy Research, Development and Information Centre, The University of New South Wales, pp. 25-27)

River Water as Heat Source

A testing facility for the "Super Heat Pump System Using River Water as Heat Source," an extremely high-efficiency building air-conditioning system, has been completed by Chubu Electric Power Co., Inc. in Minato-ku, Nagoya City, Japan.

The facility, constructed in the Head Office annex building of Toenec, an electric works affiliate of Chubu Electric Power, started operation in December 1993. This is the first time that an air-conditioning system using both the super heat pump and river water has been built.

The super heat pump is able to acquire hot or cold heat energy 6 to 7 times that of the electric power input and it's efficiency is twice as much as that of conventional heat pumps. It was developed by the New Energy and Industrial Technology Development Organization (NEDO) as a link in the chain of the Moonlight Project promoted by the Agency of Industrial Science and Technology, Ministry of International Trade and Industry.

Actual loading tests are being conducted for this system, which pumps up river water, extracts heat from the water, and recycles the water into the river without changing its quality.

The system uses the water of the Horikawa River flowing through Nagoya City as its heat source. In comparison with the atmosphere, the

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Training Course
Photovoltaics for Rural Electrification: Project Development and Administration

28 November – 09 December, 1994
Asian Institute of Technology, Bangkok, Thailand

This two week course is organized by the Energy Technology Program of the Asian Institute of Technology, Bangkok, Thailand. The course is designed specifically for government and utility company planners and project officers who are responsible for rural development or rural energy delivery and are interested in photovoltaics as a possible means for rural electrification.

The course emphasizes project design, implementation and administration and is generally non-technical though enough technical concepts will be introduced to allow participants to understand the operation of a photovoltaic system as used for rural electrification.

Specific important topics to be covered are:

- Survey techniques to determine needs and the economic situation of prospective users;
- Institutional arrangements appropriate to the special needs of individual PV systems for rural electrification;
- Methods of Comparative Economic Analysis to determine whether PV is the least cost option for rural electrification at the project site;
- Obtaining funding for PV rural electrification projects;
- Site evaluation and selection;
- The use of consultants in PV project design and implementation;
- Specifying, tendering, and purchasing for PV projects;
- PV project administration; and
- Basic PV system theory.

The course will include some theory but will emphasize case studies and practical exercises.

For further details contact:

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River Water as Heat Source

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water is cool in summer and warm in winter, so using only the river water enables energy savings by about 20%. The electricity required for building air-conditioning (heat storage air-conditioning) is reduced by roughly 60% for cooling and about 50% for heating by the combination of the heat pump and river water. Thus, the system is able to cut the peak of the daytime power demand, conserving energy, reducing CO_2 emissions and smoothing power load.

For further information contact:

Chubu Electric Power Co., Inc.
Electrotechnology Applications R&D Center
20-1, Kitasekiyama, Ohdaka-cho
Midori-ku, Nagoya City
Aichi Pref. 459
Tel: +81 52 624 9237
Fax: +81 52 624 9234

(Source: Extracted from "Super Heat Pump System Using River Water as Heat Source", *JETRO*, January 1994, p. 40)

$7.5 Billion Gas Plant – Malaysia

On June 2, 1994, Malaysia launched one of Asia's most ambitious energy projects, signing with five foreign banks to partly finance a $7.5 billion natural gas project.

The second Malaysian Liquefied Natural Gas (MLNG2) plant will bring Kuala Lumpur's gas production to 15.9 million tons a year.

"We are very pleased with the overwhelming response by the banks to this complex project. It is an endorsement of its viability," Petronas president Azizan Zainul Abidin said after signing a $1.187 billion loan package with the banks.

The $7.5 billion will be used to pay for plant, tankers and infrastructure to further increase output in Asia's second largest producer.

Officials of Petronas said the loan for the venture in oil-rich eastern Sarawak state was the firm's biggest-ever for a single project.

The loan arranged through 37 financial institutions led by the Industrial Bank of Japan Ltd, would partly pay the building cost of the upcoming plant and expansion of the MLNG1, Malaysia's first natural gas plant.

Malaysia's 59 trillion cubic feet of reserves makes it Asia's second largest natural gas producer after Indonesia.

"As the second largest supplier of liquefied natural gas in the region, our role has been growing in importance as gas becomes the favored fuel," said Azizan.

He said work on the MLNG2, which started in March last year, was progressing ahead of schedule and was expected to be completed by November 1995 – nine months after gas comes on stream.

The plant would be 60% owned by Petronas. Shell Gas BV of the Netherlands and Mitsubishi of Japan have a 15% stake each in the venture with the remaining equity held by the state government of resource-rich Sarawak.

The MLNG2's projected gas supply has been "fully booked", with Japan planning to buy 3.8 million tons and South Korea and Taiwan two million tons each, Azizan said.

(Source: Extracted from "M'sia inks $7.5b gas plant deal" by AFP, Kuala Lumpur, *Bangkok Post*, Friday, June 3, 1994, p.20)

Book Review

Chinese Fuel Saving Stoves: A Compendium

Prepared by
Chinese Academy of Agricultural Engineering Research and Planning (CAAERP), Beijing
Yao Xiangjun, Wang Mengjie, Hao Fangzhou and Zhang Jigao (eds)
FAO Regional Wood Energy Development Programme in Asia, Bangkok
GCP/RAS/131/NET, Field Document No. 40
1993, iii+55 p.

China's cookstove development and dissemination programme, with 140 million stoves reportedly installed in rural households, accounts for 70–80% of the total number of improved cookstoves installed worldwide. Not only is the number of stoves impressive, but the variety of models to suit the diverse geographical conditions and users' needs and preferences is exemplary also. At the same time considerable investments have been made in institutional arrangements with over 200,000 persons reportedly being directly involved in the programme.

The earlier compendium, "Chinese Fuel Saving Stoves", published in 1986 by the FAO Regional Office for Asia and the Pacific, introduced eight selected models of advanced fuel-saving stoves that were popularly used in farm households during the 1980–1985 period. In this compendium ten new models of high efficiency stoves that have been developed during 1986–1992 are included. It should be noted that all the improved stoves in China have their main parts, or all the parts in many cases, prefabricated from cast iron and/or refractory ceramics and concrete slabs. This production strategy helps not only to maintain the stoves' critical dimensions and service-lives, but also enables the stoves to be sold in the market similar to other household commodities. While most of the models chosen are biomass-fired cookstoves, two coal-fired models are also introduced: one for institutional cooking and the other for cooking and space heating in the household. A newly developed industrial wood- or briquette-fired furnace for crop drying applications is also included.

The report contains four chapters. Chapter 1 provides the background information on the development of improved cookstoves in China, including the statistical data on fuel saving stove dissemination in provinces and cities. Chapters 2 and 3 present ten new models of improved stoves developed during 1986-1992. The presentation of each model includes its brief development history, description, fabrication, photo-illustrations, technical drawings, general and main technical features. Chapter 4 deals with China's improved cookstove organization and network, which shows the national organization chart, national stove programme management and lists stove R&D institutes and universities, provincial and municipal promotional organizations, major improved stove manufacturers and leading experts on improved stoves in China.

This report is intended for those officials and volunteers who are engaged in programmes for introducing energy saving cookstoves in developing countries.

Indian Improved Cookstoves: A Compendium

Prepared by
Improved Chulha Division, Indian Ministry of Non-Conventional Energy Sources and Indian Institute of Technology
Sri B.M.L. Garg and Shri Paramjeet Singh Rajpal (eds)
FAO Regional Wood Energy Development Programme in Asia, Bangkok
GCP/RAS/131/NET, Field Document No. 41
1993, iii+104 p.

The Indian National Programme on Improved Chulhas (NPIC) is more than eight years old. The major thrust of the programme has been the conservation of biofuel, reduction or elimination of smoke from the kitchen, and alleviation of cooking drudgeries (usually experienced by women). By early 1992, over 12 million improved chulhas or improved cookstoves had already been disseminated all over the country. New steps are being undertaken for the development and adoption of quality standards by stove manufacturers and the commercialization of improved chulhas so that private participation can be further enhanced.

The compendium provides information on the historical backgrounds of the improved models popularly adopted, especially during the last few years, as well as of those advanced models recently developed. They comprise fixed and portable types for use in family and community cooking. Technical details of each model are also provided.

The compendium is divided into four chapters. Chapter 1 introduces the development of improved stoves in India. Chapter 2 is concerned with the organization of the Indian National Programme on Improved Chulhas. Chapter 3 presents 29 selected models of improved chulhas with descriptions, technical drawings, general specifications and test performances. Chapter 4 focuses on networks of the National Programme on Improved Chulhas with lists of organizations, agencies and people involved in the programme. There are two annexes. Annex 1 indicates the subsidy pattern for improved chulhas. Annex 2 provides Indian standards on solid biomass chulha-specification, which includes test for thermal efficiency and test for combustion efficiency.

The Indian lessons and experience derived from the programme on improved chulhas described in this compendium could be valuable to other Asian countries with similar fuelwood/biomass energy problems.

Training Courses/Conferences

Techno Indochina Congress

18–24 August 1994, Bangkok, Thailand

The International Congress on Science and Technology for Indochina, "Techno Indochina", is jointly organized by Thailand's National Science and Technolgy Development Agency (NSTDA), the Ministry of Science, Technology and Environment, and the Committee on Science and Technology of the House of Representatives of Thailand, under the auspices of the Royal Thai Government. The participating countries are Cambodia, Laos, Myanmar, Vietnam and Thailand.

Four major topics are: Agriculture and Agro-Industry; Health; Energy and Environment; and Education and Human Resource Development.

The theme of the major topic "Energy and Environment" will be focused on the following fields:

- Hydropower from large and small dams for electricity generation and irrigation;
- Uses of lignite for industrial heat;
- Large-scale driers for agricultural products;
- Solar photovoltaics and wind energy for electricity generation;
- Biomass residues and biogas for heat and power production; and
- Development of natural gas utilization.

For further information contact:

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Tel: +66-2-248 7541 to 8
Fax: +66-2-248 7549

10th Annual Canadian Wind Energy Conference & Exhibition

17–19 October 1994, Saskatchewan, Canada

This year's conference is being held in Regina, Saskatchewan – the next market for wind power in Canada and the site of an extremely attractive wind resource.

Conference topics include:

- Stand alone wind installations;
- Wind energy for on-farm use;
- Wind industry activity in Canada, the U.S. and Europe;
- Pricing and cost issues;
- Wind energy and the environment;
- Utilities and regulatory issues;
- Mechanical and pumping applications; and
- Government programs and policies.

For more information contact:

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or

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Canadian Wind Energy Association
2415 Holly Lane, suite 250
Ottawa, Ontario K1V 7P2
Canada

"African Photovoltaic College" and Second International Conference on "Implementation of Renewable and Alternative Energy Technology"

13–25 November 1994, Nsukka, Nigeria

Organised by the National Centre for Energy Research and Development (NCERD), University of Nigeria – Nsukka, and the Energy Research Group, University of Lagos, Nigeria. The activity will be co-sponsored by the International Centre for Theoretical Physics (ICTP), Trieste, Italy, ENEA (Italian Commission for New Technologies, Energy and the Environment, Italy), Society of African Physicists and Mathematicians (SAPAM), World Renewable Energy Network (WREN, United Kingdom), National Renewable energy Laboratory (NREL, USA), IPPS (Sweden) and IT Power (United Kingdom). The local coordinators are M.A.C. Chendo (University of Lagos, Nigeria) and O.C. Iloeje (NCERD, University of Nigeria, Nsukka).

1. PV College

The College will focus on both technological and socio-economic aspects that inhibit the development, diffusion and popularization of PV in the African sub-region. The activity will be based on plenary lectures given by an international faculty with an average of three lectures per day, plus seminars, laboratory sessions and tutorials by visiting experts. Communications from participants will represent an essential part of the activity.

2. International Conference

The conference will be comprised of invited papers and selected participants' contributions. It will address such issues as: new and renewable sources of energy (NRSE) and alternative energy resources (AER) in the context of national energy policies, NRSE and AER technological developments, country programme implementations, international collaboration, etc.

For further information contact:

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Publications Received

ENERGY AND ENVIRONMENT

* *Sectoral Energy Demand Studies: MEDEE-S Users and Technical Manual*, Regional Energy Development Programme, Economic and Social Commission for Asia and the Pacific, United Nations Development Programme, prepared in cooperation with the Government of France and the Asian Institute of Technology, 1992, 166 p.

* *Sectoral Energy Demand Studies: DBA & VOID Users and Technical Manual*, Regional Energy Development Programme, Economic and Social Commission for Asia and the Pacific, United Nations Development Programme, prepared in cooperation with the Government of France and the Asian Institute of Technology, 1992, 166 p.

* *Sectoral Energy Demand in Vietnam*, revised and edited by Thiery Lefevre, Regional Energy Development Programme, Economic and Social Commission for Asia and the Pacific, United Nations Development Programme, prepared in cooperation with the Government of France, the Government of Vietnam and the Asian Institute of Technology, United Nations, 1992, xix+55 p.+Annexes.

* *Sectoral Energy Demand in Myanmar*, revised and edited by Thiery Lefevre, Regional Energy Development Programme, Economic and Social Commission for Asia and the Pacific, United Nations Development Programme, prepared in cooperation with the Government of France, the Government of Myanmar and the Asian Institute of Technology, United Nations, 1992, viii+39 p.+Annexes.

* *Sectoral Energy Demand in Lao People's Democratic Republic*, revised and edited by Thiery Lefevre, Regional Energy Development Programme, Economic and Social Commission for Asia and the Pacific, United Nations Development Programme, prepared in cooperation with the Government of France, the Government of Lao People's Democratic Republic, and the Asian Institute of Technology, United Nations, 1992, vii+21 p.+Annexes.

* *Sectoral Energy Demand in Sri Lanka*, revised and edited by Thiery Lefevre, Regional Energy Development Programme, Economic and Social Commission for Asia and the Pacific, United Nations Development Programme, prepared in cooperation with the Government of France, the Government of Sri Lanka and the Asian Institute of Technology, United Nations, 1992, xvi+87 p.+Annexes.

* *Regulation, Institutional Structure and Performance of the Electricity Sector: The Case of Thailand*, by G.V. Dang, Division of Energy Technology, Asian Institute of Technology, Bangkok, 1992, v+67 p.+Annexes.

* *UNEP Greenhouse Gas Abatement Costing Studies: The Case of Thailand*, by G.V. Dang, C.J. Lim and L.B. Minh, Energy Technology Program, Asian Institute of Technology, Bangkok, 1993, vi+41 p.+ App.

* *Annual Report 1993*, Energy Research, Development and Information Centre (ERDIC), The University of New South Wales, Australia, 1994, 112 p.

ENERGY CONSERVATION

* *Residential Energy Conservation in Brunswick: Monitoring the Effectiveness of a Residential Energy Conservation Campaign*, by I. Thomas, J. Todd, K. Blakemore and D. Harries, Faculty of Environmental Design and Construction, Royal Melbourne Institute of Technology, Melbourne, Australia, February 1993, ISBN 086444-287-4, 65p.

* *The Role and Application of Energy Consumption Indicators, Norms and Standards as an aid to Energy Efficiency Policy in the ASEAN Region*, a report on work for the DITECH project by Energy Technology Support Unit, United Kingdom, published by ASEAN-EC Cooperation in Dissemination of Energy Technology (DITECH) and ASEAN-EC Energy Management Training and Research Center (AEEMTRC), June 1993, 25 p.+app.

RENEWABLE ENERGY

* *Renewable Energy: Technology for Today*, Proceedings of the 18th Annual Conference of the Solar Energy Society of Canada, 1992, 396 p.

SOLAR ENERGY

* *Energy Efficiency and Solar Energy*, Proceedings of the 19th Annual Conference of the Solar Energy Society of Canada, 1993, 289 p.

Diary of Events

- **22 – 26 August 1994, Kiev, Russia**

10th International Heat Transfer Conference

For details contact:
10th International Heat Transfer Conference
Institute of Engineering Thermophysics
Ukrainian SSR Academy of Sciences
2a Zhelyabov St
SU-22 20 57, Kiev
Russia

- **5 – 9 September 1994, Montpellier, France**

ISAP '94 – Intelligent System Application to Power Systems

For details contact:
ISAP Local Committee – EDF/DER/ER
Arnand Hertz 1
Avenue de Général de Gaulle
92141 Clamart Cedex
France

- **6 – 8 September 1994, London, United Kingdom**

Energy and Resource Management Exhibition

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Diary of Events
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For details contact:
Caroline Clark
The Energy Exhibition
Philbeach Events Ltd.
Earls Court Exhibition Centre
Warwick Road
London SW5 9TA
United Kingdom
Tel: +(071) 370 8207

- **6 – 8 September 1994, Liège, Belgium**

6th International Symposium on Short-Circuit Currents in Power Systems

For details contact:
Dr J.L. Lilien
University of Liège
Montefiore Electrical Institute
Sart Tilman -- Bat. 28
B-4000, Liège
Belgium

- **6 – 9 September 1994, Moscow, Russia**

International Congress: Water, Ecology and Technology

For details contact:
Congress Secretariat
PO Box 173, Moscow 107078
Russia
Tel: +70 95 265 9054
Fax: +70 95 265 9844

- **7 – 9 September 1994, Scotland, United Kingdom**

North Sun '94 – Solar Energy at High Latitudes

For details contact:
Mackintosh School of Architecture
Glasgow School of Art
177 Renfrew Street
Glasgow G3 6RQ
United Kingdom

- **19 – 23 September 1994, Cape Town, South Africa**

World Energy Council Assembly

For details contact:
World Energy Council
34 St James' Street
London SW1A 1MD
United Kingdom
Tel: +44 71 930 3966
Fax: +44 71 925 0452

- **21 – 23 September 1994, Port Couras, Greece**

Hydrosoft 94

For details contact:
Dr. Blain
Wessex Institute of Technology
Ashurst Lodge
Ashurst, SO4 2AA
United Kingdom
Tel: +44 703 293 223
Fax: +44 703 292 853

- **21 – 23 September 1994, Bologna, Italy**

ICHPS VI – The 6th International Conference on Harmonics in Power Systems

For details contact:
Prof Gian Carlo Montanari
Istuto di Electtrotecnia Industriale
University of Bologna
Viale Risorgimento 2
40136 Bologna
Italy

- **22 – 23 September 1994, Frankfurt, Germany**

Financing Hydropower Projects

Sponsored by International Water Power & Dam Construction.

For details contact:
Conference desk
First Europe Communications
Tel: +44 (0)71 490 3318
Fax: +44 (0)71 490 3319

- **26 – 29 September, 1994, Rio de Janeiro, Brazil**

Probabilistic Methods Applied to Power Systems

For details contact:
Dr Samy Krishnasamy
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TECHNO INDOCHINA
The International Congress on Science and Technology for Cordial Relationship with Neighboring Countries August 18-24, 1994, Bangkok, Thailand

Techno Indochina – the first congress on science and technology for Indochina – was held in Bangkok from 18 to 24 August, 1994, at the United Nations Conference Center under the auspices of the Royal Thai Government. The congress was organized by Thailand's National Science and Technology Development Agency (NSTDA), Thailand's Ministry of Science, Technology and Environment, and the Committee on Science and Technology of the House of Representatives of Thailand. His Majesty, King Bhumibol Adulyadej of Thailand presided over the opening ceremony of the congress.

The congress aimed at promoting the development and the transfer of scientific and technological knowledge among Thailand and her neighboring countries, i.e. the Kingdom of Cambodia, the Lao People's Democratic Republic, the Union of Myanmar, and the Socialist Republic of Vietnam. It was intended to promote economic cooperation through the application of science and technology for increasing achievements in agriculture, industry, energy, health and environmental conservation, and also to create awareness among the public of the increasing importance of science and technology for a better quality of life.

The congress was attended by more than 2,600 participants of which 300

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INNERTAP

Incorporates news from the Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

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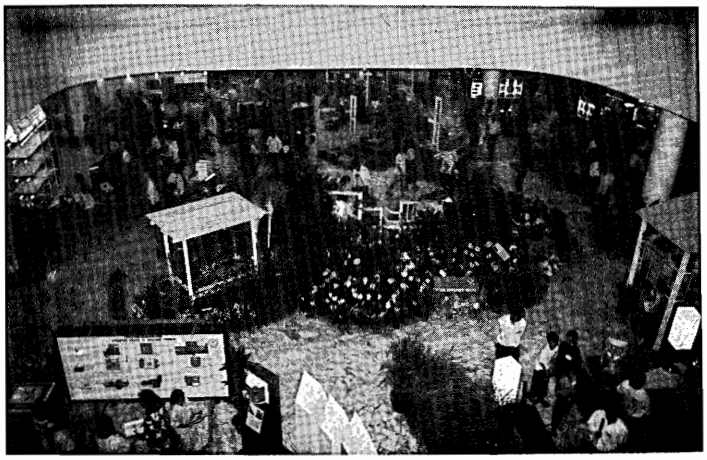
participants from Cambodia, Lao PDR, Myanmar, Vietnam and Yunnan, PRC were invited guests of the Royal Thai Government. In addition to 4,400 students who officially registered to visit the exposition, about 1500 interested people visited the exposition during 19-24 August.

The congress comprised symposia, lectures, group meetings, a science and technology exposition, and a techno exhibition on four major topics: Agriculture and Agro-Industry, Health, Energy and Environment, and Education and Human Resources Development.

Two plenary lectures on energy were presented:



"Transnational Power Development" by Somvonk Poshyananda of the Electricity Generating Authority of Thailand, and "Transnational Development of Natural Gas between Thailand and Neighboring Countries" by Prajya Phinyawat of the Petroleum Authority of Thailand.

The energy and environment exposition covered the following projects:

- In-store Paddy Drying;
- Solar Energy Fruit Dryer for Industrial Scale;
- Assessment of Solar Radiation for Thailand;
- Solar Integrator and Solar Cell Pyranometer;

- Degree Programs in Energy Technology;
- Rice Husk Gasifier for Drying of Grains;
- Heat and Power Production from Wood-Wastes;
- Anaerobic Fermentation – a Sound Technology for the Environment and a Valuable Source of Energy, the Biogas Programs in Thailand;
- Biogas System for Swine Farms;
- Electricity Generation from Landfill Gas;
- Pasak River Basin Development Project – a Project Initiated by His Majesty the King of Thailand;
- Solar Photovoltaic/Wind Hybrid System;
- Fluidized Bed Combustion Technology;
- Small Hydropower Development Projects in Thailand; and
- Natural Gas Development in Thailand.

For further information about the congress please contact:

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Three-Phase Inverter for Photovoltaic Power

Japan Storage Battery Co., Ltd. has developed and started marketing a Three-Phase Lineback Series of newly developed three-phase (200 V) network inverters available in 7 models (rated capacities of 10-60 kW) for use in photovoltaic power generation by electric utilities.

These inverters convert the DC electricity generated by solar cells into three-phase AC electricity. When the electricity generated by solar cells is inadequate, the shortage is supplemented with commercial power, and when there is surplus electricity, it is fed to the commercial power generation network.

This has been made possible by introducing the high-frequency switching technique and microcomputer technology developed through the UPS system, such as the capacity enlargement and three-phase conversion techniques, as well as the introduction of a linkage protection system.

The photovoltaic power generation system incorporates linkage protection systems such as voltage and frequency protective relays, and a function for terminating photovoltaic power generation and preventing independent plant operation to achieve safety whenever the commercial power system is interrupted.

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Thin Film Photovoltaic Partnership Program – USA

To promote commercialization of thin-film photovoltaics, the U.S. Department of Energy (DOE) is creating partnerships with U.S. industry to move technological advances from the laboratory to the marketplace. The five-year, $120-million initiative, called the Thin Film Photovoltaic Partnership Program, is being managed for DOE by the National Renewable Energy Laboratory (NREL).

The program aims at using the combined technical expertise of U.S. photovoltaic companies, universities and national laboratories to improve thin-film photovoltaic efficiency, reliability and manufacturing ability.

The formal solicitation for industry partners was issued recently by NREL and subcontracts are expected to be awarded in December 1994. Total five-year funding could reach $170 million with industry partners expected to contribute as much as $50 million.

Thomas Surek, manager of NREL's photovoltaics program says: "For a new product to succeed, it's essential to create a strong link between improved laboratory technology and engineering-related product development. This program is an excellent way to develop that link."

With companies already scaling-up pilot manufacturing facilities or building new manufacturing plants for current products, the initiative will focus on advanced thin-film technology and processing methods.

Compared to wafer-based crystalline silicon solar cells, thin-film cells require much less semiconductor material, are easier to fabricate and are far less expensive to manufacture. On the other hand, thin-film technologies have not achieved the higher crystalline silicon conversion efficiencies. However, recent laboratory advancements in thin-film efficiencies are rapidly changing this, making thin-film technologies even more promising.

"Thin films may have the greatest potential for achieving the major cost reductions needed to make photovoltaic electricity competitive for large-scale world markets," said Ken Zweibel, NREL manager of the Thin-Film Photovoltaic Partnership Program. "This initiative is an important step along that road to the big payoff."

(Source: From "DOE, NREL Seeking Industry Partners for New PV Program", *NREL Press Release* via NREL's Gopher/WWW Server, April 6, 1994)

Three-Phase Inverter for Photovoltaic Power

From P. 2

In August last year, the company marketed two models of single-phase network linkage inverters (power generation capacity 3 kW and 5 kW) for use by private households. The marketing of the inverters for branch offices has substantiated the lineup of network linkage operation facilities, and the company plans to accept orders for integrated photovoltaic power generation systems from design to installation.

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(Source: Extracted from "Three-Phase Network Linkage Inverter for Photovoltaic Power Generation", *JETRO*, Vol. 22, No. 1, April 1994, pp. 34-35)

Suntron Submersible Solar Pump

Suntron Power Products, a Melbourne based company, has despatched the first of its new generation of submersible solar water pumping systems known as the Suntron Sunpumps™.

According to Susan Saunders, Managing Director of Suntron, tests before despatch revealed an instantaneous system efficiency of 7.1% which is well in excess of that achieved by any other commercial solar water pumping system in the world.

The system tested used four standard Solarex 58 Wp solar modules, the new high efficiency Suntron submersible motor and Suntron Solar Motor Controller (SMC), and a standard, ex stock Mono SM041 submersible pump.

The new motor and controller utilises the latest technologies in both motor design and electronics, resulting in a brushless motor whose efficiency is in the order of 90% over a wide load range. It was developed with the assistance of Australia's Energy Research and Development Corporation (ERDC), CSIRO and the University of Technology, Sydney.

All the systems from the first pilot production run are being tested under field conditions by selected Suntron distributors.

System Costs

Motor	Controller	Price
0.7 Nm	200 W	$A 2,577
0.7 Nm	400 W	$A 2,600
1.5 Nm	800 W	$A 2,731
3.0 Nm	1500 W	$A 2,980

Suntron itself will shortly be installing its first system, at a borehole site in New South Wales which has a 60 m head. A six solar module system using a Suntron Suntracker™ will be installed. This system will be fully monitored and used to test long term performance and reliability of the new systems.

Orders for systems from the second production run are now being taken by Suntron, phone: (03) 894 2455, facsimile: (03) 894 3370.

Prices include input/output via an IP 56 junction box. A PS version, fitted with plugs and sockets is available as an optional extra.

(Source: Extracted from "Big Lift in Total System Efficiency", *Solar Progress*, Vol. 15, No. 2, Winter 1994, p. 28)

TI Spheral Solar Cells

Low-cost metallurgical (MG) silicon, which lacks the purity needed to create a reliable crystalline-silicon PV technology, has attracted the attention of Texas Instruments (TI). Since 1985, TI – in cooperation with Southern California Edison Co. – has been engaged in a research and development effort aimed at purifying this abundant low-cost starting material. This research has resulted in a high durable solar cell that registers efficiency levels near that of conventional PV.

In high volume production, the new technology could potentially reach $1-$2 a watt, which experts agree is necessary for large-scale PV use.

Inventor Jules Levine, TI director of advanced technology and associate project manager, hypothesized that it could be "purified" through a melt process. Upon reaching its melting point, the silicon naturally retracts into a fairly pure sphere, while most of its impurities move to the outside where they can be removed.

These purified spheres – suggesting the name Spheral Solar™ technology – are embedded in a lightweight aluminum screen and bonded through a thermomechanical process.

The unique characteristics of the technology – spheres embedded in aluminum – provide both flexibility and durability. Flexible front coverings take advantage of the technology's ability to conform to multiple surfaces, taking any number of shapes. In addition, TI is currently exploring coloring techniques that will provide greater design freedom.

Capitalizing on the flexible qualities of the cell with a polymer coating helps to reduce the module's weight, a major factor in balancing systems costs. More than 65% of conventional modules is associated with using a glass covering. The added weight introduces construction and structural issues largely associated with mounting.

TI is in the early commercialization phases of Spheral Solar™ technology, with efforts currently concentrated on product reliability, efficiency levels, and factory scale-up. Spheral Solar™ cells recently passed a series of freeze and thermal cycling qualification tests established by the National Renewable Energy Laboratory (NREL). On cells with flexible coatings, the efficiency measured by NREL improves to between 9 and 10 percent. This improvement is due to the unique light-gathering properties of the technology, which result from the uneven surface formed by the closely placed spheres. TI tests show that the acrylic coatings have a lensing effect on the curved surface of each sphere, frequently boosting efficiency into the 10- to 20- percent range.

Pilot production is underway for internal testing. By mid-1994, TI plans to produce modules for field testing. TI also is in the initial design stages of a larger PV factory to manufacture products with its technology. Start-up is scheduled for 1995.

With technical advances such as Spheral Solar™ technology, TI believes that the PV industry could virtually explode, creating more than a $5 billion market by 2010. This market could create as many as 25,000 new jobs.

(Source: Extracted from "Texas Instruments Develops Flexible Photovoltaic Alternative", by Eric Graf, *Fortnightly*, Vol. 131, No. 21, November 1993, pp. 30-31)

Grid Connected PV Test – Japan

Researchers from the Kansai Electric Power Company and the Central Research Institute of the Electric Power Industry, Japan, are engaged in the largest and most important field test of renewable energy integration on a small, artificial island near Osaka.

The Rokko Island Test Facility is analysing the integration of 100 homes powered by solar cells, fuel cells and wind generators into the electricity distribution network.

Dr. Kitamura, principle researcher of the project, has been with the Rokko Island facility since it began in 1987 with funding by the New Energy Development Organisation (NEDO).

The test facility has a total of 200 kilowatts in 100 fixed solar cell (PV) 'household' arrays. Each two kilowatt system powers lights, a television set, space conditioning and other appliances. A range of electronic power conditioning equipment to 'invert' the DC electricity of solar cells into utility-grade AC electricity is also being tested.

One of the main problems identified during the initial phase of the research is 'harmonic distortion' of the electricity being fed into the distribution network. Other potential problems are large voltage fluctuations from solar cells, reverse power flow and the phenomenon of "islanding", whereby electricity can continue to flow from a solar array even when the distribution network has been disabled.

While standards for the interconnection of distributed generating systems have been developed and used in the USA by the Institute for Electronic and Electrical Engineers (IEEE), Dr. Kitamura said that "the IEEE didn't have a Rokko Island" to develop the standards. "It's impossible to apply small experiments to the large scale," he said.

The research group is trying to simulate every possible combination of technologies. Last year the group investigated separate generating systems but next year a program will begin to look at combinations of technologies – i.e. fuel cells and PV, PV and wind, etc.

The latest generation of power electronics is larger than its precursor, expanded to incorporate a small amount of energy storage which is important from the utility point of

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Community Wind Park

Lübke-Koog is an independent community with 40 farms and 230 inhabitants on the North German coastline. Agriculture is the community's principal source of income. The area, located directly on the coast, exhibits a favourable wind regime with annual average wind speeds of 5.4 m/s at a height of 10 m.

With renewed interest in wind energy and the funding available for its promotion, some members of the community began to think about investing in this sector. This is also motivated by the fact that wind power could be a second economic base of support in addition to agriculture, where the situation was becoming increasingly difficult.

The original initiators held several town meetings which eventually led to the idea of creating a wind park that would be owned and operated by the local community.

One year later, 44 residents founded a company, bought a strip of land along the dike and set up 22 wind energy plants with a total capacity of 8.2 MW.

The total costs of the project amounted to approximately DM 22 million (US$ 13.3 million), 10 percent of which was invested by the partners themselves. The rest was financed with loans from local banks. The wind-power plants as well as the partners' farms were committed as collateral on the loans.

Since early 1993, 18 wind generators (another four wind-energy plants will be set up in 1994) have generated 13,000 MWh of electricity.

Given the high level of investments, the operators do not expect to make any big profits during the first few years. Over the long term, however, the revenue from electricity sales is intended to back up the income from agriculture.

Whereas wind generators occasionally provoked heated debates between advocates and opponents in some other communities, it is not the case here because the whole community was involved in the project in the early stages and all of the residents had numerous opportunities to participate along the way.

(Source: Extracted from "Lübke-Koog Community Wind Park", *Gate*, No. 2/94, June 1994, p. 44)

Grid Connected PV Test – Japan

From P. 4

view. It provides a more stable supply when output drops from events like passing clouds. A two kilowatt inverter is now fitted with 1 kilowatt-hour of storage which Dr. Kitamura believes is too much. Three to five minutes is a critical time for storage.

Another measure of the reality of the test is that the modules under test are also installed at a 15-degree tilt which is too low for optimum performance but it is the average roof tilt for Japanese homes. The facility is also testing module mounting procedures and has already identified a number of design faults that manufacturers have corrected.

When asked if it wouldn't be easier just to write some software to simulate the experiment Dr. Kitamura explained that three researchers at Electric Research Institute of Japan have been trying to simulate the testing on software without success.

"The performance of new technologies must be thoroughly tested before they will be widely accepted," Dr. Kitamura said.

(Source: Extracted from "Japanese Test Renewable energy Integration" by Peter O. Fries, *Solar Progress*, Vol. 15, No. 2, Winter 1994, p. 14)

Wind Power Development in China

Having thoroughly tested a range of technology from around the world China is ready for full scale wind development. According to a leading Chinese wind energy expert, wind farm installation in China will reach 75-100 MW by the end of 1995.

Huizhu Dai, Dean of the Graduate School of the Electric Power Research Institute at the Ministry of Electric Power, says that by the end of the century, 650 MW of wind will have been installed, about 100 MW per year from 1995 to the year 2000.

Wind is taking root in China. Several small wind farms have so far been installed, and Nordtank is setting up an office in Beijing. Several utilities are now starting to be involved in wind. In 1992, Fulin Wind Power Development Corp was established to promote wind farm development by giving credit.

On March 8, 1994, Nanao Wind Farm, US Konderna Co and US Environment Project Co set up a joint venture to install a 30 MW wind farm (15 x 200 kW Nordtank turbines) by the end of 1995 in Guangdong Province.

So far, 64 foreign and 14 experimental Chinese wind turbines have been installed in China. Since the county's first wind farm established at Rongehen in Shandong Province in 1986, a total of 15.69 MW of Danish turbines have been put into operation, mostly supplied by Nordtank and Bonus. Besides, some 2.3 MW of German turbines and 0.6 MW of US turbines have also been installed.

This year 15, 300 kW Nordtank wind turbines from Denmark are to be erected in Zhurehe wind farm in Inner Mongolia, four Nordtank 300 kW units at Zhanbei wind farm in Heibei Province, and five Nordtank 300 kW turbines at Donggang wind farm in Liaoing Province. And ten Bonus 120 machines, made by Hangzhou Generating Equipment Factory under a technology transfer agreement will be made and installed also in Zhurehe in Inner Mongolia.

(Source: Extracted from "One Hundred Megawatt a Year", by Ros Davidson, *WINDPOWER MONTHLY*, Vol. 10, No. 7, July 1994, pp. 22-23)

Windpower Surge In Holland

Tulips and windmills eternally paint the landscape of Holland. The traditional picture of Holland beholds old-fashioned windmills silhouetted against a dramatic sky. By the end of the 16th century, every village had at least one windmill to grind grains. The mills also drained polders, sawed wood, pressed oil, shucked rice, and did other work. About 1,000 windmills still remain as monuments. Three hundred are in use for agricultural or commercial purposes.

The wind power industry blows strongly in Holland these days. The Netherlands topped 100 MW capacity at the beginning of this year. An ambitious government program pushes for 1,000 MW installed capacity by the year 2000. By then, 30 to 40 windpower plants, with more than 700 wind turbines, will generate electricity along the coastal areas and dikes.

With limited land space and dense population, planners see maximum room for 1,000 MW, of large turbines, to conserve space. For this reason, the market does not favor a wide range of turbine sizes. Currently, the 10 largest wind power plants in the Netherlands turn out 71.5 MW. The largest wind farm, in Noordoostpolder, southwest of Groningen, whips out 15 MW.

After filling the land areas, the Dutch intend to install facilities offshore. The first offshore pilot project is getting under way. PEN, northern Holland's electric utility, will install four NedWind 500 kW turbines on Ijsselmeer. "Presently, building offshore is not cost-effective," says Wim Stam, of ECN, the Netherlands Energy Research Foundation.

To bolster wind power development, government subsidies shorten paybacks. And many Dutch utilities apparently pay a good rate for wind-generated electricity. Under the government plan, utilities will stimulate further development of technology to improve quality, lower costs, and introduce larger turbines. As a result, the government subsidy is expected to decrease.

The current government push is driven by the desire to reduce dependence on gas and oil, and reduce CO_2 and coal emissions by increasing clean energy sources.

Three major wind turbine manufacturers supply nearly all the wind turbines operating in Holland. The largest company, NedWind, builds 250 kW, 500 kW, and 1 MW machines. It is comprised of several former Dutch wind companies, which merged under the government-subsidized wind plan.

NedWind develops and manufactures its own rotor blades at its blade plant in Heerhugowaard in north Holland, using an automated fiberglass impregnation and lay-up machine. Wind Master, a Belgian company with a Dutch arm, makes a medium-size turbine. Finally, Lagerwey makes a small, two-bladed turbine that it sells mainly to farmers.

The Dutch wind market is also open to foreign companies. A wind power project of 40 Danish Mycon turbines generates 10 MW on the northern coast for EGD, the utility in Groningen. Adjacent to that project, the American company Kenetech Windpower, formerly U.S. Windpower, plans to install 74 of its 33M-VS wind turbines during the latter half of 1994. Kenetech's Grebe says this is the only utility scale variable-speed machine available. It is rated between 330 kW and 400 kW.

The safety and quality requirements for wind turbines in the Netherlands are among the strictest in the world. CIWI, the Dutch certification institute, grants certificates after extensive testing procedures and design examinations.

(Source: Extracted from "Windpower Gusts In Holland", by Robert S. Seeley, *Independent Energy*, Vol. 24, No. 4, April 1994, p. 99)

Cornish Windfarm Opened

The largest windfarm of the United Kingdom in Cornwall at Cold Northcott, near Launceston was recently opened by Energy Minister Tim Eggar. This is the fifth windfarm commissioned by National Wind Power, a company owned by Taylor Woodrow Construction and National Power, the UK's leading electricity generating company.

The windfarm has a capacity of 6.7 MW, which is sufficient to meet the electricity needs of a community of over 7,000 people. It has 22 MS-3 300 kW turbines supplied by leading British manufacturer, the Wind Energy Group Ltd, a wholly-owned subsidiary of Taylor Woodrow. The land around the turbines continues to be used for cultivation.

The turbine has two blades with a rotor diameter of 33 metres and is mounted on a 25 metre tubular steel tower. The turbines generate electricity at wind speeds of between 5.5 and 25 metres per second and have a design lifetime of 20 years.

The windfarm can be operated by remote control though there is a control room within the site sub-station.

National Wind Power has invested £48 million in wind power generation. The company has developed other windfarms at Mynydd-y-Cemmaes, Llangwyryfon and Bryn Titli in Wales and Kirkby Moor, Cumbria. National Wind Power also has a stake in a windfarm at Delabole in Cornwall.

Welcoming Tim Eggar to the site, National Wind Power's managing director Dr. David Lindley said: "We are particularly pleased to have the Minister with us today. His presence here underlines the Government's support for the development of wind power. He also demonstrates the Government's recognition of the increasingly important role windfarms will play in helping to produce "clean electricity" and to meet the country's energy needs".

"We believe wind power can make a significant contribution to UK electricity supplies and are now pushing forward with other appropriate schemes."

(Source: Extracted from "Cornish Windfarm Opened", *Energy Digest*, No. 1, 1994, p. 34)

Kenetech Windpower's Growth

Kenetech Ramps Up

With few exceptions, Kenetech, formerly known as U.S. Windpower, has won nearly every open bid for new contracts in North America since their 33M-VS model marketing campaign began. The company dominates developments in North America and will outstrip any other single wind developer worldwide in 1994.

The company has 100 MW of firm orders for 1993-1995 in the United States and Canada, 100 MW on the books for 1995-1996 in the U.S. and New Zealand, and another 50 MW of proposed projects in Spain and Germany. Kenetech's prospectus says it is also negotiating contracts for another 420 MW of capacity through 1999 in Europe, North America, and elsewhere.

With construction of its 5 MW demonstration plant for the Sacramento Municipal Utility District (SMUD), the company is well on its way to building up a critical mass of manufacturing volume.

In late winter SMUD signed a contract with Kenetech for a 50 MW wind plant. The full 50 MW is contingent on the performance of an initial 5 MW phase.

Kenetech will install, operate and maintain the facility. SMUD will buy the completed project for US$ 52 million, or US$ 1,040 per kW of capacity in 1991 dollars. Kenetech will install 17 turbines during the first half of 1994 and another 150 machines in the second phase beginning in 1996. After completion of the full 50 MW Kenetech will deliver 121.8 million kWh per year.

Kenetech is also installing 115 of its new 33M-VS turbines in California's first major repowering of an existing site. The former Renewable Energy Venture project contained an older mix of Jacobs and ESI machines, all of which have been removed. When complete, the repowering will push the total number of 33M-VS turbines installed by mid-year to 270.

In less than one year Kenetech will have become one of the world's largest manufacturers of wind turbines in the 30 to 40 meter size class, surpassing even Vestas, Europe's dominant manufacturer.

By 1996 Kenetech may have at least three 50 MW projects under construction, one for SMUD in Solano County, a second in Texas, and a third in the Northwest. Kenetech also expects to begin work on a 75 MW plant in Wyoming. By the end of 1996 or early 1997 Kenetech will have added at least 200 MW, increasing their total installed capacity 50% from 400 MW to 600 MW.

The Lower Colorado River Authority, a municipal utility in central Texas, entered a 50 MW contract to purchase power from a Kenetech plant in West Texas beginning in the summer of 1996. The authority also signed a letter of intent, termed a joint development agreement, with Kenetech for an additional 200 MW by 2002.

In February Kenetech signed a 50 MW contract with three Northwest utilities to build a plant in the Columbia Hills near Goldendale, Wash. Kenetech will site, permit, build and operate the plant. Portland General Electric (PGE), PacifiCorp, and Puget Sound Power & Light will own the project, valued at about US$ 45-50 million or US$ 1,000 per kW of capacity. Kenetech will begin construction in 1995 for completion in 1996. In mid-winter, PGE also announced the start of negotiations with Kenetech for another 100 MW after short-listing the firm under a competitive solicitation for a project in eastern Oregon.

Meanwhile, Kenetech is continuing negotiations with Hydro Quebec for a 100 MW contract and has begun monitoring wind speeds at sites on the Gaspe peninsula. The peninsula in eastern Quebec lies south of the St. Lawrence River, bordering Maine. Kenetech is also negotiating contracts for windpower projects on the U.S. side of the international border. Nevertheless, Kenetech's big future market remains California.

From 56-100 Model to 33M-VS

The prospectus states that

Cont. P. 8

Brazil Starts Wind Development

The Brazilian government has approved a loan of up to $100 million for two 30 MW wind farms in the northeast state of Ceara. The decision, made in early May, means the government will guarantee international bids for the wind farms.

According to Sergio Cardoso Maia, president of the Coelce state utility, an invitation for international bids will go out in some five to six months and the turbines should be in the ground about one year after that.

Wind speeds in the area are about 10 m/s at a height of ten metres. The region is arid and must import most of its energy from areas with hydropower. This is the second phase of the region's wind programme.

Under the first phase, resources were logged by American company NRG Systems of Vermont and an agreement was reached between the Japanese government and the state of Ceara.

Previously in Brazil, a wind-diesel project has been installed on an island with the help of the Folk Centre of Denmark. A 1 MW wind farm of four 250 kW Tacke machines from Germany has also been installed in the state of Minas Gerais under the German El Dorado programme.

The whole of Brazil could have as much as 1000 MW of wind power in the ground by 2005, predicted Everaldo Feitosa of the Federal University of Pernambuco.

(Source: Extracted from "Brazilian Start", *WINDPOWER MONTHLY*, Vol. 10, No. 6, June 1994, p. 18)

New IT Power Windpump

Windpumps were once widely used for mechanising borehole and deepwell water supplies in remote areas, but are now increasingly neglected. To contribute to the development of this still useful technology, the new IT Power windpump has been installed and is pumping water at its test site in Silsoe, Bedfordshire, the United Kingdom. This machine was designed and developed under an European Union JOULE programme, and the subsequent test programme is presently being supported by the UK government's Overseas Development Administration.

The new windpump has a three metre diameter rotor and stands on a ten metre tower at the test site on Silsoe Campus, part of the Cranfield University.

The innovations include a novel gearbox and pitch control of the rotor blades for storm protection. It is probably the first ever windpump to use rotor blade pitch control for storm protection; this is the technique used on modern wind electricity generators.

The gearbox design is based on a concept used by a windpump, which won prizes for exceptional pumping performance at the Royal Agricultural Show of 1906.

The gearbox mechanism is unique amongst most commercial windpumps in avoiding the use of a crank to drive the pump. A crank requires a compromise between being as long as possible to give a long pump stroke but as short as possible to allow easy starting.

The new IT Power windpump gearbox avoids this compromise. It is an oval epicyclic gearbox with fixed pinion in which, contrary to a crank mechanism, the length of stroke is totally independent of the effective crank length.

For the new IT Power Windpump the next step is a detailed testing programme. The new windpump is instrumented with a photovoltaic-powered data-logger to measure its operating parameters.

At the same time, IT Power is approaching potential manufacturers from developing countries with a view to initiating a co-operative programme to develop this prototype for low-cost manufacture whilst maintaining reliability. A technical seminar is planned to be held in the summer in which interested parties will meet with IT Power's technical staff to discuss the adaptation of the design for their particular needs.

It is hoped that this will lead to the new design following the original IT Windpump into production and result in a new range of windpumps suitable for the needs of the 21th century.

(Source: From "New IT Power Windpump Up...And Running", *IT Power News*, No. 13, March 1994, pp. 1-2)

Kenetech Windpower's Growth

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Kenetech has installed 4,200 wind turbines – more than any other company in the world. Danish manufacturer Vestas has installed more generating capacity (500 MW to Kenetech Windpower's 420 MW) with 4,000 turbines.

Critics charge that Kenetech would not have needed to install so many turbines if it had upgraded its aging 56-100 design sooner. Competitors steadily introduced newer larger turbines every two years during the late 1980s while Kenetech used a design relatively unchanged since its introduction in 1984. The prospectus notes that availability of the company's 56-100 design averaged 93% from 1984-1990. By today's standards, most wind turbines must be available to generate electricity more than 97% of the time. Kenetech availability fell further in 1991 to 91% before the company took corrective action. After a modest investment of US$ 13.2 million Kenetech Windpower upgraded 1300 of its fleet, increasing average availability to a respectable and competitive 97.4%.

The model 56-100 has proven highly productive for a second-generation design. In 1990 and 1991 Kenetech Windpower generated 800 kWh to 850 kWh per square meter of rotor swept area primarily from the 56-100 turbines, 15 to 20% better than Zond systems, and competitive with SeaWest, which uses a mix of contemporary as well as older designs. Third generation wind turbines at energetic sites should be capable of producing about 1,000 kWh per square meter of rotor area.

After a lengthy five-year development program, Kenetech Windpower has finally begun production of its third-generation design, the 33M-VS. Development of the new turbine cost US$ 10 million more than the 1988 projected cost of US$ 25 million. As well, the company spent another US$ 37 million in parts, tooling, and project development for its prototypes and pre-production units. This makes the 33M-VS the most ambitious and costly wind turbine development program ever undertaken in the private sector.

In side-by-side tests in the Altamont Pass, the 33M-VS has generated 3.7 times the amount of energy of the 56-100, about that expected from a wind turbine with modern airfoils that intercepts 3.5 times more wind energy than its predecessor. Though the performance increase over the model 56-100 is modest, Kenetech Windpower claims the 33M-VS is substantially cheaper to build. The company has quoted installed costs of US$ 300 per square meter of rotor area for wind plants in California, 40% less than other projects in the state and in Europe.

The company installed 22 prototypes in 1992 and another 18 in 1993 prior to the offering. The company plans to ramp up production quickly by building a total of 500 turbines in 1994, and 1,100 in 1995. If it meets its targets Kenetech Windpower could surpass its nearest competitors in sales by the mid-1990s.

(Source: Extracted from "Growth in Sight" by Paul Gipe and "Kenetech Goes Public", *Independent Energy*, Vol. 24, No. 4, April 1994, pp. 91, 92, 94, 96-98)

US to Boost Ethanol Production

The National Renewable Energy Laboratory (NREL) of the U.S. Department of Energy will fund four proposals from U.S. industry for cost-shared projects to study the production of ethanol from dedicated energy crops and forestry product wastes. These case studies could lead to biomass-to-ethanol demonstration projects and new life for areas where economies are hit hard by declines in the agriculture industry.

"The case studies are achieving several important goals. They are converting waste materials and energy crops into a valuable transportation fuel, thereby creating a new industry and new jobs," said Dr. Jonathan Mielenz, ethanol project leader at NREL.

The four proposals involve collaborations among the nation's best known energy and agriculture corporations.

In Hawaii, the Pacific International Center for High Technology Research (PICHTR) is heading a team that includes several Hawaiian companies, the Amoco Corporation and Cargill, Inc., that will investigate using sugar cane and other native crops as feedstocks for the production of ethanol and electricity.

Ethanol and other energy production could help revitalize the Hawaiian sugar cane industry, marked in recent years by the closing of sugar mills and plantations. Fruition of work outlined in the PICHTR proposal will assist in meeting the Hawaiian government's goal of developing local energy sources.

A second case study is a collaborative effort, headed by Weyerhaeuser and includes Amoco Corp., to investigate expanding the use of biomass at the Weyerhaeuser facility in New Bern, N. C. Weyerhaeuser will provide saw mill wastes and other forestry residues to produce ethanol and electricity. An effective biomass-to-energy process would help the forestry industry become more energy self-sufficient.

A third ethanol proposal is led by the University of Florida, which will team up with industry partners, including Wheelabrator Technologies, Inc., Bartow Ethanol, Inc. and Kenetech Inc., to study the use of underused native soils for dedicated energy crops that would be refined into ethanol.

Another case study is led by Wood Industries Company (WICO) of Visalia, Calif., which proposes to operate a 100-acre demonstration farm using plantation crops of sweet sorghum, kenaf and hybrid poplar, willow and eucalyptus to produce ethanol for gasoline blending and solid fuel for generating electricity. WICO will investigate cost reduction strategies for the biomass-to-energy process.

The government's funding for each ethanol project averages close to $200,000. Study findings are expected within a year.

(Source: Extracted from "Agreements to Boost Ethanol, Economic Growth", *NREL Press Release* via NREL's Gopher/WWW Server, May 19, 1994)

Success of Anagi Stove in Sri Lanka

The Urban Woodburning Stoves Project (UWSP), established in 1987 by the Ceylon Electricity Board (CEB) and Intermediate Technology Development Group (ITDG), was designed to create a sustainable market for improved stoves through commercial channels.

The owners of a number of tile factories in Negombo, north of Colombo, employed potters who were trained by the project to make two-pot Anagi stoves. The stoves were fired using the excess capacity in the factories' kilns, and distributed through their established marketing channels.

An estimated 80,000 Anagi stoves were sold in and around Colombo between 1987 and 1990. Users reported significant savings of fuel or time compared with the three-stone fire, and the popularity of the Anagi was reflected in a steadily growing demand, both in Colombo and in other areas of Sri Lanka.

In October 1990 ITDG and the Integrated Development Association (IDEA), a newly established NGO involved in energy and environment issues, embarked on the rural stoves production project. The project was designed to make the Anagi widely available throughout the island, and to bring the benefits of stove production to poor rural potters.

The stove was so successful that a number of enterprising potters had already begun to produce imitation Anagi, dubbed pirate or look-alike stoves (LAS). Performance tests showed the LASs to be inferior to the official Anagi stove.

Trainees were initially identified by tracing producers of LASs. Training is not limited to production alone; the project also provides business training to enable the potters to maximize their income from stove production, through the calculation of production economics and the development of marketing strategies.

Stove marketing

During the first year of the project a survey of stove retailers was carried out to assess potential demand for the Anagi.

This entailed persuading retailers of the advantages of the Anagi over LAS. While there was some initial reluctance to stock the Anagi – it was felt that LAS, being cheaper, had greater market appeal and, therefore, offered the prospect of higher profits – a number of retailers agreed to do so on condition that the project provide support through advertising and guaranteed quality control.

The project paid for the production of 10,000 posters, 200 notice boards and 10 large hoardings. The posters have been widely distributed in the central districts and each retailer has

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Electricity from Waste Tyres

Towards the end of last year Britain's first waste-tyres-to-energy power plant was opened at Wolverhampton, West Midlands.

The £ 48 million plant, which will generate electricity by recycling ten million waste car and lorry tyres, has been developed by US-owned Elm Energy & Recycling (UK) Ltd.

The power station has been built by the Anglo-US consortium TBV Power, a joint venture company between Wolverhampton-based Tarmac Construction and Black & Veatch, of Kansas City, which specialises in power plant design. The project has provided employment for 300 workers during construction.

"Not only does the plant enhance the environment by removing used tyres, but the project marks another milestone in US-UK cooperation", said Mrs. Anne S. Evans, Managing Director of Elm Energy.

Elm Energy was introduced to Wolverhampton by the West Midlands Development Agency after Department of Trade & Industry officials had invited Mrs. Evans, a world-renowned tyre expert, to Britain to find a solution to problems caused by the disposal of 30 million waste tyres every year.

The power generated from the plant is being purchased by Midlands Electricity for putting into the national grid. The plant will generate 25 MW of power – enough to supply 25,000 homes in the Wolverhampton area.

Mrs. Evans said that she had received particular encouragement from Midlands Electricity, the West Midlands Development Agency and Wolverhampton Metropolitan Borough Council – "a local authority with the vision to support a pioneering project which will become an international environmental showpiece."

(Source: Extracted from "Waste Tyres-To-Energy Power Plant", *Energy Digest*, Vol. 23, No. 1, 1994, p. 24)

Electricity from Poultry Litter

The inauguration of Europe's first commercial electricity generating plant which uses poultry litter as fuel, at Eye in Suffolk, the United Kingdom, is the culmination of over four years of involvement by Foster Wheeler Energy Limited (FWEL) as the Engineer and Environmental Services Specialist to the project.

This £20 million plant produces 12.5 MW of electricity by consuming 120,000 tonnes a year of local poultry litter. The electricity generated is being sold to the twelve Regional Electricity Companies via Eastern Electricity's distribution network.

It will solve the growing problem of the disposal of the litter, allow fossil fuels to be replaced by a cleaner fuel from an existing waste product, as well as yield a nitrogen-free fertiliser, rich in phosphate and potash, from the ash.

Reading-based engineering contractor Foster Wheeler has acted as Project Consultant to Fibropower Ltd, the Eye generating plant's owner, from the early work involving development studies to the technical viability of burning the fuel, as well as environmental studies and financial costing leading to the raising of project finance.

The planning aspects were a major consideration in the early stages of the project since the plant is the first of its kind, and is installed in a rural area. FWEL provided assistance to Fibropower in the various aspects of the planning application. These included considerations of noise, visual and environmental impact. FWEL also assisted Fibropower to prepare their application for authorisation under the Non-Fossil Fuel Obligation and to Her Majesty's Inspectorate of Pollution.

"Fibropower's directors and shareholders are to be congratulated on their determination to provide the world's first poultry litter electricity generating facility. Foster Wheeler is delighted to have played such a crucial part in helping to bring their innovative dream to fruition," said Jim Foley, FWEL's Managing Director, Engineering and Construction Group.

(Source: Extracted from "Poultry Litter Fuelled Electricity", *Energy Digest*, Vol. 22, No. 2, 1993, p. 27)

Success of Anagi Stove in Sri Lanka

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been supplied with a notice board. The message on all the publicity material is consistent:

Anagi fuelwood stoves for faster, easier cooking!

Stoves are sold with a leaflet, which gives instructions on the installation and use of the stove, and a 'collar' which proves that they have been made by trained producers. The leaflet and the collar both reiterate the slogan.

Estimated sales figures indicate that the promotion campaign has had a major impact on public awareness of the Anagi. In the final quarter of 1992, over 11,000 Anagi were produced. Total sales were estimated in the region of 40,000 per year, compared with the project's original target of 30,000 stoves annually by the end of the second year.

Working with other organisations

Sri Lanka is home to a large, well-established and widely respected network of community development organizations and the project is working with a number of these, as a means of making the stoves available to poor users. In some cases this is achieved through direct dissemination programmes, where stoves are given away or sold at subsidized prices as part of a community development programme; in other cases, the agencies allow people to pay for the stoves in installments.

Benefits

The potters with whom the project works are economically rational and will not start to make a new product unless they are convinced they can

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SMALL SCALE WIND ENERGY SYSTEMS

Published with financial support from the Netherlands Ministry for Development Cooperation
Editors: Goezinne & Veldkamp, Renewable Energy Consultants

EDITORIAL

Many members of the 'windpump community' are probably used to sceptic comments from the 'outside world' regarding wind energy applications. Well, this time there are three articles all showing that there may really be a bright future ahead for windpumps. There seem to be good possibilities in Vietnam and Sri Lanka; very important may also be the renewed interest from the English and Dutch development aid agencies, shown at the workshop held recently in Silsoe (UK). During this workshop it appeared that a new joint proposal addressing the four main problems hampering windpump application (lack of finance, information, and support for users and manufacturers), may be looked upon favourably by the aid agencies. This is certainly good news; naturally in these columns we will keep you informed about developments.

Dick Veldkamp/G&V

Strategic Development of Windpump Markets

A joint British/Dutch workshop on the way forward for windpump development was held at Silsoe, UK on the 11th of July 1994. Invited experts and government representatives from the two countries and several representatives of manufacturers in developing countries took part. The morning session was taken up with presentations on current technical developments, including the British and European Community programmes which are funding the testing work on three windpumps now at Silsoe College.

The afternoon session focused on strategies and goals for future market development. The keynote paper was prepared by Rod Hacker and Jan de Jongh. It started with a summary of their work for DGIS from which a worldwide market study report was produced. The presentation then went on to propose short term objectives for action by funding agencies.

The results of the market study were discussed in the article by Jan de Jongh in the last RERIC News (Vol. 17, No. 2, June 1994). Summarising the results of studies on 22 countries, four main strategic problems were identified.

1) Finance – the lack of access to affordable credit for potential purchasers of windpumps and the lack of working capital for manufacturers to invest in design, production and after-sales service.
2) Information – many governments, agencies, NGOs and purchasers do not have a good awareness of windpumping. The manufacturers have difficulty in obtaining information on windpump design and manufacture.
3) Support to users – there is a need for training in the use of windpumps for water supply and in their operation by users. The need for improved maintenance services has also been made clear from experiences in many countries.
4) Design and manufacture – manufacturers need assistance to select and/or adapt windpumps which are best suited to their markets. Many of them also need assistance to raise manufacturing standards.

It was proposed that the short term goals for intervention in the markets by foreign agencies should address the four strategic problems. It would be necessary to tailor programmes to each local situation because of the tremendous variety of users' needs and local capability. These themes cannot all be pursued on a worldwide basis, but carefully selected projects with the right combination of components would create successful markets in some countries and would set the example for others to follow.

Some lively discussion resulted in general agreement that the four strategic problems had been correctly identified and needed to be tackled in a coordinated manner in each distinct market. The most disagreement arose over whether or not it is possible to develop a complete windpump design which can be transferred into a new market with absolutely no local adaptation. It was noted that similar conclusions to those of the market study had been arrived at by the WERA workshop in 1991. A working group was established then to develop specific proposals. Unfortunately nothing came of this due to lack of funds. It would be good to see some concrete proposals produced jointly by the participants of this workshop. It is to be hoped that the positive conclusions and degree of unanimity of the workshop will then help to persuade donor countries to assist suitable programmes.

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The potential of Vietnam (part 2)

In the previous article (RERIC News, Vol. 17, No. 2, June 1994) we considered the supply side of windpumps in Vietnam. Comments on the wind regime remained ambiguous. A low annual wind but with possible strong diurnal effects that can favour windpumps. Like many countries Vietnam has limited accurate data. Regarding the water supply, it was noted that the rural areas have an abundance of shallow wells of 10 m depth. Many (59%) need rehabilitation but the comment was made that a Columbian style windpump combined with a rehabilitation programme held considerable potential. And finally, the article looked at the history of windpumps to glimpse the human resources and local production. Research in Vietnam seemed uncoordinated and was suffering from the age old divide of academia and industry. With the recent move to a market economy perhaps local industry will take up the challenge. If the demand is there!

This article looks at the demand side of the equation to see if the socioeconomic factors are in place for a strong windpump industry.

The New Free Market

Vietnam has an emerging free market economy set against a backdrop of socialism and one party state. Many see it as a

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InNIVAtion 3000

During a recent reconnaissance end-use survey of wind pump systems in the Anuradhapura District of Sri Lanka, some interesting information came to light about the wind pump model NIVA 3000. This prototype, which was first marketed in the late 80s, is a descendent of the earlier available WEU I/3 model. This latter model was developed by the Consultancy Services Wind Energy for Developing Countries (CWD), the Netherlands, in collaboration with the Wind Energy Unit (WEU) of the Water Resources Board (WRB) in Sri Lanka. In 1976 they launched a wind pump programme for small-scale irrigation in Sri Lanka. By 1980 the WEU I/3 unit (rotor diameter of 3 m) was introduced. Ten years later 180 windpumps had been locally produced and installed. Unfortunately, soon after institutional support ended in 1987, windpump sales stalled.

In the wake of these events a renewed initiative was undertaken by the former project manager of the Wind Energy Unit to overcome the technical deficiencies of the WEU I/3 design, which were regarded as one of the causes of the ending of the programme. The result of these efforts was the introduction of the new prototype NIVA 3000 of 3 m diameter, which was cheaper, lighter and more reliable than its predecessor. The NIVA 3000 also has a better safety mechanism and a low cost pump. The philosophy behind the design is to achieve a low initial investment cost level, at the possible expense of higher maintenance costs. Some 12 machines have been sold on a commercial base.

Of the 6 units encountered during the reconnaissance trip, only 1 was found to be non-operational. This, despite the fact that comprehensive maintenance activities, initially provided by the manufacturer STAR Engineering, have been suspended for the last two years, because of an accident that befell the company owner. Currently maintenance is being provided by the end-users themselves. It is interesting to note that those end-users that most heavily rely on their wind pump product are most active (and innovative) in performing maintenance. These are usually the smaller farm owners. The larger farmers are inclined to abandon the wind pump and purchase engine pumps. Set against the wind pump however, an engine pump is twice as costly annually.

The beneficiaries of wind pumps in this part of Sri Lanka include commercial farms, community centres and small farmers. An example of the first is a commercial sericulture farm with 5 NIVA 3000 units which was visited during the survey. Examples of the second are a Children's Home and a Youth Services Training Centre. Farms of different sizes use these wind pumps to cultivate crops. The maximum area that can be irrigated for cash crops by one wind pump during the dry season is 1-2 acres. For orchard crops, such as mango and coconut trees, which only need irrigation as seedlings, the maximum acreage is higher (up to 10 acres).

The value of the wind pump in this region is evident from bank records of loans provided to end-users in the early 80s as part of the wind pump programme. Apparently, loan recovery from wind pump users was the most consistent among customers receiving loans for agricultural equipment. This would indicate that the added value of the wind pump, for example expressed in profits from extra crop yield, justified the acquisition.

The NIVA 3000 is an innovative improvement of WEU and CWD pioneering engineering that has considerable potential inside as well as outside of Sri Lanka. The user-tested design is ready to be picked up by capable manufacturers.

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The Potential of Vietnam

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potential new Asian tiger, an economy with a fast and steady growth rate. Its economy is certainly rapidly changing with a strong impact being the gradual acceptance by, and normalisation of relations with, the international community. The coming of Coca Cola to Vietnam was big news in the region.

But this momentum of change and its potential for the future should not lull observers into a false sense of hope for the rural economy. The general rural population is one of the poorest in the world and there is very little disposable income. Gross National Product per capita is $200. Most rural areas still require clean domestic water. Between 1960 and 1980 a drive to create shallow wells led to 3,000,000 new wells. Of these over 50% are now in serious disrepair and most give poor quality water. The priority for the government is not increased quantity of water, but increased quality.

In the new economy who will pay for this upgrading of domestic water supply? In the old system one could rely on central government intervention and a windpump programme could perhaps be built into it. In the new economy the water supplies will be constructed by the 'slightly rich'. The people are hard workers. A visit to Hanoi shows almost every piece of land under cultivation. Gradually as a fair price is given for these goods, perhaps some will gain the wealth to improve their own water supplies.

Market Segments

So can we identify market possibilities for windpumps? While the actual change in the economy is a bit of an unknown we can surmise the following:

For the domestic water supply, the market may be very small due to general poverty of rural people. A simple Colombian windpump, at say $150 for the machine and a similar amount for the drilling of a private hole, now is about one third of a families annual income. Some will definitely make the investment – but will this be an assured market strong enough to stimulate local manufacture?

For village or community supply there are a possible 140,000 tubewells to be drilled by UNICEF. These wells would be 'open' to market forces but the supplier of windpumps could lobby UNICEF and the relevant national, provincial, and district government departments, gaining sales through the development programmes.

Irrigation in Vietnam is widespread. From less than 3m head, there is a seasonal requirement to pump water. Since there should be a correlation between the double and triple cropping of an irrigation system, one might think that this would lead to a demand for windpumps. There might be a possible substitution of diesel if it becomes economically viable. With free market forces the currently subsidised price of fuel is bound to increase. When that happens the farmers may be squeezed in their profits and a well placed supplier of windpumps might pick up the market. A casual survey among eight farmers indicates otherwise: windpumps are not favoured due to the need for precise and timely application. Any supplier would have to provide a package that included the windpump, a storage tank for smoothing the application of water on to the crops, and perhaps even an agricultural education or extension package. Like so many other products the entry of windpumps into this market will depend on the marketing that is attached to them. A salesman who offers a package that fills a gap in the market will be well rewarded.

Salt pans are popular in the South along the coast. Water is pumped by foot using a paddle pump. Some substitution has been possible using purpose built windpump but the windpump is thought to be expensive. The salt pans market is limited, estimated to number only 600 units.

Alternatives

If there is a market in a few areas such as domestic and irrigation, will the Vietnamese prefer windpumps to the alternatives? If the right package at the right price were offered, perhaps. However, when this reporter interviewed a number of decision makers, most of those interviewed dismissed windpumps as prohibitively expensive. They said that Vietnam would 'need ultra cheap windpumps due to general rural poverty'.

If the country is to prosper some water must be pumped – agriculture depends on it. What then are the competitors to windpumps? Vietnam has a growing industrial capability. It currently produces the No6 handpump in a number of provincial workshops. Most of these are supervised by UNICEF to achieve the necessary quality control. The production of these handpumps requires the same skills that would be necessary for windpump manufacture. The handpumps form the basis for a large UNICEF programme, the sole large scale implementor of a water supply programme. Perhaps these workshops could expand into a complementing windpump product for the same programme. The handpumps are used on tubewells and shallow wells for domestic water and the total cost of the equipment is $60. Having said that, the total cost of equipment, tubewell, cover, UNICEF drilling team, and administration, is nearer $800. So a windpump at $200 is not out of the question.

Other pumping alternatives include electric grid connected pumps, capable of supplying to 75 families, approximate cost $250 and imported diesel pumps for irrigation for use on large scale cooperatives.

Political Will

In many countries the fortune of wind energy can stand or fall on government policies. Even in free market conditions there seems to be a need for some sort of explicit or implicit government support. In Vietnam, the Government already has a multi objective renewable energy pro-

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The Potential of Vietnam

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gramme. However, its commitment to this in 1990 was only $60,000. In general Vietnam expects only to finance one tenth of a project, with the rest coming from donors. At this ratio, this programme if approved by an outside donor, would be a $600,000 programme to cover all aspects of renewables. And the picture looks bleaker when one considers the emphasis by the government on biogas and stoves. In its stated preferences, wind power ranks fifth after micro hydro and solar.

There is some agitation below the surface. To try to encourage wind energy various government officials including some in the controlling Ministry of Energy are lobbying for:

- mobilisation of capital from local authorities and international organisations;
- a subsidy on technology of 25 to 50% to encourage demonstration projects;
- encouraging a policy of extension;
- a policy of using mass media (Director National Renewable Energy programme).

And the Head of the Wind Energy Group of the Centre for New and Renewable Energy proposes the following steps to disseminate windpumps:

- outline the map for classified dissemination of wind energy utilisation including wind and water data, and grid electrification;
- analysis of wind machines to select suitable systems with proper design;
- analysis to determine the way to supply wind machines and wind equipment for their application;
- pilot projects;
- dissemination of wind energy utilisation selected in step 1 including mass production, organising maintenance and repair, training technicians.

Perhaps there is the political will in some quarters. However, as Vietnam heads to a free market condition, the main driving force will be money.

Are Windpumps in Vietnam Worth the Money?

The windpumps on offer at the moment are constructed by government run institutions. These do not have a realistic market view or any sensible cost accounting. When asked for the price of a windpump, the institution just cannot be explicit. In one conversation with three people in the room the estimates varied from $200 to $1000 for the same 3m diameter machine.

Total salt pan windpumps installed between 1980 and now, are said not to exceed 400 at the most generous estimate. Most officials said that less than 50 of these are still operating. Ho Chi Minh Centre for Thermal Equipment and Renewable Energy, has manufactured the 8BP350, a 3m diameter low solidity windpump, in limited numbers (less than 10). The system was described as a 'commercial prototype'. The Institute of Energy, Hanoi, manufactures a 3m diameter medium solidity windpump; approximately 10 have been distributed. Costs were given as $200 but one must remember the comment above. They also have a low solidity prototype VN272, only 2 manufactured and no cost calculated. Would these machines make it on the emerging free market?

Let us refer back to the handpumps. The possible $200 3m machine should be compared with the cost of wells and handpumps. Well repairs or new wells of 5m cost in the order of $30. Tubewells cost about $350. Handpump No6 costs $32 plus piping and installation (total $60). If the rural economy grows, perhaps this system does indeed have a place in village communities. If only 5% of communities preferred to pay the extra dollars to upgrade from handpump to windpump, this would be sufficient for someone to make a profit and a windpump industry to form.

What Does the Future Hold?

With the facts obtained one would have to leave the question open. Given the existing situation there are problems of disparate and uncoordinated research leading to repetitious work, a limited government commitment to renewable and in particular to wind energy, extreme poverty of rural population (which puts even the simplest windpumps out of price range) and a dependence of rural population on government provision of water supplies. In that sense the picture looks bleak.

But Vietnam is changing at a staggering rate. Tall buildings are changing the skyline of the cities. Factories are producing international household names like Coca Cola. The market is expanding. If a private entrepreneur or an agency like UNICEF can develop suitable systems and link them through local bodies to local water programmes, there may be a future. The wind resource is there, the water is just below the ground, the manufacturing potential is there, there is some political will. Everything is in place – who then will be the entrepreneur?

Simon Batchelor/Gamos

Citation is encouraged on the condition that the source is indicated.
Reactions or other contributions are welcomed. Please write to:
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Responsibility for the articles rests solely with the authors. Contributions should preferably not be longer than 300 words. For longer articles please contact the editors. The editors reserve the right to shorten reactions and articles.

Success of Anagi Stove in Sri Lanka

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profit from it. The fact that only two of the trained potters have given up making stoves (for non-economic reasons) suggests that Anagi stoves are more profitable than other products such as water jars or cooking pots.

Users cite the same benefits – faster cooking, the use of two pots and fuel savings – time and again. Direct observation also tends to support these views.

The project has commissioned two nationwide surveys to assess levels of awareness and market penetration of the Anagi among 2000 randomly selected households throughout Sri Lanka. The results of the 1991 Omnibus Survey suggest that most purchasers find that the stoves meet their expectations.

The demand for improved stoves continues to grow among retailers and users.

(Source: Extracted from "The Anagi – Successful Sri Lankan Stove", by Peter Watts, *Boiling Point*, No. 33, May 1994, pp. 8-10)

Vietnam to Boost Small Hydro Capability

From 12 to 15 January 1994, the World University Service-Vietnam and FAKT (Association for Appropriate Technology, Germany) organized a seminar on small and micro hydropower in Hanoi. The seminar aimed at developing a national strategy to strengthen Vietnam's capability to develop small and micro hydro potential more effectively.

Vietnam has approximately 2500 hydro stations with outputs of no more than 100 kW, representing a total installed capacity of 100-200 MW. These serve irrigation and drainage needs, as well as producing electricity for about 200,000 households.

There are a further 400-500 micro stations with capacities of less than 0.5 kW (totalling 200 kW), of which about 35 percent are not working at all, and the operation of the remainder is generally poor or unreliable.

The seminar brought together experts from the international network Hydronet, who gave talks on experience gained in Nepal, Sri Lanka and Indonesia.

The exchange of experience resulted in a plan of action, put forward by the "Programme on New and Renewable Sources of Energy", under the auspices of Vietnam's Ministry of Education and Training. This plan proposed action on four strategic levels:

- Transfer of technology based on international experience;
- Establishment of a policy environment conducive to mini hydro development;
- Preparation of national credit institutions to finance micro hydro installations; and
- Co-ordination of efforts of all the institutions involved in mini and micro hydro development at a national level.

It is hoped that this will lead to a new coordinated activity, and to increased international cooperation.

(Source: From "Vietnam aims to boost small hydro capability", *Hydronet* 1/94)

Tidal Power

Using the movement of the tides to do useful work is by no means a new idea. There were hundreds of tide mills operating around the coast of medieval Britain alone. A traditional tide mill comprised a small barrage or dam across the mouth of a tidal inlet. As the tide rose, sea water was allowed into the inlet via sluices. As the tide fell, this trapped water was then allowed back out via a conventional water wheel, which provided mechanical power, normally for grinding corn.

Electricity Generation

Recent attempts to extract energy from the tides have concentrated mostly on producing electricity, but the most common method of doing so is still very similar to the old tide mills. First find an inlet, such as a large estuary, with a high tidal range.

Second, build a barrage across the mouth of the estuary. The incoming tide flows freely through the open sluices until the inner lagoon is full. Then, as the tide turns, the sluices are shut. As the level outside the barrage falls, a head (difference in height) is created across the barrage. This means that when the water is allowed to run back out to sea through the barrage, it will drive turbines, which in turn will drive generators to produce electricity.

A simple system like this will produce a maximum power level for a period of a few hours, twice a day. It is even possible to devise more complex systems with multiple barrages to create several lagoons at different levels, and to generate a lower level of power output at a more constant rate.

Based on this principle a number of tidal power stations have been built throughout the world. The first was at La Rance in northern France. Built in the 1960s, it has an installed capacity of 240 MW, and is the largest built to date. There are much smaller working examples in Canada, China, and Russia. Many countries have carried out studies into specific tidal barrage projects, including some much larger than the La Rance scheme. The largest proposed to date is an 8000 MW scheme on the Severn Estuary between England and Wales. Very few of these proposed projects seem likely to go ahead, for a number of reasons.

There are environmental concerns about tidal barrages, as with all sources of energy. Building a barrage changes the patterns of flow and siltation upstream of the barrage, which will have a significant effect on the ecology of the estuary.

There are other negative impacts, particularly during the construction phase, but the main barrier to the development of tidal barrages is fi-

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Demonstration Test of Wave Power Generation System – Japan

Tohoku Electric Power Co., Inc. of Japan has installed a 130 kW wave power generation facility in the south breakwater of its Haramachi Thermal Power Plant in Hara City, Fukushima Prefecture, and will commence a full-scale demonstration test starting from 1996.

From the 1984 financial year the company has been engaged in research to develop a wave power generation system at the Electric Power Technology Research Institute of Sendai City. A unique wave power generation system has been devised, and confirmed, through theoretical analysis and water tank experiments, to have better technological characteristics than conventional counterpart systems. Now demonstration tests of the system will start in a real marine environment.

The air chambers can be associated with coastal installations, such as breakwaters, converting the wave surge motion into reciprocating air flow motion. The hydromechanically designed "Water Valve" plays an important role in rectifying and directing the air flow to and from the ducts.

Since wave energy is used most effectively, it will be possible to construct a large-scale power generation facility using large-capacity turbine generators for obtaining stable output. Because this system uses water valves and has few mechanical parts, it is highly reliable.

Two wave power generation caissons are used, they are 20.85 m long, 25.6 m wide, and 24 m high. Electric power is generated by the vibrating water pillar type wave valve integration system using four air chambers, with an output of 130 kW provided by a horizontal axle type induction generator using a tandem type air impulse turbine.

The company plans to conduct a demonstration test from 1996 for a period of three years using this wave power generation system. The test aims to accumulate basic data and verify the efficiencies of various system parts, and confirmation of the water valve wave rectification effect and the degree of wave energy integration, while simultaneously verifying the power generation characteristics and confirming the network linkage characteristics, with the purpose of commercializing the system.

For further information contact:

Tohoku Electric Power Co., Inc.
Public Relations Section
3-7-1, Ichiban-cho, Aoba-ku
Sendai City, Miyagi Pref. 980
Japan
Tel: +81 22 225 2111
Fax: +81 22 222 2881

(Source: Extracted from "Demonstration Test of Power Generation Systems with Water Valve Energy Rectifiers", *JETRO*, Vol. 22, No. 2, May 1994, p. 35)

Tidal Power

From P.11

nancial. A large barrage will, typically, take around eight years to build and cost an enormous amount of money. It is estimated that the current proposal for a 700 MW barrage on the Mersey in northern England will cost around £900 million at current prices. Once up and running, the cost of operating the system would be extremely low and the barrage would operate without major expenditure for well over a hundred years.

In the long term, the cost of electricity from such a scheme would be extremely low. In the short term, however, investors would have to put all their money up front now, with the prospect of no income at all for the first eight years.

This made tidal barrages uncompetitive during the recent boom of private sector renewable energy projects in Europe.

So, is there an alternative approach? Researchers in the United Kingdom believe that there is: the tidal stream turbine.

Tidal Turbine

The principle is to place a water turbine, rather like a boat's propeller, in the flow of a fast-flowing river. The power to drive the turbine can be used to pump water, to drive a generator, or whatever is required.

Now IT (Intermediate Technology) Power Ltd has teamed up with Scottish Nuclear Ltd and NEL to develop a water current turbine for use in tidal streams.

Tidal streams occur where a narrow channel restricts the flow of water between two areas of tidal water. The periodic difference in water level between the two areas sometimes results in very fast-flowing water through the channel, unlike a large, fast flowing river. Technically speaking, it would be perfectly possible to fix a current turbine in the channel to capture some of the energy in that flowing water.

Another approach is to build structures on the sea bed, rather like underwater wind turbines. The IT Power consortium believe they can develop a much cheaper system by using floating turbines.

The consortium has built a 10 kW prototype and are now testing it in the relatively low speed flows (2 metres per second) of a Scottish loch. A moored buoy keeps the turbine in place. The turbine and generator are suspended below the surface, and therefore out of the way of the turbulence of surface waves, but high enough off the sea bed to capture the best flows.

Tidal current turbines have none of the environmental concerns of tidal barrages, and could conceivably be much more attractive to private investors, with rapid manufacture and installation.

If all goes well, the consortium hopes that full-scale grid-connected units of between 100 and 500 kW output will eventually be installed.

(Source: Extracted from "Northern News", *Appropriate Technology*, Vol. 20, No. 4, March 1994, pp. 24-25)

Wave Power Project Gets Financial Support

Applied Research and Technology (AR&T), the Inverness, Scotland-based company, which has designed a 2 MW wave generator called Osprey (Ocean Swell Powered Renewable Energy), says it has secured an ECU 550,000 EU Joule grant to build a £3 M pilot plant after its application for funding was turned down by the UK's Department of Trade and Industry (DTI). It has received the balance of funding from six industrial partners, all from the private sector.

The DTI's decision not to help finance the project is said to be consistent with its new strategy aimed at stimulating a commercial market in new and renewable energies, but not including wave power.

AR&T aims to develop wave power technology which can compete with fossil fuels on a like-for-like basis, helping to create a substantial export and manufacturing base in Britain.

A two-year study carried out by ETSU (Energy Technology Support Unit, a DTI-controlled body) has concluded that Osprey can generate power for as little as 4 p/kWh.

AR&T has spent over two years developing Osprey, an oscillating water column type wave generator, which it claims is the first wave power device suitable for mass production.

The company plans to build a prototype of the scheme off Dounreay in Scotland with funding from the EC's Joule Programme, Inverness and Nairn Enterprise (part of the Highlands and Islands Enterprise Network), Scottish Enterprise and the private sector. The Highland Regional Council helped out with additional funding for the sea-bed assessment phase of Osprey's development.

The pilot plant will be used as a full scale test-bed to evaluate theoretical and model studies AR&T has performed on energy capture, structural loadings and economic forecasts. Assuming an average wave power level of 29.9 kW/m, Osprey has an average capture efficiency of 115%, according to a productivity assessment by the DTI. Availability is 91%.

Based on a turbine designed by AR&T's scientific director, professor Alan Wells, Osprey harnesses the power of the ocean's swell through four turbines located in control stacks at the top of the water columns.

These Wells turbines turn in the same direction irrespective of the direction of air flow through the columns. This eliminates the need for potentially unreliable valves.

According to the company, careful work has gone into evolving a design that will give the highest energy capture from the waves, while minimising costs and environmental impacts. The average capital cost of the system (including contingencies and project management fees) is put at over £3 M.

The pilot device, which will be anchored to the sea-bed, will be situated 300 m out to sea at a depth of 14.5 m. Design lifetime is 25 years.

The project is supported by several companies, including France's Cegelec DEI, GEC-Alsthom Large Machines, Scottish Hydro-Electric, British Steel, which is providing free steel plate for the prototype and AEA Technology, Dounreay.

(Source: Extracted from "Power Left High and Dry", *International Water Power & Dam Construction*, Vol. 46, No. 6, June 94, p. 53)

Energy Efficient Terminal – Hong Kong

With 600 hectares of land now available, foundation work for the new airport passenger terminal substructure on Chek Lap Kok, Hong Kong will commence soon. When completed the terminal will be one of the world's largest, and in keeping with the times, it has been designed to be both user- and environmentally-friendly.

According to the design the total floor area is about 490,000 square metres. The measurement includes all terminal and concourse floor areas including the Automated People Mover (APM) station platforms and the plant mezzanine over the baggage hall.

The envelope of the building comprises primarily the roof and external walls. it has demanding structural, acoustic, fire and thermal performance requirements, satisfied by a combination of standard materials and systems, and advanced but "well proven technologies".

The roof is designed as an integral part of the "Departures" level public areas lighting system. By day, skylights bring a generous supply of natural light into the building, supplemented by artificial light as required. At night, artificial sources will illuminate the space by reflection from the underside of the roof vaults.

Wall cladding provides weatherproof, thermal and acoustic insulation seals to the whole building.

"The design incorporates extremely efficient overall thermal transfer values (OTTVs), and modern glass systems optimize transparency and reduce heat and glare contrast to levels acceptable to people in the terminal," said Peter Wright, Engineering Director of the project.

The OTTV is a measure used to give a comparative indication of envelope performance in terms of heat gain into a building. OTTV is calculated on a standardised series of tables and formulae and involves evaluation of each element of a building's envelope – window, solid wall, floor, sky lighting – its orientation, and its effect on energy transfer into the building throughout the year. The lower the figure, the more energy-efficient the building.

Wright emphasizes the efficiency of the terminal design and notes that the building envelope represents 21% of the total energy requirement.

He explains: "Within the envelope, skylight is 3%, roofing represents 2% and glazing 9%. Solar penetration into the building from skylights and glazing represents just 12% of the total load. The other contributing loads con-

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Striving for Green Cars

From Japan to Detroit, automobile manufacturers are striving to create the green car, a vehicle that, in all its forms and incarnations, promises to be one of the cleanest technologies on earth. To create the green car of the future, say designers, they will replace dangerous substances with safe ones, recycle car components from antifreeze to old tires and develop alternative fuels.

To meet high environmental standards, automakers began renovating their practices at the heart of the matter: the manufacturing process. In the last three years, Chrysler has cut its use of ozone-depleting chlorofluorocarbons (CFCs) in manufacturing by as much as 70 percent. It has also removed CFCs from air-conditioning systems, instead using the CFC-free refrigerant R-134a. Many companies will be following suit as the international agreement of the Montreal Protocol banning domestic CFC production and importation goes into effect in January 1996.

Car manufacturers are also turning to a variety of cleaner fuels in order to clean up smog-shrouded cities. At Mazda, the fuel of the future is hydrogen. The Mazda HR-X2 prototype, introduced at the 30th Tokyo Motor Show last year, is powered by a hydrogen rotary engine that produces no hydrocarbons or carbon dioxide, two of the main components of city smog.

Meanwhile, at General Motors, a two-seat electric car named the Impact emits no pollutants and can travel 110 to 160 kilometers on a single charge, depending on driving habits and conditions. GM will begin consumer-testing the Impact in 12 U.S. cities this year, teaming up with local electric utilities, which will provide service and infrastructure. About a thousand people have been selected to drive the vehicle for two- and four-week periods. "We have a lot to learn from our customers' experience with the vehicle before we can determine whether it can succeed in real-world markets," says Kenneth R. Baker, vice president in charge of the GM Research and Development Center.

Another alternative to standard gasoline-powered cars is Volkswagen's Golf Ecomatic, recently introduced in Europe and powered by a diesel engine that shuts down automatically whenever the car doesn't require propulsion – while waiting at traffic lights, slowing to a standstill in heavy traffic or driving downhill. In city traffic alone, Volkswagen engineers estimate that 60 percent of the trip is spent either coasting or waiting. And overall the carbon-dioxide emissions produced by the Ecomatic are 22 percent less than those of a standard diesel-powered automobile.

The new Calibra sport coupe from GM Opel is made with an easy-to-recycle plastic, known as polypropylene. That fact is significant, explains Karl Jullig, Opel's chief engineer, because the plastic elements are especially aerodynamic and significantly lower the car's fuel consumption.

The green car will be good not only for the environment but also for business. "In the long run environmental success is essential to business success," says Dennis R. Minano, vice president of the environmental and energy staff at General Motors. "And many companies have recognized this reality, as a growing number of people want to purchase products from environmentally responsible firms."

(Source: Extracted from "Green Car 2000", by Cathy Spencer, *Newsweek*, June 20, 1994)

Energy Efficient Terminal – Hong Kong

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sist of equipment and people at 33% and the cooling of outside air just above 40%. Thus in fact, the building envelope is a small contributor to the total energy requirements."

The roof acts as a vast insulator over the whole building and is designed to be an effective component in the thermal performance of the overall building envelope. Engineers describe the roof design as "five times more efficient than a typical Hong Kong roof", having built-up roofing concrete slabs and a gypsum board-suspended ceiling.

Below the top waterproof layer of PVC membrane is 90 mm of high-density mineral wool which is the primary insulation material. It was selected as it has very efficient thermal and acoustic performance and is non-flammable.

The passenger terminal is not a heavily glazed building, Wright stresses. "The accepted comparison criteria – glazed areas to floor area – is very low".

The amount of light that is transmitted through the glass is 25% and the solar transmission is 12%. As a comparison, clear glass transmits 85% of light and 65% of heat.

"The design optimises transparency while reducing radiant heat and critically, at the same time, we are using a system that precludes reflective external surfaces which could jeopardize aircraft operations."

Other key design features enhancing energy efficiency include variable air-conditioning systems and variable speed fans controlling space temperatures by automatically adjusting air flows to meet demand. Energy-efficient motors and chillers will be specified.

Low level air-conditioning in high bay areas will create thermal stratification, resulting in lower energy loads and spill air from public places will be used to cool secondary areas such as the baggage hall and plant rooms.

The building management system will control mechanical and electrical systems and optimize energy usage to shut down lighting and air-conditioning in unoccupied areas, turning off moving walkways and provide energy efficient control of all air-conditioning functions. Sea water cooling is also to be used.

(Source: Extracted from "Energy-efficient terminal takes off at Chek Lap Kok", by Alex Pithie, *Asia Engineer*, Vol. 22, No. 4, April 1994, pp. 27, 28)

2nd AIT Training Course on

Solar Photovoltaic Pumping Systems for Rural Development

16-27 January 1995, Energy Park, Asian Institute of Technology, Bangkok, Thailand

Course Outline

This course is designed to provide participants with a technical understanding of pumping systems powered by solar photovoltaics. It is intended principally for persons who have responsibility for the selection and installation of small and medium sized rural water supply systems.

For better understanding, participants should have some knowledge of basic electrical and hydraulic principles though an introduction to both will be provided as part of the course.

Course Design

For most of the ten days of actual course work, mornings will be spent on lectures and demonstration sessions, while afternoons will be used for practical work. Practical work sessions will be done in groups no larger than five persons per instructor. Practical work will utilize equipment commonly in use for solar pumping systems, and experiments are designed to show component operation and failure modes, installation requirements, troubleshooting and maintenance procedures.

By limiting the number of participants to 20, attention can be paid to individual participant's needs. Every day, participants will be evaluated and examined regarding the day's work and additional study material. Assistance will be provided to the participants where understanding of the course material is inadequate.

Instructors in the course include internationally recognized experts in photovoltaics and AIT technical staff who have long practical experience with PV pumping systems.

Pre-requisites

Candidates should have an understanding of basic DC electricity and should have job responsibilities relating to purchasing, specification, design, supervision, installation, repair or maintenance of solar PV systems.

Language of Instruction

The language of instruction is English and the participants are expected to have the ability to understand, speak and write in English.

Application and Registration

The number of participants is limited to 20. Applications using the pre-registration form should reach AIT not later then 1st November 1994. Acceptance will be on first come-first served basis, hence all applicants should submit applications as soon as possible. Any candidate not accepted will be considered for the next course, the dates of which will be announced later. Only those applicants who receive a confirmation should come to AIT. AIT reserves the right not to accept late registrants.

Requests for additional information or application forms should be sent to:

Energy Park Manager
Energy Technology Program
Asian Institute of Technology
GPO Box 2754, Bangkok 10501
Thailand
Fax: (66-2) 524-5439; 516-2126
Tel: (66-2) 524-5408; 516-0110-29
Telex: 84276 AIT TH

THERMIE Programme Evaluation

THERMIE Programme

THERMIE (1990-1994) is a 700 MECU programme run by DG XVII (Energy) to improve energy efficiency, promote wider use of renewable energy and reduce the environmental impact of conventional energy production methods.

Activities include:

- Financial support for energy technology R&D projects: 426 MECU for 530 projects in 1990-1993;
- Associated measures to promote the application and market penetration of energy technologies;
- Coordination of promotional activities with national and other European programmes.

The OPET Network: established to carry out the associated measures, OPET (Organisations for the Promotion of Energy Technologies) is a EU-wide network of more than 40 public and private organisations experienced in the energy sector. They carry out energy studies and audits, market and technology assessments, seminars, training courses, etc.

In the Fourth Framework Programme (1994-1998): THERMIE's technological demonstration activities will be combined with the follow-up to the JOULE Programme (energy R&D) to form the Specific Programme for Clean and Efficient Energy Technologies. The OPET network will continue to be the main tool for dissemination activities.

Evaluation

Recent evaluations of the THERMIE Programme confirm its effectiveness as a bridge between energy R&D and the market, and point the way forward for energy technology development and diffusion.

A report summarising a number of evaluations of the THERMIE Programme was presented to the European Council in December 1993. The studies included an evaluation and cost/benefit analysis of THERMIE demonstration projects in the fields of energy saving and renewable energy, and evaluations of associated meas-

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National Science and Technology Development Agency (NSTDA) – Thailand

The National Science and Technology Development Agency (NSTDA), Thailand, is a funding and research organization established in 1991. An autonomous organization operating under the policy guidance of its board, chaired by the Minister of Science, Technology and Environment, NSTDA effectively brings together under one roof a funding office and three national research centers formerly in the Ministry of Science, Technology and Environment, namely: the Office of the National Science and technology Development Board, the National Center for Genetic Engineering and Biotechnology (NCGEB), the National Metal and Materials Technology Center (MTEC) and the National Electronics and Computer Technology Center (NECTEC).

Established to be a major "driving force" for rapid science and technology (S&T) development in support of national economic and social policies, NSTDA has a dual role: that of a supporting and of an implementing agency. Support is given to both public and private sectors in the three main areas of work of the national research centers, and includes research funding, information services through the Technical Information Access Center (TIAC), institution-strengthening programs and human resource development through a substantial number of scholarships, both local and overseas. Implementation involves in-house research, development and engineering (RD&E) in the three institutes' areas of interest, preferably on demand from industry, and services to meet the latter's needs, e.g. technical services, consultancy and training courses.

Apart from inducing RD&E through providing support and implementing RD&E by in-house activities, NSTDA will also invest in RD&E, which includes technology upgrade of the private sector, S&T commercialization and investment in technology ventures.

In order to catalyze tripartite cooperation among the private sector, academic institutions and NSTDA, the agency is setting up a Science and Technology, Research and Development Park (STRDP), and construction will start in 1994 at Rangsit, north of Bangkok. Among other facilities, the site will house technology and business incubators, the main NSTDA office building and the three national research centers. The park aims to attract high-value international and local investment, and to develop networking to provide benefits to the private sector as well as to educational and research institutes. For example, assistance in technology transfer, identification of specialists, markets, potential partners, and opportunities for commercialization and for attracting more RD&E funding. The park will also provide the base camp from which NSTDA can launch all its operations and activities. An example of NSTDA's activities is Industrial Consultancy Services.

INDUSTRIAL CONSULTANCY SERVICES (ICS)

The Industrial Consultancy Services (ICS) is a NSTDA program, implemented by the Industrial Development and Techno-Business Division, which aims to provide technical assistance to Thai industry by:

- supporting Thai industry to use technical consultants efficiently at reasonable cost;
- providing technical experts for problem-solving or production development;
- communicating problems or needs of industry to technology institutes such as universities and research institutes.

How can ICS supports companies? It provides assistance through technical services, financial assistance and expert services.

Technical services

- Diagnosis of preliminary technical problems by experts; and
- Identification of experts, both local and overseas, to solve technical problems as well as assist in production development, which includes technology management, but not administration and marketing.

Financial assistance

- For preliminary problem diagnosis: 3,000 baht per day, but not exceeding 2 days per case;
- For problem solving or technology development: 50% of the cost of a consultancy project.

Expert services

Local expertise

- High calibre technical personnel from universities and research institutes; and
- Consulting companies.

International cooperating organizations

- Canadian Executive Services Organization (CESO);
- International Executive Service Corps (IESC, US);
- Japan Overseas Development Corporation (JODC);
- Australian Executive Service Overseas Program Limited (AESOP);
- Senior Experten Service (SES, Germany);
- Steinbeis Foundation for Economic Promotion (Germany);
- British Executive Service Overseas (BESO); and
- Netherlands Management Consultancy Program (NMCP).

For further details on activities of NSTDA contact:

Public Relations Department
National Science and Technology Development Agency (NSTDA)
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Bangkok 10400
Thailand

APEC Towards Clean, Diversified Energy

The Asia-Pacific Economic Cooperation (APEC) energy working group will promote cleaner and more diversified energy sources within its 17 member states, group co-chairman Russell Higgins said.

"APEC's biggest challenge will be underpinning Asia's rapid economic growth whilst maintaining environmental protection," Higgins said. He added that APEC countries already consume half of the world's energy.

The group is meeting in Tokyo to discuss coordinated energy databases, clean coal technology and energy conservation.

According to the Japanese Ministry of International Trade and Industry (MITI), though Southeast Asia has generally maintained the highest growth rate in the Asia Pacific region, bottlenecks have developed in infrastructure, manpower, and supporting industries. Capital and engineer shortages, insufficient infrastructure and environmental problems are behind the bottlenecks.

However, industry analysts and multilateral agencies continue to forecast an energy capacity explosion for the Asia Pacific region over the next decade.

Many of them believe in Asia's ability to meet the power demand of its industries to expand at the rate of 6.8 to 7 per cent annually, compared with the world average of 3.1.

According to Higgins, an important aspect of APEC's energy strategy will be coordinating technology transfers from environmentally advanced, developed nations to those whose rapid growth rates have pushed energy efficiency and environmental concerns to the side-lines. Bilateral aid will be an important facet, but so will the exchange of experts from the developing economies.

Demand for liquefied natural gas (LNG), the rising star of clean energy sources, is already burgeoning in Japan, South Korea, Taiwan and in southern China, Higgins said.

Japan's Institute of Energy Economics (IEE) places Asia's LNG appetite at 63 to 67 million tonnes in 2000 and 75 to 95 million tonnes in 2010, standing in stark contrast with 44 million in 1992.

Japan's Gas Association predicts that LNG consumed in this country during the fiscal year starting April 1994 will be approximately 10.6 million tonnes. The IEA sees Japan's LNG demand at 50 to 51 million tonnes in 2000 and 54 to 62 million tonnes in 2010.

South Korea and Taiwan are also major LNG converts, whose appetites are expected to expand on a similar scale.

(Source: Extracted from "APEC to Work Towards Clean, Diversified Energy", by Olivier Fabre (Reuter), *The Nation*, Saturday, 28 May 1994, p. B5)

Book Review

Rural Lighting

A Guide for Development Workers

By Jean-Paul Louineau, Modibo Dicko, Peter Fraenkel, Roy Barlow and Varis Bokalders
Published by Intermediate Technology Publications Ltd
103-105 Southampton Row, London WC1C 4HH
United Kingdom

This guide book is a result of a co-operative project involving the Stockholm Environment Institute (SEI), IT Power Ltd, and the Swedish Mission Council (SMC). It has been sponsored by the Swedish International Development Authority through SEI.

The origin of the book derives from the needs of SEI and SMC field staff and other development workers worldwide who have found much of the information currently available on lighting systems to be fragmented, scarce, too theoretical, and therefore difficult to use.

This book, therefore, aims to provide information both on lighting needs in general and on the technologies, performance and economics of various available lighting systems.

The book reviews the options for providing lighting in rural areas in some detail. It simplifies the procedures for specifying the most cost-effective systems. It also guides the reader in understanding and interpreting manufacturers' specifications for their products.

Since the main reason for the lack of good lighting in rural areas is the absence or inaccessibility of grid electricity, a major element of this book is to review the options for producing and storing the electricity needed for lighting. Non-electric lighting possibilities are also discussed, as some of them are in widespread use. New developments in the field of solar photovoltaics are also presented, as these provide good quality lighting systems independently of the mains and are becoming increasingly available.

Another important topic covered in detail is the use of primary and secondary cells for torches and handlamps.

Although this book is primarily aimed at showing methods for minimizing the energy needs for providing light where there is no mains electricity supply, the aspects of the book on the selection and use of efficient lighting will be of considerable relevance when planning lighting even in conventional urban applications.

The book also includes a buyers' guide with information on lighting systems manufacturers and suppliers, and products.

The chapters can be read independently so as to allow the reader to have quick access to relevant and practical information.

The book is meant for development workers and project managers working in rural or semi-urban development, health, farming and small business sectors. It also can be useful to other readers dealing with lighting problems.

THERMIE Programme Evaluation

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ures, including dissemination activities, and previous European programmes in the field.

The report was produced mid-way through the THERMIE Programme and found that of the projects with a 'clear result' (well advanced, completed or abandoned), 61% achieved complete success.

However, the dissemination of these projects into industry, is still well below what could be achieved, particularly in the fields of renewable energy sources and rational use of energy.

Major Environmental Impact

The cost-benefit analysis of THERMIE projects showed that the energy saving and renewable energy projects carried out in the 1990-1992 period saved or substituted 95.2 million toe of energy and avoided the emission of 388 million tonnes of CO_2, 2.9 million tonnes of SO_2, 1.25 million tonnes of NO_x, 173,000 tonnes of volatile organic carbons and 938,000 tonnes of CO over their lifetimes.

Over 500 associated measures were also evaluated. These turn out to be highly effective ways of helping THERMIE technologies penetrate the marketplace.

Compared with previous programmes, the projects are more commercially successful and involve both greater SME participation (60%) and more transnational collaboration.

Although the report was produced at the programme's mid-way mark, THERMIE is likely to make a significant impact on European energy technology.

For more information contact:

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Fax: +32 2 295 0150

(Source: Extracted from "THERMIE Evaluated" and "The THERMIE Programme", *Innovation & Technology Transfer*, Vol. 4/94, July 1994, pp. 21-22)

Publication Received

* *The Directory of Survey of On-going/Completed Projects on New and Renewable Energy Resources and Technologies in Thailand 1990-1992*, INNERTAP/THA-PUB 5/94, INNERTAP Thailand, National Energy Information Center, Department of Energy Development and Promotion, Bangkok, Thailand, 1994, ISBN 974-7571-30-7, 146 p.

Training Courses/Conferences

1995 ASME/JSME/JSES International Solar Energy Conference
19-24 March 1995, Hawaii, USA

The Solar Energy Division of the American Society of Mechanical Engineers in conjunction with the Japan Society of Mechanical Engineers and the Japanese Solar Energy Society will host its 1995 annual International Solar Energy Conference, in late March, 1995.

The conference will include keynote addresses, invited presentations, technical paper presentations as well as social events.

Papers are solicited in all areas of solar energy research and development including: fundamentals and theory, solar pond and ocean energy, photovoltaics including applications, solar heating and cooling, building energy conservation and solar buildings, detoxification, bioconversion, space applications of solar, solar thermal power, industrial process heat, wind energy system and component simulation and economic analysis, testing and measurement.

For further information contact:

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Mechanical Engineering Dept.
Texas A & M University
College Station, TX 77843-3123
Tel: (490) 845-1280
Fax: (490) 845-3081

Rural Electrification with Renewable Energy Technologies: Policy Options and Strategies
21-26 May 1995, Southampton, United Kingdom

This International Seminar is organised by the British Council (Seminar No. 9530) and will be directed by Anthony Derrick. It will review the options for accelerating the introduction of renewable energy technologies into the electrification and development of rural areas in developing countries.

The topics to be covered during the seminar include:

- Performance, cost and economics of renewable energy technologies;
- Applications in rural electrification, including household energy, water supply, rural industries, and communications;
- Barriers to introduction of renewable energy technologies – technical, economic, institutional; and
- Options for introducing renewable energy technologies – financing schemes, implementing agencies.

The program will be of particular interest to rural development project managers, professionals in development banks, financial institutions in developing countries and rural electrification specialists.

For further information contact:

Marketing Manager
International Seminars Department
The British Council
10 Spring Gardens
London SW1A 2BN
Tel: +44(0)71 389 4264/4252/4226
Fax: +44(0)71 389 4154
Tlx: 8952201 BRICON G

Diary of Events

- **2 – 6 October 1994, Phoenix, USA**

1994 International Joint Power Generation Conference (IJPGC '94)

For details contact:
Mr J.S. Edmonds
MCM Enterprise Ltd.
2755 Northup Way, Bellevue
WA 98004-1495
USA

- **3 – 7 October 1994, Bangalore, India**

Bioresources/94: Biomass Resources – A Means to Sustainable Development

For details contact:
Dr. Frank Rosillo-Calle
Conference Secretary
Biomass Users Network
Information and Skills Centre
King's College University of London
Division of Life Sciences
Campden Hill road
London, W8 7AH
United Kingdom
Tel: +44 71 333 4085
Fax: +44 71 333 4084

- **3 – 7 October 1994, Cairo, Egypt**

Conference on Solar Electricity Photovoltaics & Wind

For details contact:
Dr. Fuad Abulfotuh, NREL
1617 Cole Boulevard
Golden, CO, 80401-3393
USA
Tel: +1 303 231 1201
Fax: +1 303 231 1231

- **5 – 8 October 1994, Ho Chi Minh City, Vietnam**

Enex Vietnam 94

For details contact:
Reed Tradex Co.
1611-1613 16th floor, BB Building
54 Soi Asoke
Sukumvit 21 Rd.
Bangkok 10110, Thailand
Tel: +66 2 260 7103
Fax: +66 2 260 7109

- **10 – 14 October 1994, Thessaloniki, Greece**

EWEC '94 – European Wind Energy Association Conference and Exhibition

For details contact:
The Secretary
Organizing Committee
EWEC '94
19th km Marathonos Ave.
190 09 Pikermi, Attica
Greece
Tel: (01) 362 7069
Fax: (01) 3614709

- **16 – 28 October 1994, Denver, USA**

Dam Safety, Operation and Maintenance

For details contact:
International Affairs Technical Services Office
D-7200 US Bureau of Reclamation
PO Box 25007, Denver
Colorado 80225
USA
Tel: +1 303 236 6953
Fax: +1 303 236 5151

- **17 – 18 October 1994, New York, USA**

Third Annual Independent Energy Forum

For details contact:
International Business Forum
7 Penn Plaza
370 Seventh Avenue
Suite 901
New York, N.Y. 1001
USA
Tel: +1 212 279 2525
Fax: +1 212 279 9307

- **18 – 21 October 1994, Beijing, China**

International Conference on Power System Technology

For details contact:
Prof Zhou Xiaoxin
Electric Power Research Institute
Qinghe, Beijing 100085
China

- **24 – 26 October 1994, New Delhi, India**

International Conference on Environmental Issues in Minerals and Energy Industry

For details contact:
G.S. Khuntia
General Manager and Convenor
Conference Secretariat
Raw Materials Division
Steel Authority of India Ltd (SAIL)
Rourkela Steel Plant
Rourkela - 769 011, Orissa
India
Tel: (91) 0661 890 801
Fax: (91) 0661 8651/3085
Tlx: 0635 235

- **26 – 28 October 1994, London, United Kingdom**

PEVD '94 – 5th International Conference on Power Electronics and Variable-Speed Drives

For details contact:
PEVD '94 Secretariat
IEE Conference Services
Institution of Electrical Engineers
Savoy Place
London WC2R OBL
United Kingdom

- **31 October – 4 November, Vancouver, BC, Canada**

Energy Efficiency and DSM Conference

For details contact:
Kelly Port
The Conference Connection

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Diary of Events

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111 Presidential Boulevard
Suite 155
Bala Cynwyd, PA 19004
USA
Tel: +1 215 667 3114
Fax: +1 215 667 5593

- **1 – 2 November 1994, Oslo, Norway**

Petroleum Tax Conference

For details contact:
Fax: +47 599 7238

- **1 – 4 November 1994, Ho Chi Minh City, Vietnam**

Saigon Electricity Expo '94

For details contact:
E.A. Kay, CP Exhibition
2801 Tung Wai Comm. Bldg.
109 Gloucester Road, Wanchai
Hong Kong
Tel: 852 511 7427
Fax: 852 511 9692

- **2 November 1994, London, United Kingdom**

Electricity Purchasing: The Over 1 KW Market

For details contact:
Starform Communications Ltd
Heather House, Heather Gardens
London NW11 9HS
United Kingdom

- **2 – 3 November 1994, London, United Kingdom**

Electricity Pricing

For details contact:
AIC Conferences
Nestor House, Playhouse Yard
London EC4V 5EX
United Kingdom

- **7 – 9 November 1994, London, United Kingdom**

4th International Conference: Trends in Distribution Switchgear

For details contact:
Ms J. Chopping
Conference Organiser, Secretariat
DS94 Conference Services
Institution of Electrical Engineers
Savoy Place
London WC2R OBL
United Kingdom

- **7 – 10 November 1994, Manila, Philippines**

Water Philippines

For details contact:
Turret Group
171 High Street
Rickmansworth, WD3 1SN
United Kingdom
Tel: +44 923 228 577
Fax: +44 923 221 346

- **8 – 9 November 1994, Hertfordshire, United Kingdom**

2nd Electricity Law Seminar: It's a Small World

For details contact:
International Bar Association
2 Harewood Place
Hanover Square
London W1R 9HB
United Kingdom

- **8 – 10 November 1994, Vienna, Austria**

8th International Seminar on Hydro Power Plants

Technical papers are invited on the following session topics: Uprating and Refurbishment, Remote Control and Diagnostic Systems on Hydro Power Plants.

For details contact:
Alfred Königsberger
Technische Universität Wien
Institut für Wasserkraft-maschinen und Pumpen
Karlsplatz 13/305
A-1040 Wien
Austria
Tel: +43 222 5801/3296
Fax: +43 222 504 1148

- **13 – 16 November 1994, Washington, DC, USA**

Nuclear Energy Forum

For more details contact:
Conference Office
US Council for Energy Awareness
1776 I St., NW, Suite 400
Washington, DC 20006-3608
USA
Tel: +1 202 293 0770
Fax: +1 202 466 0246

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Library and Regional Documentation Center, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

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Fourth International Symposium on Renewable Energy Education

December 12–14, 1994, Bangkok, Thailand

The Fourth International Symposium on Renewable Energy Education (ISREE-4) was held at the Asian Institute of Technology, Bangkok, Thailand, during December 12-14, 1994. The symposium was organized by the International Association for Solar Energy Education and the Asian Institute of Technology. The ISREE-4 was sponsored by International Solar Energy Society (ISES), Swedish Agency for Research Cooperation with Developing Countries (SAREC), The Canadian International Development Agency (CIDA)/AIT-Canadian Universities Consortium Partnership Project, Agence de l'Environnement et de la Maîtrise de l'Energie (ADEME), Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, and Regional Wood Energy Development Program, FAO.

The ISREE-4 was also supported by the United States Agency for International Development (USAID), the British Council and the French Ministry of Foreign Affairs.

The symposium was attended by 55 participants from 25 countries. During ISREE-4 38 papers were presented on different aspects of renewable energy education such as training, teaching, curriculum development.

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Professor R.H.B. Exell, Emeritus Professor of the Asian Institute of Technology and Technical Advisor of RERIC, delivering his paper at the Symposium.

INNERTAP

Incorporates news from the Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

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Supplement: Small Scale Wind Energy Systems

Solar Energy for Prawn Wintering

A new method of providing the warm water needed for parent prawn wintering using solar energy has been developed in the People's Republic of China. The technique involves use of a shallow solar pond for collection and storage of heat.

In China, in prawn cultivation parent prawns must be kept in slightly warm water (8°C) during the winter in order to provide larval shrimp for the next summer's crop. Traditionally this water is heated using coal, at great expense and at great cost to the environment.

System Design

Using solar energy for prawn wintering involves heat collection, heat storage and temperature maintenance. The system designed provides sufficient energy for the safe wintering of prawns with suitable water temperatures.

The temperature control facilities include: a salt gradient solar pond, a shallow solar pond and a "plastic house".

Salt Gradient Solar Pond

This is the key facility for supplying heat to the whole wintering operation. This installation allows the continuous use of solar energy and inter-seasonal solar energy storage. It can balance the water temperature regained in prawn wintering.

Shallow Solar Pond

The shallow solar pond was built on the south side of the salt gradient solar pond, the bottom of the pond is lined with PVC and the top is covered with PE film. This pond serves as a parent prawn wintering pond for preheating marine water on sunny days. It provides sufficient heated water to allow daily exchanges of not less than 10 percent.

"Plastic House"

The prawn wintering operation is carried out in the "plastic house". Its main function is to collect heat, hold temperature and control lighting.

The solar pond was built inside the house. The sun-facing side of the solar house is covered with white glass fibre tiles with PE film inside the house, PVC film is used to control lighting.

Parent prawn wintering pond

Four parent prawn wintering ponds were built side by side at the north flank of the salt gradient solar pond. Three PVC heat-exchanging pipes were installed in each wintering pond. Heat is provided by circulating water from the storage zone of the salt gradient solar pond.

Performance and Costs

Temperature is the key factor for survival of parent prawns in the wintering operation. The maximum temperature range is 6-12°C whilst the optimum temperature range is 8-9°C.

During the experiment, the average temperature in the wintering pond "plastic house" was 11°C and the minimum temperature in January was 5.4°C.

In mid-November 1,100 young parent prawns were put into the pond. On the 21st March 851 parent prawns had survived, so the survival rate was 77.4%.

The project costs totalled $5,700. With the solar pond technology for parent prawn wintering, the equivalent of 35 kg of coal and 0.24 m^3 of fresh water can be saved per prawn. The cost for each prawn is $1.11 and each prawn saves $1.21 over the conventional coal burning technology.

The installation of the solar energy system improves the environment and saves fuel. The ratio of net profit with the solar energy system over investment is 1.5, that is the system is economically viable.

In fact, a greenhouse containing a solar pond for parent prawn wintering can operate with multiple functions, e.g. when winter is over it can be used to grow seedlings. If the solar energy cannot supply sufficient heat, a back up electric heater can meet the requirement. The operational water of this installation was 150 m^3 and was able to produce 20-30 million prawn seedlings. This should make a profit of about $ 6,250-12,500 in a year, after recouping capital outlay.

Thus, the technology can produce a suitable environment for prawn wintering in China. The technique is also applicable to wintering for many other marine species. For example, protected aquatic farms can be built using solar ponds, so that fresh produce can be supplied throughout the year. These can be compared to protected agriculture such as is carried out in greenhouses.

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(Source: Extracted from "Solar Aquaculture – A Wintering Technique for Parent Prawns" by Cao Jin Long, *SunWorld*, Vol. 18, No. 3, September 1994, pp. 14-15)

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For further information on the ISREE-4 contact:
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Participants attending the 4th International Symposium on Renewable Energy Education

Solar Air Heating System Wins Award

A simple, highly efficient solar air heating system that can cut heating costs in industrial and commercial buildings has been recognized as one of the most important technological advances of 1994 by Research and Development magazine.

The transpired solar collector, jointly developed by the U.S. Department of Energy's (DOE) National Renewable Energy Laboratory (NREL) and Conserval, a Canadian solar heating and conservation engineering company (See "SOLARWALL – Canada", *RERIC News*, Vol. 17, No. 2, pp. 3-4), won the magazine's prestigious R&D 100 award. This is the 16th annual R&D 100 award NREL has won.

The collector is a perforated sheet of dark metal that preheats outside air to increase air temperature by as much as 50 degrees Fahrenheit. Fans pull the preheated air through holes in the perforation and into the building's ventilation system for additional conventional heating. The transpired collector can be included in new construction or retrofitted in an existing structure as part of a south-facing roof or wall.

The energy cost-savings potential of the transpired solar collector is substantial. The cost payback period for a new building system is approximately three years; a retrofitted system has a payback of six to seven years.

NREL and Conserval worked parallel paths in developing the transpired collector. NREL applied air flow and heat transfer research through computer modeling, simulations and wind tunnel testing. The result is a collector that captures roughly 80 percent of available solar energy – a world record for solar air collectors.

The system has no moving parts other than ventilation fans, needs little maintenance, and can be used for crop drying and other applications where outside air needs to be heated.

(Source: "Solar Air Heating System Wins National Research Award", *NREL's Press Release*, Golden, Colorado, USA, August 18, 1994)

Tests in Antarctic Conditions

Small-scale wind generators were used and tested in the Antarctic as early as the first post-war expeditions of the 1950s. High failure rates (due to both low temperatures and powerful gusty winds), energy storage problems and the continuing need for complete back-up systems led to their withdrawal, except for a few small field installations for charging batteries for scientific and communications equipment.

Developments in wind turbine technology have led to larger and more reliable machines.

Recently, tests on larger types of commercial wind generators have been carried out: by the French at New Amsterdam Island (1986-1988), by the Germans at George Von Neumayer Station (1991 to date), and by the Australians in the sub-Antarctic at Heard Island (1992-1993).

New Amsterdam Island

A 10 m diameter vertical axis Darrieus rotor D10-2 (with 67.7 m^2 swept area, rated 30 kW at 13.5 m/s) was designed and constructed at New Amsterdam Island by the Centre d'Etudes Nucléaires de Grenoble. The turbine showed good capabilities with daily energy production of 400 kWh recorded for wind speeds ranging from 12 to 25 m/s. High winds led to failures but there is still potential for improvements.

George Von Neumayer Station

At George Von Neumayer Station, a 10 m diameter vertical axis H rotor (56 m^2 swept area, rated 20 kW at 9 m/s) has been developed as a joint project between the Alfred-Wegener-Institute, Germanisher Lloyd, Hochschulke Bremerhaven and Heidelberg Motor. It can withstand wind speeds as high as 68 m/s and temperature as low as -55°C. It is characterized by simplicity (permanent magnet, no mechanical transmission). In its second year of operation, it is running continuously without interruptions or breakdowns and produces roughly 5% to 15% of the energy requirement of the station.

Heard Island

At Heard Island, a 7 m diameter two bladed horizontal axis turbine Vergnet-Aerowatt UM 70X (38.5 m^2 swept area, rated 12 kW at 12 m/s) showed good performance in extremely variable, high, gusty winds. The unit operated over a three month period during which it produced an average of 62.2 kWh per day. Over the time of actual operation, the average output was 6.1 kW. This turbine has a rated survival wind speed of 110 m/s which should make it worthwhile testing in the East Antarctic coastal stations where any outdoor structure has to be designed to withstand winds of 90 m/s.

(Source: Extracted from "Wind Turbines in Antarctica" by Antoine Guichard, *Solar Progress*, Vol. 15, No. 2, Winter 1994, p. 25)

Incentives Boost Wind Market in India

Market incentive programmes are making wind power plant development a lucrative business for private sector companies in India.

The private sector is taking over the reins of wind energy development in India and the pace of wind plant construction on the subcontinent is now one of the fastest in the world. Some 64 MW was installed in India during the past year and applications to build a further 970 MW are being processed by the authorities. Total installed capacity in India is currently about 120 MW.

The rush of development activity over the past months has been spurred by a number of events. Confidence in wind energy has been boosted by the commercial success of a series of wind plants in Tamil Nadu, developed by the private sector since 1990. Following this success in the south the government's aim has been to create a national market in which wind and other renewables become attractive investments in their own right.

Instead of the government's direct support as before, a number of market incentives have been introduced, the most recent of which is a far reaching action plan for renewables. Couple this to a five year tax holiday for all new industrial undertakings for the generation or distribution of power, then the wind market in India has arrived.

The action plan was officially announced by Ajit Gupta, the director of the Ministry of Non-Conventional Energy Sources (MNES), and will run until 1997. It expands the country's target for wind energy, contained in India's 8th Plan for economic development, from 100 MW to 500 MW. Aside from hydro this is the largest target for any single renewable source. The total renewables target has been expanded from 600 MW to 2000 MW.

More importantly, the plan includes detailed guidelines outlining how the Indian states should structure their market incentive programmes for non-conventional energy sources. The guidelines cover a wide range of activity, from tariffs and conditions for grid connection, to sales tax exemption and other tax credits.

The fiscal incentives are to start immediately and remain in force for five years. The minimum rate of purchase for renewable power by a State Electricity Board is set at INR 2.25/kWh ($0.072), with no limit on the amount which may be delivered or on when delivery should take place. The rate will be reviewed annually and linked to a standard index, such as the wholesale price index.

The states appear to be responding well. Punjab, Uttar Pradesh and Madhya Pradesh have already announced incentive programmes based on the guidelines. Tamil Nadu, Kerala, Andhra Pradesh and Gujarat have also devised programmes, though with modifications to the guidelines. Gujarat has introduced a scheme of sales tax credits which MNES is encouraging other states to follow.

Gupta says that meeting rural energy needs must be the prime target of India's renewables policy.

Minister for MNES, S. Krishna Kumar, points out that the government investment in renewable energy is less than 1% of the total investment in the energy sector. "As a result of our efforts we are able to mobilise five rupees from outside our budget for every rupee we put in," he says.

As well as outlining the market incentives to be adopted by the states, MNES is also masterminding detailed wind mapping of the whole of India. The ministry says it has approved 150 wind monitoring stations and 470 wind mapping stations in 22 states. Of these, 251 wind mapping and 88 wind monitoring stations are in operation. At 58 wind monitoring stations in eight states – Tamil Nadu, Gujarat, Andhra Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra and Lakshadweep Islands – mean annual wind speeds greater than 5 m/s have been recorded. Detailed wind plans have also been mapped out for the southern Tamil Nadu coastal area and southern districts of Andhra Pradesh. A government wind energy centre is being established at the Indian Institute of Technology of Madras, to be financed by Danida and the United Nations Development Programme.

(Source: Extracted from "Dynamic Market Rapidly Unfolds" by Neelam Mathews, *Windpower Monthly*, Vol. 10, No. 9, September 1994, pp. 24-27)

Overview of Wind Energy Projects in India
(Total installed capacity is 116.66 MW*)

State	Demonstration Projects		Private Sector Projects	
	Installed Capacity	Under Way	Imstalled Capacity	Under Way Applied for
Tamil Nadu	19.27	4.00	64.49	53.86
Gujarat	16.34	4.44	12.12	572.88
Andhra Pradesh	0.55	2.50	–	248.00
Karnataka	0.55	2.00	–	71.00
Kerala	–	4.00	–	25.00
Maharashtra	1.10	1.50	–	–
Madhya Pradesh	0.59	–	–	
Orissa	1.10	–	–	–
Single turbine	0.55			
TOTAL (MW)	40.05	18.44	76.61	970.74

* as of 31.05.94

Hydrogen Storage First for Alaska

The world's first community powered entirely by a large scale wind plant with hydrogen storage could be built next year in Alaska. The $ 10 million system, to power St George's Island in the Bering Sea, would eliminate use of fossil fuels there, says project originator Glenn Rambach of the Lawrence Livermore National Laboratory in the United States.

St George's Island is 600 miles from Anchorage and has a population of just 140. It is presently powered by a diesel generator. Fourteen Model 15-50 wind turbines from small American wind company Atlantic Orient would be used. If the project is built, wind power would be siphoned off to an electrolyser, which would separate hydrogen from water and store it to power the town when the wind dies down.

The demonstration project has wide potential at sites in Alaska where electricity costs $ 0.25-0.70/kWh, says Rambach. It also has potential in Canada and other remote locations, especially those in the developing world once component costs are lower. The US Department of Energy is being asked to provide $ 5 million.

At the Lawrence Livermore National Laboratory, Rambach is also developing a concept for powering cars from the wind. Using the same electrolysing principle, wind power would be used to make hydrogen fuel for the cars. These hydrogen hybrid cars, which would have special internal combustion engines, would refuel at "wind" or "hydrogen stations" instead of "petrol stations."

Rambach says that a single Kenetech 33M-VS wind turbine could power 100 cars continuously, each driving 12,000 miles a year, for a cost of $ 20-30 for 300 miles. The difficulty would be getting, say, 100 of the special cars built for a demonstration project, he says. Auto manufacturers generally build thousands or millions of one model, not 100, he notes.

(Source: Extracted from "Hydrogen storage first for Alaska", *Windpower Monthly*, Vol. 10, No. 8, p. 16)

Research Breakthrough to Cut Ethanol Cost

A genetic engineering breakthrough at the National Renewable Energy Laboratory (NREL) of the U.S. Department of Energy (DOE), could substantially reduce the cost of producing ethanol from biomass and move the technology closer to being economically competitive with gasoline. The breakthrough, combined with the use of inexpensive feedstocks, could cut in half the per gallon cost of ethanol from biomass. NREL recently applied for a patent on this new ethanol production process.

Christine Ervin, DOE's assistant secretary for energy efficiency and renewable energy, says: "Ethanol from biomass can be a significant source of domestically-produced transportation fuel that can reduce our need for imported oil, improve urban air quality and help create jobs. This breakthrough, together with our continuing advances in biomass conversion technology, mean that ethanol from biomass can be economically competitive today for blending with gasoline."

The technological advance NREL scientists achieved through the support of DOE's Biofuels Energy Systems/Biochemical Conversion Program results in a substantially more efficient process for making ethanol. The most common method of ethanol production uses yeast to ferment glucose, a 6-carbon sugar that is the major component of most biomass feedstocks. Alternatively, the bacterium *Zymomonas mobilis* is more efficient than yeast and is well-suited to ethanol production.

In a major breakthrough, NREL researchers have genetically engineered a new strain of *Zymomonas* that can ferment xylose, a 5-carbon sugar, in addition to glucose. Because xylose can comprise 25-40% of biomass, the new bacterium greatly expands the percentage of feedstocks that can be fermented into ethanol.

According to NREL researchers, using the new bacterium along with inexpensive feedstocks, such as agriculture residues and sawdust, would lower the cost of ethanol from biomass from about $1.20 per gallon to around $0.60 to $0.70 per gallon. DOE's overall goal is to produce ethanol from dedicated energy crops such as switchgrass and hardwood trees that is cost competitive as a pure fuel on the open market.

In addition to advancing technology to lower the cost of ethanol from biomass, NREL is forming new partnerships with industry to use the technology. For example, the Amoco Corp. is scheduled to be the first industrial partner to apply NREL's new pilot plant now being completed to provide data needed to commercialize a biomass-to-ethanol process.

(Source: "Research Breakthrough Could Lead to Substantially Cheaper Ethanol", *NREL's Press Release*, Golden, Colorado, USA, August 5, 1994)

Wind Power Up in Sweden

According to the Swedish power generator's R&D organisation, Elforsk AB, electricity produced by wind almost doubled between 1992 and 1993 in Sweden.

The number of wind power plants has increased by nearly 50 per cent to 129 in 1993 and with an additional seven power producers in 1994, the number totals 136.

The most probable cause of the boom is increases in government support for construction of wind power plants, Elforsk said.

Despite the increase, wind-produced power still accounts for only 0.04 per cent of the total energy consumption in Sweden.

(Source: "Swedish Wind Power Up", *SIP – Sweden in Focus*, Vol. 68, No. 102, July 1, 1994, p.7)

Fuel from Green Microalgae

A discovery made by scientists at the Hebrew University, Jerusalem, makes it possible to grow a green microalga, *Dunaliella parva*, and convert it into a liquid fuel.

Of all forms of plant life, algae are known to be the most productive CO_2 users. They can fix greater quantities of carbon dioxide per land area than higher plants like trees and sugar cane. Microalgae farming can increase the productivity of desert land almost 70-fold to a level more than twice that of tropical rain forest.

Unlike other biomass crops which require agricultural land, algae for this purpose can be grown on desert land, salt flats and closed bays. The technology, thought to be unique, for the thermal conversion of *Dunaliella parva* into oil has been developed by Professor Benzion Ginzburg at the Hebrew University of Jerusalem.

Work on the ALF (Alga to Liquid-Fuel) project commenced in the mid-1970s. In the initial stages of the development, research focused on maximization of the lipid content of the biomass. However, the discovery that high-quality hydrocarbons could be obtained from proteins, and that young, vigorous algal cultures exhibited a high protein content, led Professor Ginzburg to the conclusion that the protein component of the biomass was the most important element for oil production.

First, extensive experience was gained in the laboratory for growth and thermal conversion of the algal biomass. Later, a small-scale demonstration facility with 400 m^2 ponds was operated on the Mediterranean coast of Israel. Since 1982, the project has been inactive.

Work carried out so far shows that:

- *Dunaliella* is a very unusual micro-organism, a naked plant cell;
- Lacking a cell wall, it is very suitable for genetic manipulation;
- The alga grows in saline environments of a wide range of concentrations;
- Under laboratory conditions with artificial light, the alga has a growth rate doubling time of less than two hours;
- The resulting biomass is an outstanding source of material for pyrolysis into oil;
- It has a high protein content and produces high quality hydrocarbons.

Extrapolating from the results obtained with the 400 m^2 ponds, an energy farm of 100 hectares should yield at least 2000 tons or 16,000 barrels of liquid fuel annually. The most important nutrient required is CO_2, the final product being 90% carbon. A major by-product is ammonium carbonate (NH_4CO_3), a nitrogenous fertilizer.

Biomass is most easily processed in the form of a sludge. Three methods have been tested, namely flocculation, flotation and skimming.

The final stage of the conversion into oil consists of a wet process of thermal treatment (pyrolysis) yielding short-chain hydrocarbons and the ammonium carbonate by-product.

The economic feasibility analysis of the technology has determined the total cost of the oil produced to be $21.6 per barrel of crude oil. Allowing for a 20% mark-up brings the price per barrel to $26.

The price of crude oil is said to be about to rise to $27.30 in 2000 and $30.00 by 2005. These figures do not include any carbon tax or any surcharge that might be levied out of concern for the environment.

Development of the project is in the hands of Profile Technology Ventures, in conjunction with Yissum, the R&D company of the Hebrew University, Jerusalem. An independent company will commercialize the technology in two stages of a research, development and implementation effort over a period of about six years.

Stage 1, the first three years, will require about $6 million to bring this technology to the point of building a pilot plant.

(Source: Extracted from "Power fuel produced from green microalgae" by Phil Bloom, *Modern Power Systems*, Vol. 17, Issue 7, July 1994, p. 32)

Small Hydro Power in China

By the end of 1992, the total installed capacity of small hydro power stations in China exceeded 14.9 GW. The provinces of Sichuan and Guangdong lead the country, with two million kW of small hydro power stations in operation in each province. The provinces of Fujian, Hunan and Yunnan each have small hydro power stations exceeding one million kW in operation.

Statistics of small hydro power development in China are shown in Table 1.

The total installed capacity of small hydro power stations in China has been increasing steadily. About 600,000 kW to one million kW of small hydro power was added per annum in China over the past few decades.

The number of small hydro power stations has been decreasing since 1980. This is due to the fact that a good number of small hydro stations were put out of commission each year. These stations might not be properly designed, constructed, equipped and/or operated.

The average size of a single station has been increasing remarkably. The trend is to build larger stations. Since 1986, the upper limit of a small hydro power station has increased from 12 MW to 25 MW. Some advanced counties in China are currently building stations up to 30-60 MW.

Among the 51,389 small hydro power stations in operation in 1992, 2501 stations with individual capacities of over 500 kW accounted for 60%

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Small Hydro Power in China

From P. 6

of the total generating capacity. A further 15,486 stations, with individual capacities of 100-500 kW, accounted for 34% of the total generating capacity. The number of stations smaller than 100 kW totalled 33,402 and contributed 6% of the total generating capacity.

Rural electrification programme

In 1982, the Chinese government initiated a rural electrification programme in 100 pilot counties. The aim of the programme is to promote rural electrification in the whole country by setting-up leading examples, as well as to accumulate successful experience in rural electrification in the Chinese style, in line with a comfortable standard of living.

A nationwide survey of the potential candidate counties was carried out in 1983. The pilot counties were nominated by the provincial governments and reviewed and approved by the central government in 1984. Implementation of the programme was carried-out in 1985-1990. By June 1990, the programme was completed.

One hundred and nine counties which are inhabited by a population of 30.4 million were selected. Mostly they are situated in remote areas, where the economic conditions are generally poor.

The total small hydro power installation of the 109 counties increased from 1406 MW in 1985 to 2446 MW by June 1990. During those five years:

- The average annual per capita electricity consumption increased from 117 kW in 1985 to 240 kWh in 1990;
- The total industrial and agricultural product value of the pilot counties increased 128%;
- The profit gained from small hydro power stations averaged RMB Yuan 1.5 M (US$ 0.2 M)/ county in 1991; and
- With the rapid growth in township enterprises, a large number of surplus labourers in the countryside gained employment.

A total investment of RMB Yuan 4.1 bn (US$ 0.5 billion) was spent on carrying out the programme, of which only RMB Yuan 0.5 billion (US$ 55 M) came from the central government, accounting for 12% of the total expenditure. The rest was raised by county authorities through various financing channels, including bank loans.

A second rural electrification programme, to be implemented in 1991-95 is now underway. About 70 million people in 200 counties will benefit from it. During those five years, some 2570 MW capacity of new small hydro power stations will be built.

The central government is committed to investing RMB Yuan 1 bn (US$ 110 M) in the second programme. The programme is now more than halfway completed. The central government increased its financial support to compensate for the high rate of price escalation in recent years.

According to a seminar held in Hunan Province in 1986, micro hydropower units were made in 50 factories in seven provinces in south China.

Several types of micro machines are available in China. They include micro propeller turbines for low head stations, micro Francis turbines for medium heads and micro turgo turbines for relatively high head stations.

In some parts of China, small hydro power stations with an installed capacity of a few hundred kW have been built recently by rural entrepreneurs and run as a private business.

The owners borrow money from the agricultural bank and repay the loan with the revenue from electricity sales within two to three years.

Rural power grids

With the rapid growth in small hydropower stations, rural power grids were gradually formed at county level. The small isolated stations were usually linked together first to supply nearby villages. Then, groups of small stations serving the villages were connected, to form a county grid. Statistics show that in 1978, only 38% of the small hydro stations were connected to the county grid. By 1991, the figure had risen to 83%.

Inter-county power grids were also established. By 1990, 39 inter-county power grids were in operation, covering 200 counties.

As the government encouraged the use of seasonal hydro electricity in cooking, boiling water, tea processing, tobacco processing and many other baking or drying processes to reduce the use of firewood, the preservation of forests has improved. It was estimated that around 20% of households in the electrified areas use seasonal hydro energy to replace firewood.

(Source: Extracted from "Recent trends in small hydro power in China" by Cheng Xuemin, Small Hydro Supplement, *International Water Power & Dam Construction*, Vol. 46, No. 9, September 1994, pp. iv-ix)

Table 1. Small Hydropower Development in China

Year	Accum. installed capacity (MW)	Energy generation (TWh)	Number of stations	Average size per station (kW)
1960	238	–	8993	26.5
1970	1019	–	19182	34.9
1975	3083	6.69	68300	45.1
1980	6952	12.70	88555	78.2
1985	9520	24.13	70600	143.8
1990	13180	39.28	–	–
1991	13853	37.33	54660	253.4
1992	14920	51.5	51389	290.3

Source: China Electricity Council, Beijing, PR China

Volcanoes – Major Energy Alternative in the Philippines

The Philippines lies in the Pacific "rim of fire" – a chain of volcanoes ringing the ocean – where the Earth's magma is closer to the surface. The country, long suffering from volcanic eruptions, is learning to harness the destructive powers of the earth.

The abundance of volcanoes, hot springs and mud pools dotting the archipelago's 7,100 islands makes underground steam one of the most promising alternative energy sources in this oil-importing nation.

Since the operation of its first geothermal plant in 1979, Manila has gone a long way in exploiting the earth's superheated bowels to light up homes and power industries.

The Philippines is the world's second largest geothermal energy producer next to the United States with an installed capacity of 1,074 MW. This source accounts for about 8% of total energy needs.

The geothermal reserves of the country are estimated at about 4,000 MW, making its development a major part of Manila's long-term programme to attain power sufficiency after sweating out an energy crisis in 1992 and 1993.

Nessim Forte, country manager of Ormat Inc., a Nevada-based geothermal plant builder, says among the alternative energy sources that Manila is developing, such as coal, natural gas and solar, geothermal power is the most feasible. It is also environment-friendly because it doesn't burn fuel or emit carbon dioxide into the atmosphere.

According to Windsor Refuerzo, spokesman of the state-owned Energy Development Corp (EDC), Manila will increase its geothermal capacity to over 2,000 MW by year 2000 when electricity demand is projected to reach 10,817 MW from the current 4,000 MW to meet the demands of a growing economy.

To achieve this objective, the government has lined up 163 geothermal wells for drilling over the next six years to supply plants earmarked to produce 1,060 MW. Total project cost is about 36 billion pesos ($1.38 billion).

From 2001 to 2010, Manila aims to develop additional geothermal fields in 13 areas, including the main Luzon island, to tap between 381-796 MW of power at a cost of about 52.5 billion pesos ($2.01 billion).

These projects have attracted several big foreign companies.

Contracts were awarded to US firms Ormat, Magma Power Corp and California Energy Co to harness 640 MW of geothermal power on central Leyte island – the country's largest steam field – under a build, operate and transfer scheme.

Japanese giants Marubeni Corp and Itochu are among several bidders for a 40 MW, $40 million geothermal plant on Mount Apo in southern Philippines. The total capacity of the Apo field is 240 MW.

Geothermal plants can last for 30 years just like other facilities and are much cheaper to explore than oil and gas.

Each geothermal well costs $1.1 million, Refuerzo said, adding that 12 wells are needed for a 100 MW plant. An oil well costs about $25 million.

(Source: Extracted from "Volcanoes RP's 'major source' of alternative energy", *Bangkok Post*, Tuesday, 23 August 1994)

Indonesia to Speed up Geothermal Development

Indonesia's Ministry of Mines and Energy has set up a special working group to find ways to speed up the development of geothermal projects.

Java has more than 100 volcanic cones, of which some 15 are active and seven under observation. The World Bank estimates that a power output of 16,000 MW could be created from geothermal steam. At present, Indonesia's geothermal capacity is just 260 MW.

The government is anxious to exploit private power development of geothermal if possible. There are no such plants in operation, although several have been proposed by developers with agreement for one having been signed with the government last year.

The difficulty in developing private operations is determination of fuel prices, since geothermal steam is an unconventional fuel, to say the least, and therefore cannot be compared with oil or coal.

Private sector geothermal projects include three earmarked under the PLN's expansion plan (known as 'solicited' projects) and four proposed by the private sector to the government outside the PLN plan ('unsolicited' projects).

The solicited projects include the 2 x 55 MW geothermal plant at Sarulla in North Sumatra, which is being developed by Unocal Geothermal Indonesia Inc, under a joint contract with Pertamina. Agreement was signed early last year for power to be sold to the PLN. The plant is eventually to be turned over to the PLN ownership and control. Other solicited projects are the Patuha and Wayang Windu plants in West Java. These have long been on the drawing boards with prequalification of several developers taking place in 1991.

The unsolicited projects include a 55 MW plant at Dieng, Java, proposed by Himpurna-Roba of Indonesia and California Energy; and a 6 x 20 MW unit complex each at Ulubelu and

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Biogas Feeds Fuel Cells

California's recycling law which mandates that communities divert 25% of solid waste from landfills by 1995 and 50% by the year 2000, is helping to spur research into uses for biogas. A specific example is a pilot project now under development in Folsom, California, which incorporates an anaerobic digestion/anaerobic composting process that could eventually supply enough biogas to a fuel cell. The Sacramento Municipal Utility District (SMUD) has two fuel cells in operation and is participating in a research project.

Recently, the California Prison Industry Authority (PIA) began operating a processing facility at the Folsom prison, designed for 100 tons/day of mixed waste from the City of Folsom. The 35,000-square-foot Correctional Resource Recovery Facility (CRRF) uses minimum security inmates from Folsom's Return to Custody Facility to manually separate recyclable and compostable materials from the waste stream. The PIA will be using a new technology, high solids anaerobic digestion, to compost the organic fraction (representing approximately 60-70% of the waste stream). Construction began in June on a 40-foot wide by 120-foot long and 22-foot deep anaerobic digester.

Once the vessel is operational in 1995, the composting process and the gradual breakdown of organic material will produce biogas, which SMUD hopes to use to power an adjacent two megawatt fuel cell. The electricity generated will serve SMUD customers, including the waste facility and nearby correctional institutions. Thermal heat, a by-product from the electrical generation process, will be used to maintain the heat balances required to facilitate the anaerobic digestion process.

The Folsom demonstration project does more than help Folsom meet landfill diversion goals set by the state. It also allows inmates to gain work experience that could lead to employment in the growing recycling industry. The inmates earn an average of 55 cents an hour, plus a one-day reduction of their prison term for every day worked.

Once the digester comes on line, the recovered organic fractions will be shredded to the proper size for composting (less than an inch). The material will be mixed with wastewater biosolids and fed into the anaerobic digester, where it will remain for approximately 30 days. Digester contents will be mixed using large mixers according to temperature or time monitoring signals. The digester operates at thermophilic (about 130-140°F) conditions. Biogas will be produced along with wet digestate. Once removed, a bulking agent, such as wood chips, will be added to the material, then moved to the aerobic drying area. Currently, the organic fraction being separated from the 50 tons/day of incoming MSW (roughly 20 tons/day) is being aerobically digested on drying beds.

Feeding the Fuel Cell

Often described as continuously operating batteries, fuel cells create electricity without rotating machinery. But unlike batteries, they don't need re-charging and operate non-stop. Current fuel cells mix natural gas with steam to release hydrogen. The hydrogen then enters the fuel cell and combines with oxygen, extracted from the surrounding air. Hydrogen and oxygen atoms join to form water, a chemical reaction that releases energy and heat.

SMUD has two 200 kW fuel cells already in operation. The plants, manufactured by ONSI Corp. in South Windsor, Connecticut, convert natural gas directly into electricity and thermal heat. But SMUD's desire to use alternative and renewable fuel sources whenever possible is prompting its Advanced Resources and Technologies Division to study ways to supplant fossil fuels with biogas.

As the digester is brought into operation in 1995, RSI Associates, a SMUD subcontractor funded by a Western Area Power Administration (WAPA) grant, will develop an appropriate means of monitoring the biogas produced. RSI also will suggest a biogas clean-up method and recommend a compatible fuel cell for the generation of electricity and useful heat.

The Sacramento utility already is investing in solar and wind power and looking optimistically at biogas as a way to further diversify resources, while lowering costs and reducing air pollution. Biogas may prove to be an important ingredient in SMUD's new environmentally responsible power mix that is preparing Sacramento for a sustainable energy future.

(Source: Extracted from "Biogas, Compost and Fuel Cells" by B. Wichert, L. Wittrup and R. Robel, *BioCycle*, Vol. 35, No. 8, August 1994, pp. 34-36)

Indonesia to Speed up Geothermal Development

From P. 8

Rajabasa in Lampung and Lumut Balia in South Sumatra, proposed by PT Enerindon Supra Abadi. The contracts would be formed with Pertamina.

Existing geothermal plants operated by the PLN include the 140 MW Kamojang units of 30 MW and 2 x 55 MW units) in west Java, built with technical assistance from New Zealand; the 2 x 55 MW plant at Mount Salak in West Java, which went into operation last July, and a 3 MW plant at Uluumbu, Flores, in east Indonesia, and a 2.5 MW plant at Lahendong, North Sulawesi. A 55 MW unit at Darajat, West Java, is expected to be commissioned later this year. It is being built jointly by Amoseas Indonesia Inc. and Pertamina.

(Source: Extracted from "Jakarta seeks ways to kick-start geothermal projects", *Power in Asia*, Issue No. 159, 5th September 1994, p. 13)

Saint Ouen Plant – Exemplar of Waste Incineration

Built at a cost of 1,000 M French Francs, the Saint Ouen Waste Plant in Paris is widely recognised as an exemplar of what can be achieved by waste-to-energy schemes in an urban environment.

The Saint Ouen story really begins with SYCTOM, an organisation formed in 1984 by Paris and 80 neighbouring municipalities for the purpose of treating household waste in the Paris region. Every year 2.2 million tonnes of refuse is produced there by about 5,000,000 inhabitants.

SYCTOM currently owns three incineration plants at Issy-les-Moulineaux, Ivry and Saint Ouen. The Saint Ouen plant, commissioned in 1990, is the third waste treatment plant constructed on the same site. The first was built in 1896, and the second in 1954.

The design and construction of the third plant had two major objectives: protection of the environment and improving the image of Paris. SYCTOM therefore required that the plant should satisfy environmental standards and should have an aesthetically pleasing design.

Apart from the architectural aspect, then, the Saint Ouen plant has four distinctive main features:

1. Ever greater levels of environmental protection

The plant was designed to eliminate noise and noxious odours, so that it could be integrated into an urban environment. To control air pollution, the plant is equipped with electrostatic dust filtration, followed by a water-and-lime wet flue gas scrubbing unit which meets the standard required by forthcoming European legislation. All liquid effluent is stored and treated before being returned to the sewer network. An analytical system enables the plant operator to check at any moment that the pollution control systems are operating as effectively as possible.

2. Automatic operation

A digital control-monitoring system guarantees optimum performance of all equipment with the minimum of intervention.

3. Energy recovery

The efficiency of energy recovery is over 80%. This high figure is achieved due to the city's district heating network, which is able to absorb all the steam generated by the plant throughout the seasons. As a result of these steam sales Paris has some of the lowest waste treatment costs in France. The plant is also equipped with an 11 MW turbine generator set which produces the 5 MW or so required to service the plant itself and a surplus sold to Electricité de France.

4. Technological and design options

These options relate mainly to the furnaces, boilers, cranes and flue gas treatment. The three 28 tonnes/hour furnaces produce less than 1% of non-combustible materials in the ash during normal operation. The boilers are not easily clogged up by fly ash. As for the cranes, maintenance has been reduced considerably by using automatically-controlled variable speed motors. Finally, operating flexibility has been increased substantially by the introduction of two parallel flue gas treatment lines for each boiler, avoiding total shutdowns of the furnace-boiler units when maintenance of the gas clean-up system is required.

The overall result of these features is a plant with a remarkable production capacity and a utilisation factor in excess of 85%.

In 1992, the Saint Ouen plant incinerated 635,000 metric tonnes of wastes, producing 1,536,000 tonnes of steam and 52,000 MWh of electricity. In addition, 12,000 tonnes of scrap iron were recovered and recycled.

Thus, the Saint Ouen plant is an excellent example of integration into the urban landscape and benign impact on the environment – proof that a well-designed and well-operated plant can provide an economic solution to municipal waste disposal.

(Source: Extracted from "Domestic Waste Treatment in Large Cities – the Example of Saint Ouen", *Review*, Issue 22, May 1994, pp. 28-29)

Waste Plastics as Powdered Fuel

The Plastic Waste Management Institute, jointly with Mitsui Engineering & Shipbuilding Co., Ltd., Japan, has established a basic technology for utilizing waste plastics, which have a high heat of combustion, as a powdered fuel for power generation boilers.

Coal and other fuel resources are powdered for use as boiler or coke furnace fuel. Basic research to commercialize the technology was started in 1993 to utilize waste plastics as a powdered fuel in the same way as powdered coal.

With the new technology, waste plastics not containing metals, halogenated substances, films, or other wastes are pulverized and sprayed pneumatically into a boiler with a fixed-rate feeder for combustion. In experiments, improvements were made in the pulverizing technology used for producing powdered coal and on the combustion technology for recovering the energy most efficiently.

Four plastics were tested: polyethylene (PE), polypropylene (PP), polystyrene (PS) and poly-ethylene terephthalate (PET); and actual wastes such as foamed styrol fish box blocks, and PE and PP packaging film particles.

Mitsui Mining Co., Ltd. and Plastic Waste Management Institute jointly developed a system using 0.18 kW of power per kilogram of waste plastics to convert the plastics into pulverized

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SMALL SCALE WIND ENERGY SYSTEMS

Published with financial support from the Netherlands Ministry for Development Cooperation
Editors: Goezinne & Veldkamp, Renewable Energy Consultants

EDITORIAL

One of the classic problems of water pumping lies in the crank mechanism, which converts the rotating motion of the rotor into the up-down motion of the piston pump. To obtain small forces in the pump rod, one would like to have minimum piston area and maximum stroke. However, a large stroke brings two unwanted things: large sideways movement of the pump rod and large acceleration forces. By coincidence two interesting solutions to the problem are presented in this issue: one developed in Nicaragua, and one developed by IT Power in the UK (based on a principle patented around the turn of the century!).

Dick Veldkamp/G&V

LMW Reborn

New support for LMW

LMW, a well-known Dutch supplier of small wind turbines for battery charging and water pumping, recently got new impulses in its efforts to serve its existing market and to explore new ones. Lack of capital prevented further growth and Mr Johan Kuikman, the managing director of LMW, had been looking for fresh capital during some time. Eventually he succeeded in this by finding a new shareholder: Mr Paul Hensing and the support of a financial institution: the Triodos Bank. Paul Hensing may be considered to be an expert in the field of wind energy, his latest affiliation in this field being the managing director of Windmaster Netherlands. Also the Triodos Bank is a well-known party in wind energy. It participated in a number of wind farm projects and created a wind fund for small investors. The full name of LMW changed from 'LMW Windenergy B.V.' in 'LMW Renewables B.V.', indicating a wider range of products.

What is going to change?

LMW has traditionally been serving the Western European market, of people who live in remote regions (e.g. Scandinavia and Ireland); people who want an electricity generating system for their holiday homes, caravans, boats; scientific institutions (e.g. meteorological institutes) and telecommunication purposes. In this market segment a growing interest can be observed of individuals, who have a connection to the grid, but wish to cover their own electricity consumption in a clean way, with a grid connected PV-system or wind turbine. LMW considers this market to be its home market and will not change its efforts to serve it.

In recent years the increase of the turnover of LMW especially came from the developing countries and the Eastern European countries. Larger projects were carried out in these countries: in India LMW supplied 22 turbines in the range 600-3600 W for households and community centres in a number of villages in the Uttar Pradesh region; in Indonesia LMW supplied about 40 wind turbines in the range 250-2500 W, with which two villages near Jepara were completely electrified, regarding their need for electricity for lighting and small electronic equipment. In Russia LMW supplied about 40 wind turbines in the range 1-10 kW in severe continental climate conditions for farmers and scientific institutions.

In these countries a growing interest is observable with the governments to bring electricity to remote and isolated regions by means of wind or PV-systems. With respect to this market, LMW changed its policy. The wind turbines in the above mentioned projects in Uttar Pradesh, Jepara and Khabarovsk were mainly produced by LMW in The Netherlands. Enabled by broader financial possibilities, thanks to the new financiers, LMW is aiming at setting up joint-ventures in these countries for local production together with a local industrial partner. The advantages are obvious:

- the price of the wind turbines can be reduced with 30-50%;
- maintenance can be organized by the local joint-venture, which will also keep a storage of spare parts;
- increase of highly valued employment;
- reduction of the foreign currency component in the national energy expenditure.

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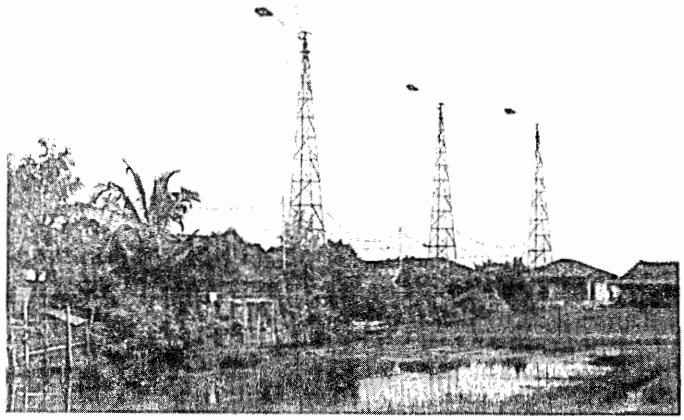
LMW Reborn

From P. 1

As a result of the lower prices, it becomes far more feasible to bring electricity to the remote and isolated communities and to improve their standard of life. The main conditions which must be fulfilled for setting up such joint-ventures are in the first place (of course) the presence of a local market, and in the second place the presence of a concrete, large project to start with. A large project is essential for starting up: it offers continuity to the joint-venture during the first two years and it enables the completion of technology transfer, training and technical and management assistance. After these two years the joint-venture must be considered to be able to perform its own business with incidental support.

Finance

For such a large project LMW can act as an intermediary for finance. The Dutch Government is providing grants for environmental projects in developing countries up to 45% of the project costs. If a significant portion of the project is produced locally (max. 40%), the foreign currency part of the project can be limited until only 15% of the project costs. Furthermore both the Dutch Government and the European Commission are providing loans and grants for feasibility studies, technical and management assistance and training and both are eventually willing to participate in the equity of the joint-venture. LMW is now discussing new large projects in Russia, China and Indonesia.



Electrification by application of LMW wind turbines of a village near Jepara (Indonesia).

Joint-venture experience in Russia

In Russia a joint-venture has been established between LMW and Dalreo, a Russian industry. This JV, called LMW Windenergy Company, has been operating for the last 2½ years and the prospects are very promising. In the set-up of this JV, LMW learned about the necessity of the presence of a large project in the starting phase. The Russian JV started without such a project and though the turn-over was satisfactory, it was very hard to finance and organize proper training and assistance. This JV is now discussing a large project in Russia to take care of this omission.

Cont. P. 3

Development of a New Small Windpump for Manufacture in Developing Countries

IT Power has developed a new innovative design of mechanical water-pumping windmill suitable for rotor diameters of two to four meters. The initial design work was carried out under the European Community JOULE I Programme and during 1993/94 testing and design modification of a prototype was carried out in the UK with the support of the UK ODA (Overseas Development Administration). As part of this latter project, collaborative links were established with six manufacturers from developing countries who were interested in manufacturing such a design. These collaborators are from Zimbabwe, Botswana, India, Indonesia and Mongolia and in July 1994 all visited the UK to see the prototype and comment on design issues.

The first IT Power small windpump prototype consists of a 3 m diameter rotor with sixteen blades. The tower is fabricated from steel angle section. It is three cornered, offering a small but useful economy in materials and construction compared to a four cornered one. Using a steel angle section design has enabled a kit construction to be produced, which can be easily assembled. The tower is hinged at the base to allow the whole machine to be assembled horizontally at ground level. It is raised using an A-frame and hand operated winch.

The windpump is innovative in having a form of epicyclic rack transmission mechanism that produces a quasi-constant torque load (combined with speed reduction) which addresses the start-up problem common to conventional crank driven windpumps. Conventional sinusoidal (crank) mechanisms always have the disadvantage that the stroke is twice the crank throw, so a short crank throw eases starting but also results in a short stroke (which is a disadvantage) while the new mechanism is unique in making the torque radius for starting (equivalent of the crank throw) independent of the stroke. It is also mechanically simple as it only requires two rolling element bearings plus two more to support the rotor. Conventional windpumps demand significantly higher wind speeds for starting

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LMW Reborn

From P. 2

Price and exploitation costs consequences

As mentioned before, by producing locally the price of the products can be reduced with 30-50%. This means for instance that a 250 W wind turbine can be offered for less than US$ 1000. In Indonesian conditions (average wind speed at 'good' locations only 4 m/s), a 250 W wind turbine produces sufficient electricity to cover the need for lighting and small electronic equipment of 3 households. With a soft loan for 8 years these households should pay about US$ 4/month for an average consumption of 100 kWh/year. So even in the less favourable wind regime of Indonesia wind generated electricity is within reach of large groups of households. The amount of US$ 4/month is without compensation for saved fuel, which is presently subsidized by the Indonesian Government.

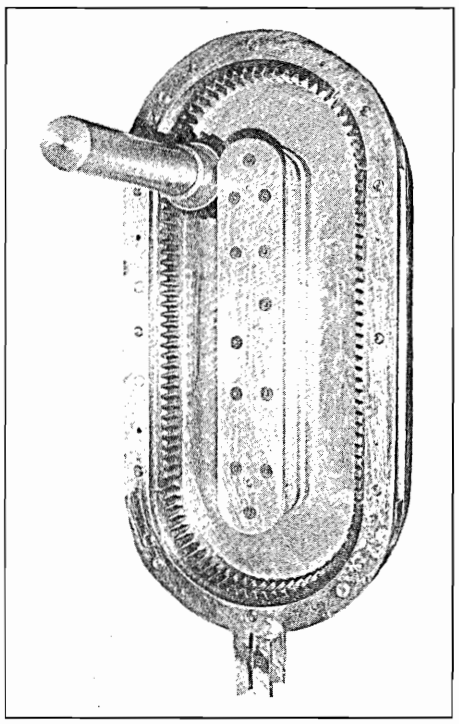
Paul Hensing, LMW, Groningen, Netherlands

Development of a New Small Windpump for Manufacture in Developing Countries

From P. 2

than to keep the system running due to the fact that the starting torque requirement is generally of the order of 300% of the mean running torque. The new mechanism offers useful improvements in performance either by reducing the cut-in wind speed for a given pump size and head, or by allowing a larger pump size to be used for a given cut-in wind speed.

Preliminary monitoring results indicate that efficiencies of over 20% are achievable over the wind speed range 4 to 5 m/s. The new windpump starts in wind speeds around 3 m/s, depending on pump bore, head and un-counterbalanced transmission mass, and runs down to around 2 m/s even without counterbalancing. Conventional cranked commercial windpumps generally perform with efficiencies in the 15 to 20% range with starting at around 4 m/s.



The new IT Power Windpump gearbox – an innovative design.

There are indications that starting wind speeds could be further reduced by rotor optimization. In addition a limited study has been made which assesses the effect of counterbalancing the system. Further work is both of these areas will be undertaken during the next phase of work to develop the design.

To protect the windpump in high winds an automatic furling system was incorporated. This is achieved by allowing each blade to rotate about its central axis and thus turn edge-on to the wind. The blade movement is driven via a mechanical linkage from a drag-plate located above the transmission mechanism and behind the rotor. This is spring loaded so that the wind needs to reach 10-12 m/s before the drag plate can be displaced causing the rotor blades to furl. It has been concluded that this furling system when fully developed would be more suitable for larger machines, hence it is intended that future designs of this machine will incorporate a traditional tail furling system.

P. Fraenkel, F. Crick & R. Barlow
IT Power Ltd, The Warren, Bramshill Road, Eversley, Hants, UK

Success of Rope Windpump in Nicaragua

Development of the rope windpump

The rope windpump was developed in Nicaragua during the last four years, and is a combination of a modern low cost windmill and a classic rope-and-washer pump (see RERIC Vol. 16, No. 3). The rope-and-washer pump consists basically of a rope-without-end with pistons on it (in the most simple version these may be wooden disks), which fit into a standard PVC-pipe with a small clearance. The rope is led over a driving wheel at the top end of the pipe, and over a guiding block at the pipe bottom end. By rotating the wheel the rope is pulled up through the pipe; in this way water is lifted by the pistons.

Development was started by choosing a simple but proven pump type. In 1989 a good rope-and-washer-handpump existed (bomba de Mecate), which during 8 years had been developed into a simple, reliable and cheap machine. In practice it was shown that users could (and did) maintain it themselves. More than 5000 pumps of this type have been installed now in Nicaragua.

The first rope windpump had a low solidity rotor and a fixed (non yawing) head. This was possible because in Nicaragua the wind is predominantly from one direction. In 1990 a safety system was added, and several rope windpumps were installed. These pumps were visited regularly to observe technical and maintenance problems. Where

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Success of Rope Windpump in Nicaragua

From P. 3

needed the design was changed and the number installed rose to 25 by the end of 1993.

Actual design

In the actual design the rotor is able to turn: the safety/yaw system is based on a modern CWD design, and consists of an eccentric, low solidity rotor and hinged tali vane. The rotating movement of the rotor and rotor shaft is directly transferred by rope and pulley to the pump shaft. A second pump shaft pulley pulls up the pump rope with PE-pistons through the pump tube; in this way the water is lifted. Acceleration forces do not exist in this design, since both the transmission and the 'pump rod' have a continuous, rotating movement. Hardwood oil-soaked bearings are used throughout, because they are cheap and durable.

A slotted pump shaft bearing allows the mill head to rotate some 300 deg, but naturally the rope windpump is most efficient if rotor is perpendicular to the wind. In case of back winds or storm the rope 'automatically' comes off, leaving the head free. At this moment tests are going on with the head that can turn around completely.

The welded rotor has 4 or 6 blades; the spars and the shaft are made of tube to reduce weight. The mill head is a welded angle iron construction. The 3-legged tower is welded, and the foundation is made of angle iron with a reinforced concrete base.

As a backup system a handle can be mounted on the pump shaft and water can be pumped by hand in case water is needed on days without wind.

Technical data of rope windpumps

Rotor diameter	2.4m	3m
Maximum pumping head	25 m	50m
Water output (10 m head, wind speed 4.5 m/s)	18 l/m	35 l/m
Tower height	7 m	10 m
Investment cost	US$ 370	US$ 600

Production, installation and maintenance

The workshop in Managua that developed and now produces the windpump has sold some 40 machines until now. Of these, 60% is sold to farmers, mostly for cattle watering and domestic use. The others are for irrigation, and are mainly financed by local development organisations. The time to produce a windpump with low or medium skilled personnel is 50-100 hours. For the production only basic tools are needed, such as welding equipment, drills, a grinder, and hand tools (no lathe is necessary). The complete windpump can be transported in a small pick up-truck. The installation takes 4-6 hours, together with the future users, which are instructed on-the-job. The maintenance basically consists of adjusting the pump and the transmission rope, and adding some oil in the bearings every month.

Problems

Like in most developing countries, the purchasing power in Nicaragua is low, and loans are expensive or hard to get. Fortunately some local organisations will now start a credit programme for windpumps. During the first two years there were also several technical problems with rotor and tail construction and the rope guiding block: improvements were necessary. A more difficult problem is convincing the users that preventive maintenance is necessary, such as adjusting the transmission rope before it starts slipping. experience shows that it takes one or two 'burnt' ropes before the users see the need for maintenance.

Conclusion

It is interesting to see that even the first rope windpumps installed are still in operation and being maintained. The reason seems to be that the rope windpump has no hidden 'complicated' parts and with some explanation anybody understands how it works. Because of this the user can maintain the pump himself without the help of an 'expensive' technician. Another reason of course is that the investment cost are quite low.

Latest news

Recently a windpump with 3.6 m rotor diameter was made for places with lower wind speeds; three of these have been installed so far.

Dick Veldkamp/G&V
(based on information from Henk Holtslag/Nicaragua)

Citation is encouraged on the condition that the source is indicated.
Reactions or other contributions are welcomed. Please write to:
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SELCHP

The South East London Combined Heat & Power (SELCHP) plant began operating commercially at the beginning of the year, and will turn household and commercial waste from neighbouring London boroughs of Lewisham and Greenwich into electricity.

The £90 million plant is the result of a joint initiative by three London boroughs which in 1986 perceived a need for an alternative disposal route to their rapidly filling landfills. Shareholders in the SELCHP plant include Associated Energy Projects (AEP), Martin Engineering Systems, and Lewisham and Greenwich Borough Councils. The 5.5 acre site location takes advantage of existing roads, and is convenient for the electricity distribution network.

Two identical incineration lines will be fed by overhead cranes taking waste from bunkers which have a four-day capacity, enabling waste to be stored over holidays and weekends, vital to maintain a 24 hours a day, 7 days a week operation. Each of the two furnaces can burn 29 tons of waste an hour on Martin grates. High pressure steam from the boilers feeds a single 31 MW steam turbine, and when exhausted is condensed in air-cooled condensers. Pollution control equipment includes acid gas scrubbing and bag filters to trap dust and particulates. On-line monitoring of the plant's operation will be available at Lewisham's Environmental Health Department offices.

Robert Wheatley, managing director of SELCHP, explained that most of what is emitted from the 330 foot high chimney is steam, and invisible except on cold damp days. "Neighbors have assumed that the plant is not operating when they have seen no visible signs from the stack for several days".

Close cooperation with residents living close to the site was an important part of SELCHP's planning and development, and residents continue to be involved with the plant's efficient functioning.

(Source: Extracted from "SELCHP", *Warmer Bulletin*, No. 42, August 1994, p. 19)

Waste Plastics as Powdered Fuel

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particles with a diameter of 320–480 µm. Mitsui Engineering & Shipbuilding and Volcano Co., Ltd. applied their combustion technologies to solve the problem of plastic melting before combustion as fuel.

At present, 30% of plastics is burnt in heavy oil, but when working a 600-kg capacity boiler for 8,000 hours throughout the year, the cost of the plastic fuel will be about ¥23/kg, comparable to or less than that of heavy oil, and the cost will be reduced further with a larger boiler.

According to calculations by Plastic Waste Management Institute, when installing a waste plastic pulverization system for a boiler with a treatment capacity of 600 kg/h, the pulverized plastic fuel can be produced at a cost comparable to the procurement of class C heavy oil. An investment of about ¥400 million will be required for the acceptance facility, pulverization facility, fuel storage facility, fuel supply facility, and boiler remodeling cost, which can be depreciated in 15 years through fuel cost reduction.

The pulverized waste plastic fuel emissions contain levels of NOx one-half that generated by pulverized coal combustion and one-third that by petroleum combustion, while no SOx is generated. This will encourage commercialization from the aspect of environmental preservation.

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(Source: Extracted from "Technology for Utilization of Waste Plastics as Powdered Fuel", *New Technology Japan*, Vol. 22, No. 4, 1994, pp. 36-37)

Thailand to Curb Energy Consumption of Buildings

High energy-consuming buildings in Thailand face a hard time in the new energy-saving era. In early August, 1994, the National Energy Policy Office (NEPO) announced it will support the Energy Conservation Act BE 2535, which will control electricity consumption volumes. The measures, ruling that any building's annual energy consumption must not exceed 1,000 kilowatts, are expected to go before the Cabinet for approval shortly before taking effect in three to four months.

According to Kecha Thirakomen, Environmental Engineering Consultants (EEC) Co Ltd's managing director, buildings which were completed a long time ago would be affected because they will be under the tight control of the NEPO's committees. In addition, it is difficult to change the designs of these buildings to reduce energy consumption.

He added that the only method to solve the old buildings' problem is to change the types of electrical appliances and lighting sources, which will help decrease energy consumption.

The government has allocated 6 billion baht (around 240 million dollars) for energy saving funds to assist project owners in case their buildings must be adjusted. However, the building owners have to set an appropriate and reliable plan to cover the improvement so as to get approval and funds from the government.

The fund idea has been copied from the energy conservation regulation of Singapore, which has proved very successful. However, the Thai government has applied some portions of this only.

There is a good trend in energy conservation among developers of building projects, Kecha continued. Currently, the developers are much more willing to accept a trade-off at

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New Energy Efficient Ultraviolet System for Water Purification

The Energy Efficiency Project is collaborating with Lawrence Berkeley Laboratory (LBL) on a demonstration of how ultraviolet (UV) light disinfects drinking water effectively and inexpensively. Researchers expect the technology, which disrupts the DNA in bacteria cells and destroys their ability to reproduce, to have a dramatic effect in countering cholera, typhoid, dysentery, hepatitis, and other common water-borne diseases. In addition to human health benefits, using energy-efficient UV light for water purification offers an environmentally sound alternative to the traditional practice of boiling water, which contributes to greenhouse gas emissions and deforestation (for fuelwood). Boiling water is now the most commonly used method of purifying water in Latin American, Asian, and African countries.

Research into the process began in 1993, and researchers' analyses showed that a UV-based disinfection unit can purify drinking water for as little as half to one U.S. cent per metric tonne. Thus, it would cost between two-and-a-half and five U.S. cents per capita annually to disinfect the drinking water for a typical village resident. The team also found that UV disinfection will be effective against the new "Bengal" strain of cholera that is sweeping South Asia, against which there is still no vaccine.

Since UV purification is very energy-efficient (it is 40,000 times more efficient than boiling water over a cookstove), the Energy Efficiency Project and the U.S. Department of Energy's ADEPT Program provided funding to support research into its application. This and other funding were used to improve the physical design of the disinfection unit. The newly designed unit uses 254 nanometer wave-length rays produced from a low-pressure mercury arc. Hydraulic testing demonstrated that this unit, which uses a single 40-watt UV lamp (similar to a fluorescent lamp), is capable of treating 30 liters (approximately 8 gallons) of water per minute even under worst-case scenarios of poor water quality and decreased UV output.

Technology Application

A workshop lead by the researchers was organized by the Orissa Renewable Energy Development Agency (OREDA) in Bhubaneswar, India, which planned to define and organize field tests of the UV units in the monsoon season. The workshop was successful: OREDA was able to organize financial and technical support for testing 41 purification units throughout the country. In early June 1994, UNICEF India granted funds for the units to be built and tested in India this summer. Data from the first field tests should be available from the local Indian organizations

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Thailand to Curb Energy Consumption of Buildings

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the beginning and harvest profits in the long term from an energy conservation design.

For old buildings, it is good to renovate and change the original materials simultaneously. Usually, the buildings will be renovated every 5-10 years to maintain the shape and condition. In particular, Central Department Store Lad-prao has just replaced its original building materials with energy-conserving ones and decorated the shopping centre at the same time. The method could be applied to other buildings as well.

Air-conditioning consumes the most energy in every type of building. Therefore, the success of an energy-conserving system will be dependent upon the air-conditioners. Currently, there are new air-conditioning systems which absorb less energy, but the price is higher.

Contractors will be able to negotiate a lower price in case a project wants many units of the new system. For example, Seacon Square Development Co Ltd was able to purchase York energy-saving air-conditioners at the same price as common systems.

"Besides changing the system, Thais must also change their behaviour, and not prefer low temperatures," says Somchai Khuvasanond, SEM Engineering Co Ltd's deputy managing director.

Usually, air-conditioners are set at 24-25° Celsius which is suitable for local weather, but many people want it colder. A one degree Celsius lowering results in 7-9 per cent more energy consumed. The government should educate people about this, Somchai said.

According to Pareuhut Ungsakul of Plan Architect Co Ltd, to save energy, the architect needs the cooperation of a project's owner. The architect is only able to introduce energy-saving materials if asked by the project's owner. But sometimes, the owners do not understand the benefits involved.

Most projects in Bangkok are high-rise buildings that use mirror exteriors due to their light weight, wind-resisting and rust protection qualities.

Jindarat Uamsuk, project architect of Design 103 Co Ltd, says that double-glazing diminishes heating and noise levels. The most obvious example can be seen at Vanich Building II which has been called the most economical building in Thailand, he added.

Although double-glazing is 10-20 per cent cheaper than reflective mirrors, owners prefer to use the latter because of their beauty.

"Every concerned party, the architects, the engineers and the project's owner, should understand and cooperate to solve the problem. So far, the owners do not want to invest much. But the regulations which will be effective soon will encourage them," noted Jindarat.

(Source: Extracted from "Steps under way to cut power usage at buildings", *The Nation*, Monday, August 22, 1994, p. E8)

New Energy Efficient Ultraviolet System for Water Purification

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in November.

Future work on the UV purification technology will expand the field testing in India and extend the project to other countries. Both Mexico and Brazil have expressed interest in the system. Technical issues currently being addressed are the testing and availability of suitable electronic ballasts and UV reflectors for use in the purification units. The project's ultimate goal is to make inexpensive (under US$100), locally built, easy-to-use UV water purification units available in developing countries. These units would be capable of disinfecting 30 liters of water per minute using the same amount of electricity required to operate a single light bulb.

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(Source: Extracted from "New Ultraviolet Water Purification System Proves Energy Efficiency Technology has Direct Health and Environmental Benefits", *Global Efficiency Monitor*, October 1994, pp. 3-4)

Transnational Power Development in Indochina

In Indochina, large energy resources, such as hydro, coal and natural gas have a promising potential for transnational power development. This will enable a country to develop large indigenous resources and trade through an electricity network, otherwise these resources will be less attractive to develop. The energy trade in the form of electricity is therefore one of common interest. The power system interconnection will enable the participating countries to exchange power economically, share a spinning reserve, enhance their reliability levels, and undertake peak lopping.

Energy Resources Potential

The subregion consisting of: Cambodia, Lao PDR, Myanmar, Thailand and Vietnam, is rich in energy resources such as hydro power potentials, coal deposits and natural gas.

Hydro resources are abundant especially in the upper regions of the main water basins of the Mekong and Salween rivers.

The total economically exploitable hydro resources in this subregion are estimated at nearly 700 TWh average annual production capacity, comprising Cambodia 41 TWh, Lao PDR 102 TWh, Myanmar 366 TWh, Thailand 49 TWh and Vietnam 82 TWh. But so far only 2% has been developed in Lao PDR (1.1 TWh), Myanmar (1.1 TWh), Thailand (4.6 TWh), and Vietnam (5.8 TWh), which covers some 13% of the total electricity consumption in this subregion.

As for oil and gas resources, they are developed in Myanmar, Thailand and Vietnam. There is potential for more extensive use of natural gas based on newly discovered reserves in these three countries. The total resources are estimated at approximately 2,200 M tons of oil and 570 billion cubic meters of natural gas, while present consumption is 23.5 M tons of oil and 5.5 billion cubic meters of gas.

Thailand's Cooperation with Neighboring Countries

At present, Thailand has a power system interconnection with Lao PDR and Malaysia, and is cooperating on energy resources development with Lao PDR and Myanmar.

Thailand – Lao PDR

Thailand purchases power from the Laotian hydroelectric plant in Nam Ngum on the Mekong River, north of Vientiane. The first phase of this interconnection with 30 MW capacity was completed in 1971 and the second phase of 80 MW in 1978. The $25 million earnings represent about one half of Laotian annual export income.

Further downstream of Mekong, Thailand sends a smaller amount of power back to two Laotian towns remote from the Vientiane power grid.

In June 1993, the Government of Lao PDR and the Government of Thailand entered into a Memorandum of Understanding (MOU) under which the Laos Government agreed to

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Guide to Energy Efficiency and Renewable Energy Programs

The Global Energy Efficiency Initiative (GEEI) has prepared a guide for developing countries that summarizes U.S.-based energy efficiency and renewable energy programs. The guide is intended to help developing countries find resources to carry out their own sustainable energy projects.

The guide will provide two types of listings:

- programs that provide assistance in energy efficiency and renewable energy; and
- organizations with expertise or interest in these fields.

Listings will be grouped under the categories of funding, information, professional exchange, technical assistance, and training.

For further information or to obtain a copy of this publication, contact:

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(Source: Extracted from "Guide to Efficiency and Renewable Energy Programs", *Global Efficiency Monitor*, October 1994, p. 8)

Energy Consumption, Carbon Emissions to Grow

Energy consumption and resulting carbon emissions are projected to rise twice as fast in the Third World as in the industrialised countries, according to a US Department of Energy report.

The report, "International Energy Outlook 1994" estimates that energy usage in the developing world will grow at the average rate of about 2.7 per cent a year between 1990 and 2010 compared with an average growth rate of 1.4 per cent per year for the industrialised countries over the same period.

The differing mix of energy sources used by industrialised and developing countries explains the differences in their shares of carbon emissions. The report notes that developing countries use more fossil fuels than nuclear or hydroelectric power. As a result, developing countries could generate more carbon emissions and yet consume less total energy than the industrialised countries.

In addition, the study notes that the industrialised countries will increasingly rely on cleaner natural gas than more polluting coal, which will continue to be used heavily in developing countries.

However, the study notes that the share of total carbon emissions in industrialised countries is decreasing, its fossil fuel consumption per capita is high compared to that of developing countries. The study estimates that if developing countries consumed as much energy per capita as the industrialised countries, the carbon emission outlook for 2010 would have been about five times worse.

Among the industrialised countries, the United States remains the biggest polluter with the highest per capita of carbon emissions in the world through the entire 1990-2010 projection period. But like the other industrialised countries the level of carbon emissions is expected to remain stable.

Among developing countries, China is the greatest polluter. Total Chinese carbon emissions are expected to increase by an average of 3 per cent per year over the projected 1990-2010 period, with increased burning of coal, the chief source of pollution.

(Source: "World Energy Outlook '94: Energy Consumption, Carbon Emissions in Third World to Grow", *Progress*, Vol. XXXXI, No. 2, September 94, p. 2)

Transnational Power Development in Indochina

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supply and the Government of Thailand agreed to purchase, up to 1,500 MW of electricity by the year 2000.

Thailand – Malaysia

The power system interconnection between EGAT (Electricity Generating Authority of Thailand) and TNB (Tenaga Nasional Berhad) of Malaysia was first energized on February 1, 1981. The interconnection consists of a 24.5 km single circuit 132 kV transmission line linking Sadao Substation of EGAT and Chuping Substation of TNB; and two 115/132 kV transformers, rated 66.7 MVA each, installed at Sadao Substation.

Despite non-synchronous operation due to its small size, the interconnection has proven to be very beneficial to both EGAT and TNB over the past 12 years of operation, especially during crisis situations.

The second interconnection (Hat Yai 2 Substation in Thailand – Chuping Substation in Malaysia) has been approved and is expected to be completed in April 1997.

Thailand – Myanmar

A number of border hydroelectric power projects can be developed under Thailand-Myanmar cooperation. There are 8 projects which could be constructed such as Mae Sai Hydro Project, Klong Kra Project, Upper and Lower Salween Projects, Nam Moei 1, 2 and 3 Projects and Mae Kok Project. The total capacity is 6,400 MW with an average annual power generation approximately 37,000 GWh.

At present, Thailand and Myanmar have agreed in principle to develop 2 projects: Klong Kra Project (130 MW, 238 GWh), and Mae Sai Project (12.8 MW, 64 GWh) and the other projects are still under consideration.

Power purchase from Vietnam and Cambodia has not yet materialized. However, in the past, Electricity of Vietnam proposed that EGAT should buy electricity generated from a hydro electric power project, located in the northern part of Vietnam, and passed through a 500 kV high voltage substation which would be constructed at Danang in Vietnam. The transmission line could be connected from the high voltage substation at Danang, passed through Savannakhet in Lao PDR to Mukdahan Province in Thailand.

Conclusion

Based on geographical considerations, Thailand has the possibility of substantial interconnection with other countries. In the long-term and given the right political conditions in the Indochina peninsula, it can act as the intervening grid to bring power to or from the rich hydroelectric potentials of the Salween and Mekong Rivers at the boundaries with Myanmar, Laos and Cambodia.

Cooperation over electricity production among the countries would support the development and management of energy resources, which is a basic component in strengthening the socio-economic development of each country as well as the socio-economic development of Indochina as a whole and its neighbouring countries. Joint efforts to secure energy resources are among the key cooperative actions in the national and regional development programmes of Indochinese countries.

(Source: Extracted from "Transnational Power Development" by Somvonk Poshyananda, *Abstracts & Proceedings: Techno Indochina*, The International Congress on Science and Technology for Cordial Relationship with Neighbouring Countries, 18-24 August 1994, Bangkok, Thailand, pp. 266-273)

China's Energy Development

Since the introduction of economic reforms and the open-door policy started 15 years ago, China's annual GNP growth rate has averaged at 9.6 percent. In 1993, China's GNP stood at US$500 billion, 13.4 percent higher than that of 1992. Energy supply is one of the strategic problems for China. The rapid economic growth creates a huge demand on the energy supply. This is both a real challenge and a great opportunity for the development of the energy industry.

In 1993, China generated 0.81 Tera kWh of electricity, 700 kWh per capita, which is only half of the world's average and 1/15 of that in industrialized countries. In the next 3-5 decades, it is expected to increase by 10 times in order to reach the level of middle-level developed countries. It is estimated that China will add 15,000 MW in power generating capacity annually, thus doubling the scale of power production by the end of the century.

China possesses abundant energy resources. She ranks first in the world in hydro potential with 2,000 Tera watt hours (TWh) per year, but only 9 percent is exploited. She ranks third in coal reserves with proven deposits of 1 trillion tons.

The known oil reserves in 1993 stand at 78.75 billion tons, and natural gas at 3.33 trillion cubic meters. The renewable resources, such as solar, wind, geothermal, tidal, and biomass energy, have even greater potential.

Between 1981-1990, China's primary energy production and consumption increased by 5 percent every year. In 1992, China's primary energy output reached 1.072 billion tons of standard coal equivalent. Coal accounted for 75 percent of the energy supply for the nation.

According to a recent study, in the foreseeable future, coal will remain the primary source of energy, and make up 70 percent of total consumption.

In the year 2000, China is expected to produce 1.5 billion tons of coal, 165 million tons of oil, and 25 billion cubic meters of natural gas.

There exists great potential in energy conservation. China's unit GNP energy consumption is 4-5 times higher than that in the developed countries. Its coal utilization efficiency is 20 percent lower, while the electricity loss during transmission, distribution and utilization is 16 percent higher.

The Chinese government has set the target of saving 3 percent energy annually. Although yearly energy production is projected to increase by 4 percent, there will still be a shortage of 500-600 million tons of standard coal equivalent each year, a figure which is expected to be recovered through energy saving efforts.

After decades of surveys and multi-disciplinary studies, China has launched a huge hydroelectric power scheme on the Yangtze River: The Three Gorges Hydroelectric Power Project. When completed, the 10 billion-dollar project will provide an installed generating capacity of 18 GW, among others.

Wind, geothermal, solar, tidal and bio-mass resources are widely tapped throughout the country. Today, you can see small wind generators for local households spread throughout the northwestern sparsely populated provinces. The geothermal power stations in Tibet meet over half of the power demand of its capital city of Lhasa.

New and renewable energy will gradually increase its share in the overall energy profile. In rural areas, fuel wood trees are to account for 10 percent of the new afforestation acreage by 1995.

The perspective of heavy coal consumption has caused uneasiness among the scientific community and environmentalists, who believe that the increase of CO_2 emissions will worsen the greenhouse effect and contribute to global warming. At present, no practical alternatives for both development and emission-decrease have been proposed yet. However, there are several alternatives that could help to alleviate the problem.

The protection of forests, especially subtropical forests, and a large-scale afforestation campaign would help compensate for the damage done to the atmosphere by the emission of greenhouse gases.

On the average, one hectare of forest absorbs 90 tons of carbon per year. A nationwide campaign of afforestation has been going on since the late 1970s. About 10 million hectares of mountainous areas and wasteland are afforested each year. In addition, 2.4 billion trees are planted annually in the vicinities of cities and towns. The forest coverage of the nation's territory has been increasing steadily by 1 percent each year.

The second remedy is the application of clean coal technology. For example, the Integrated Gasification and Combined Cycle (IGCC) technology for coal-power plants would reduce CO_2 by 20 percent, SO_2 by 90 percent and NO_x emissions, with no dust release at all. An agreement of cooperation on IGCC technology was recently signed by the US and Chinese governments, planning the construction of a pilot IGCC plant in China.

And obviously, further exploitation of hydro, solar, wind, geothermal and tidal power would greatly mitigate the situation.

(Source: Extracted from "China: A Land of Hope" by Song Jian, Beijing Review, August 22-28, 1994, pp. 7-10)

Algae To Reduce Emissions from Power Plants

An experimental carbon dioxide absorbing device has been established in the Yokosuka plant of the Tokyo Electric Power Company. It is a row of long, transparent tubes filled with a murky green liquid that may hold the key to reducing emissions of greenhouse gases.

The tubes, with a total length of about 40 meters, run through a room illuminated to match the relentless sunlight of a summer day.

The green substance is *nannochloris*, a type of alga commonly found in ponds and marshes, and the pipes that carry it are all part of the experimental device, one of the largest of its kind in the world.

The device is now being tested as a possible way to convert into oxygen the large amounts of carbon dioxide in the power plant's emissions.

Three years into the project, researchers at Tokyo Electric Power Co. hope that it will help reduce carbon dioxide emissions, which are considered a major cause of global warming.

So far, in experiments the device has been able to reduce the amount of carbon dioxide passed through it by about half.

If the device proves effective, it will be connected to the actual power plant for further experiments.

However, the problem is how to grow enough algae to cope with the daily emission from a large power plant.

For example, to filter the emissions produced by a 600,000 kilowatt plant, a 40-square-kilometer reservoir, approximately 860 times the size of the Tokyo Dome, would be needed to grow the algae.

They plan to carry out the first stage of operation using exhaust fumes by the end of this year, but researchers are not sure how well the algae will cope with other substances found in emissions, such as sulphur and nitrogen.

"It would be nice if the device could actually take carbon dioxide in from one end and release oxygen from the other. But that is impossible at least in the near future," says Shunji Kunito, who heads the Tokyo Electric Power Co. Engineering Research Center.

"If the device is able to reduce the gas by 10%, it would be worth it. We could install such a machine on other power plants and reduce the overall level of emission," he adds.

(Source: Extracted from "Algae gains respect" by Osamu Sakamoto (Asahi Shimbun), *Bangkok Post*, Friday, September 16, 1994, p. A2)

Vanadium Battery for Large Scale Storage

A joint research team consisting of researchers of Mitsubishi Petrochemical Co., Ltd. and Kashima-kita Electric Power Corp. (Japan) and Prof. M. Kazacos and her research team of New South Wales University (Sydney, Australia) have jointly acquired a bright outlook for the large-scale generation of electricity using a concentrated vanadium electrolyte cell.

Mitsubishi Petrochemical, on the basis of technologies for storing surplus late nighttime electricity and for backing up solar cell systems, has developed a prototype vanadium battery system jointly with Kashima-kita and the New Energy and Industrial Technology Development Organization (NEDO), and with Prof. Kazacos who possesses the basic patent relating to the technology.

The principle of the vanadium battery, or more specifically Vanadium Redox Flow Battery, is to store electricity by utilizing oxidation and reduction reactions. This principle essentially uses the phenomenon that the charges on the vanadium cations in a sulfuric acid solution are changed by cell charging and discharging. In the charging state, the vanadium ions are V^{5+} and V^{2-}. Passing this electrolyte into a cell causes the electrode to remove one electron from the V^{2-} ions which become V^{3-}, while the V^{5+} ions gain an electron to become V^{4+}, so a current is generated by electron movements when the positive and negative electrodes are joined together.

The vanadium battery is distinct in that the electricity is stored in the electrolyte, so increasing the electrolyte volume and the number of cells will enable the power storage volume and output to be increased easily. In addition, the system is operable with ease at room temperature, and is quite safe since no toxic gas is generated.

New South Wales University is already striving to develop electric automobiles and power storage battery systems using the vanadium battery. Mitsubishi Petrochemical and Kashima-kita have consigned basic research to the university and have been jointly trying to establish technologies for system scale enlargement. They have succeeded in continuous charge and discharge using a plant of 10-kW scale. Their further plan is to engage in 50 hours of continuous power generation with a plant of 50 kW class within 2-3 years, for back-up power generation by isolated island and mountain communities as well as resort centers, to develop a semi-commercial facility of 200 kW class, and to commercialize a plant of over dozens of megawatt capacity for use as a backup power generation system for late nighttime power storage.

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(Source: Extracted from "Large-Scale Storage of Electricity with Vanadium Battery", *New Technology Japan*, Vol. 22, No. 6, September 1994, pp. 33-34)

Monitoring Acid Rain in South China

The Guilin Environmental Monitoring Station in Guangxi Zhuang Autonomous Region, People's Republic of China (PRC), has started monitoring acidic particles in the city's rainfall with equipment donated by the Japanese International Group of Cooperation.

The incidence of acid rain was found to be as high as 86 to 98.5 per cent, and the annual average pH of the rainfall was 4.3, with the lowest at 3.08. In other words, nine of 10 rainfalls were acidic.

In the city of Guilin in 1993, the incidence of acid rain was as high as 70.6 per cent, and the annual average pH of the rain was 4.65.

The incidence of acid rain in Wuzhou was 45.1 to 89.4 per cent, and the average pH of the rainfall decreased annually. The sulfur dioxide-containing smog created by the Wuzhou Power Plant affected the area's vegetable production. In one case, several days after a severe rainstorm on June 6, 1991, the green pines in the Wuzhou Quedian Forest Farm turned withered yellow.

Acid rain has damaged the urban environment and virtually restricted economic development in Guangxi, say experts.

Last July, a joint scientific research project was signed between the Department of Social Development Science and Technology of the State Science and Technology Commission, PRC with the Japanese International Group of Cooperation to study the atmospheric pollution and regional acid rain particles in areas around Liuzhou.

The project's objectives are to identify the cause of the acid rain in South China, its spread and impact on the environment, as well as to offer scientific treatments and solutions.

Japan donated equipment worth 400 million yen and helped train Chinese technical personnel to use it. The project was officially launched on July 1, 1994 in Liuzhou, Guilin, Wuzhou and Guangzhou, and will be completed within a year.

(Source: Extracted from "Scientists study cause of acid rain in South China", by Xu Jianguo, *China Environment News*, No. 61, August 1994, p. 2)

Book Review

European Directory of Renewable Energy Suppliers and Services 1994

Edited by Bruce Cross
James & James Science Publishers Ltd.
5 Castle Road, London NW1 8PR, England
ISBN 1-873936-26-5, May 1994, 484 p.

This is the largest and most comprehensive annual guide to the renewable energy industry. It is the fourth edition of this Directory. It continues to grow, and now has the details of over 5,000 companies and organizations included in listings (compared to about 4,000 companies and organisations in the 1993 edition).

The directory includes a wide range of articles on Biomass, Rational Use of Energy, Geothermal, Hydro & Wave, Instrumentation & Metering, Energy Storage, Photovoltaics, Solar Thermal, and Wind Power. Updates on prospects for renewable energy in developed and developing countries, information about CEC programmes and about activities in a range of locations and disciplines is also included along with a selection of case studies showing renewable energy in action. There is a reference section with a bibliography and a list of conferences.

Companies and organisations are arranged alphabetically with a short description of each, and classified by activity.

The directory is meant for readers interested in renewable energy, it serves as a valuable reference for those who are in need of equipment or services.

The book priced at £ 49.50 or US$ 75.00 is available from:

- James & James Science Publishers Ltd., 5 Castle Road, London NW1 8PR, England. Tel: +44 71 284 3833. Fax: +44 71 284 3737;

or in North America from:

- Books International, PO Box 605, Herndon, Virginia 22070, USA. Tel: (703) 435 7064. Fax: (703) 689 0660.

Publications Received

ENERGY

* *Annual Report 1993*, Public Utilities Board, Singapore, 1994, 87 p.
* *Abstracts and Proceedings: Techno Indochina – the International Congress on Science and Technology for Good Relationship with Neighbouring Countries*, published by Thailand's National Science and Technology Development Agency (NSTDA), Bangkok, Thailand, 1994, ISBN 974-7571-59-5, 342 p.

RENEWABLE ENERGY

* *National Workshop on Renewable Energy: Improved Chulha, Kiln and Other Related Devices*, 11th – 13th December 1993, Bhubaneswar, India, Preprints, Department of Science & Technology, Government of Orissa, Orissa Renewable Energy Development Agency, and Regional Research Laboratory (CSIR), Bhubaneswar, India, 1994, 212 p.
* *European Directory of Renewable Energy Suppliers and Services 1994*, edited by Bruce Cross, published by James and James Science Publishers Ltd., London, United Kingdom, ISBN 1-873936-26-5, 1994, 484 p.

Training Courses/Conferences

Energy & Environment Expo Manila '95
17–20 January 1995
Manila, Philippines

This is the first Philippine international conference on energy efficiency & demand side management.

Suggested topics of the conference include:

Policies, plans, programs:
- Directions, perspective, policies, plans and programs of international, regional domestic institutions and agencies for economic development, environmental quality promotions, energy efficiency and DSM;
- Government role in planning for economic development and application of energy efficiency and DSM technologies;
- Environmental plans and policies promoting energy efficiency & effective long run marginal cost pricing;
- Energy efficiency DSM programs in developing countries;
- DSM in integrated resource planning.

Technologies & applications:
- Energy efficiency for town planning;
- Energy efficiency in residential buildings;
- Energy efficiency in commercial buildings;
- Energy efficiency in industrial plants;
- DSM and power quality;
- Integrated energy efficiency programs;
- Sustainable development in selected developing countries;
- Energy efficiency and transportation;
- Marketing strategies for energy efficiency;
- Selling DSM technologies to the corporate-level;
- Establishing sound environmental standards through DSM;
- Vendors' and manufacturers' perspectives on DSM and energy efficiency;
- Integrated water resource management and energy conservation programs;
- Measurement and evaluation of energy efficiency programs;
- Standards for energy efficiency;
- Motivations, requirements and incentives for DSM programs;
- Design and implementation of DSM programs;
- Master planning of DSM programs;
- High efficiency lighting systems;
- Improved efficiency motors;
- Thermal storage systems;
- Improved air conditioning systems;
- Designing buildings for energy efficiency;
- Improved design of electrical appliances; and
- Biomass cogeneration.

For details contact:

Philippine Energy Conservation Center, Inc.
Suite 6-H, 6th floor
Don Tim Bldg.
5468 Superhighway Corner Gen. Mascardo St.
Makati, Metro Manila
Philippines
Tel: 86-74-97 or 88-17-53
Fax: (632) 86-74-97

Fourth International Course on the Implementation of Wind Energy
24 April–5 May 1995
Petten, Netherlands

Wind energy is receiving increasing world-wide interest as a means for the pollution-free production of electricity. Under favourable conditions wind energy is an economically attractive option and in more technological advanced countries the technology is reaching maturity.

This course is organised by the Netherlands Energy Research Foundation, ECN and Renewable Energy Development, RED.

The emphasis of the course programme is on large scale grid connected wind energy systems. The programme has some flexibility in order to respond to the interests of the participants. Parallel lectures can be given on other wind energy technologies, such as, stand alone systems, hybrid systems, wind diesel, wind PV systems, wind electric battery chargers, and wind pumps.

The implementation of wind energy in a region or country undergoes several phases. The course programme follows these phases with particular emphasis on the **planning of wind energy, preinvestment studies, technology assessment, manufacture, installation, operation, maintenance and training.**

For further information contact:

C. Looijeseijn
Netherlands Energy Research Foundation, ECN
P.O. Box 1, 1755 ZG Petten
The Netherlands
Tel: +31 2246 4459/4364
Fax: +31 2246 3836
Tlx: 57211 REACP NL

The 4th ASEAN Science and Technology Week
11–19 August 1995
Bangkok, Thailand

It has been more than two decades since the ASEAN Committee on Science and Technology (ASEAN COST) was formed to promote scientific and technological development in Southeast Asian countries. Various achievements of the ASEAN COST are due to its role as the focal point for cooperation of ASEAN scientists, technologists and users of their work in industry, trade and the public sector. It also serves as the

focal point for cooperation with other countries outside ASEAN including Australia, Canada, European Communities, Japan, New Zealand, United States of America, and international organizations. In order to promote greater awareness of current development in, and application of, science and technology throughout the region and elsewhere, the ASEAN Science and Technology Week (ASTW) is held once every three years on a rotational basis among ASEAN countries. The First, Second and Third ASTWs were successfully organized in Malaysia, the Philippines and Singapore in 1986, 1989 and 1992, respectively.

The objectives of the ASTW are as follows:

a) to create awareness of the public of the increasing importance of science and technology in ASEAN;
b) to promote the development of scientific and technological expertise and manpower resources in ASEAN;
c) to promote the transfer of technology among ASEAN countries and from more advanced countries to the ASEAN region;
d) to provide a forum for promotion of relevant aspects of science and technology in ASEAN;
e) to promote regional and international cooperation in science and technology;
f) to provide the opportunity for ASEAN scientists and engineers to interact with their counterparts; and
g) to promote science and technology among ASEAN youths.

The Fourth ASTW will present to the public the achievements and potentials of science and technology, generated both in the ASEAN region and beyond, relevant to the rapidly increasing needs of the public and private sectors, in light of the continuing dynamic growth of the region. The theme of the Fourth ASTW is, therefore, **Science and Technology: The Future of ASEAN**.

For further details contact:

Ms. Wanasri Samanasena
National Research Council of Thailand
196 Paholyodhin Rd.
Bangkok 10900, Thailand
Tel: (66-2) 579 2285
Fax: (66-2) 561 3049 or (66-2) 579 3402

HIDROENERGIA 95
Fourth International Conference and Exhibition
18–20 September 1995
Milan, Italy

The economic, social and even cultural importance of the utilisation of small hydro power resources is widely acknowledged. In fact, it is a national resource rather than an imported product and it is non-polluting and, once implemented, unaffected by economic circumstances.

When considering the necessary environmental requirements, in most cases, the effect of small hydro power projects on the environment is beneficial.

As a consequence, Small Hydro deserves support and subsidy in both highly industrialised countries and the Third World.

In remote regions of developing countries the introduction of Small Hydro is of vital importance and, in some cases, it can even solve moral and legal conflicts between man and the environment.

Accordingly, the use of hydro power should be maintained and developed.

The International Conference Hidroenergia'95 will be the occasion to report on developments in the field of small hydro power, on operational experience, and to discuss the future of small hydro power projects in Europe and worldwide.

In this forum, countries, governments, public and private bodies, academics and individuals will be encouraged to make greater use of hydro power resources compatible with the environment.

Study tours and technical visits will be organised for participants and accompanying persons.

The topics to be discussed during the conference will include:

1. **Economic and political aspects of small hydro**
   - European strategies at local and national level;
   - Specific legislation;
   - Authorisation procedures;
   - Socio-economic aspects;
   - Current European practice; and
   - Taxes on CO_2. External costs of the energy production.
2. **Technological and engineering aspects**
   - Electromechanical equipment, including new procedures;
   - Setting and control;
   - Telemetry;
   - Hydraulic layout and civil works;
   - Transient conditions;
   - Estimation of the resources;
   - Synchronous or asynchronous generators; and
   - Refurbishment and improvement.
3. **Environmental impacts**
   - Multipurpose projects;
   - Nature and landscape conservation; and
   - Fish passage and protection.
4. **The world-wide market, European programmes and international co-operation**
   - The international co-operation programmes: case studies, know-how and technology transfer;
   - The market in the East Europe and CIS; and
   - The EC programmes: THERMIE, ALTENER, VALOREN – case studies.
5. **Financing**
   - Finance for less-developed countries;
   - Purchase and connection costs;
   - Reduced rate loans; and
   - Bank conditions and risks evaluation.

For further details contact:

FAST
Mrs. Paola Gabaldi
Piazzale R. Morandi, 2
20121 Milano
Italy
Tel: (39-2) 7601 5672
Fax: (39-2) 782 485

Diary of Events

* **23 – 26 January 1995, New Delhi, India**

Renewable Energy AsiaPacific '95

For details contact:
Ms. Cassy Kurtzman
Advanstar Communications Asia Ltd.
23/F, Tai Yau Building
181 Johnston Rd.
Wanchai, Hong Kong
Tel: +852 832 4998
Fax: +852 575 461

* **16 – 17 February 1995, Hua Hin, Thailand**

Combustion of Solids and Treatment of Products

For details contact:
Dr. Bundit Fungtammansan
Chairman of Organising Committee
King Mongkut's Institute of Technology, North Bangkok
Bangkok 10800
Thailand
Tel: (66-2) 587 4351
Fax: (66-2) 585 6149

* **22 – 26 March 1995, Beijing, China**

Hydro-Science and Engineering

For Details contact:
Mr Tan, Ying
Local Organizing Committee
ICHE'95, IRTCES
PO Box 366, Beijing 10044
China
Fax: +86 1841 1174

* **3 – 8 April 1995, Hannover, Germany**

Wind Energy Trade Fair/Energy & Environment Technology at Hannover Messe '95

For details contact:
Husum Messe GmbH, J Behnke
Leisewitzstrasse 37
30175 Hannover
Germany
Tel: +49 511 852 358
Fax: +49 511 852 564

* **7 – 10 May 1995, Kissimmee, FL, USA**

13th International Conference on Fluidized Bed Combustion

For details contact:
Mr. Steven Drenker
PFBC Program Manager
Electric Power Research Institute
3412 Hillview Avenue
Palo Alto, CA 94303
USA
Fax: +1 415 855 2954

* **9 – 12 May 1995, Noordwijkerhout, Netherlands**

11th Members Conference of the International Flame Research Foundation

For details contact:
Ms. N. van Haaster
Leeuwenhorst Congress Center
Langelaan 3, NL-2211 XT Noordwijkerhout
Netherlands

* **18 – 31 May 1995, Florence, Italy**

1995 World Geothermal Congress: Worldwide Utilization of Geothermal Energy

For details contact:
George Frye, Executive Director
International Geothermal Association
LBL 50C, Rms. 106-108
One Cyclotron Road
Berkeley, CA 94720
USA

* **22 – 26 May 1995, Singapore**

Sixth Asian Congress of Fluid Mechanics (6ACFM)

For details contact:
6ACFM Secretariat
Annabel Ooi
Centre for Continuing Education
Nanyang Technological University
Nanyang Avenue
Singapore
Fax: +65 791 6178

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Library and Regional Documentation Center, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The "RERIC News" is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership along with the other three regular publications namely: RERIC International Energy Journal (formerly: Renewable Energy Review Journal); RERIC Holdings List; and Abstracts of AIT Reports and Publications on Energy. For further details contact:

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New Hybrid Scheme for Rural Electrification – Indonesia

Thousands of households in remote Indonesian villages may be turning the power on for the first time thanks to the installation and use of pre-payment electricity dispensing meters activated by cards with magnetic strips.

Disposable magnetic cards – like telephone cards – would provide set quantities of electricity service and would be sold through local shops.

The meters and magnetic cards are one part of a new commercial model that promises to revolutionise the supply of electricity to Indonesia's rural communities and lead to its application in other developing areas, such as the townships of South Africa.

More than 60% of Indonesia's rural households, some 60 million people, are still not electrified and are forced to rely on kerosene lamps, car batteries and dry cells for light and power.

Electrification has been restricted because of the archipelago nature of Indonesia: the country is composed of 3,000 inhabited islands stretching 5,000 km from east to west and 2,000 km from north to south. This makes expansion of the public grid on a national or multi-province basis tremendous difficult and expensive. Moreover, rural demand is small scale, making the economics problematic.

The new electricity supply model aims to help overcome these problems and supply power to Indonesians outside of cities and towns in a way that they can afford and which does not require huge government subsidies.

The model uses decentralised renewable energy-based hybrid power plants for power – much lower in operating cost and environmentally benign compared with the usual diesel oil plants for small communities.

The meter prepayment system ensures village households can match their electricity consumption with their capacity to pay at any time. It also allows efficient low-cost revenue collection.

The model has been developed by the US company, Integrated Power Corp. (IPC), a subsidiary of Westinghouse, in co-operation with the PLN, the state utility and the government, technology agency, BPP Teknologi.

Hybrid generators, developed by IPC/Westinghouse, and used in several other countries since 1987, have been successfully tested in terms of their ability to provide sufficient power output for small community electrification at two sites in eastern Indonesia.

Now eight power systems are to be put in place during the next year in eastern Indonesia to test the model in its complete form. This pilot project is being funded by the government. At the same time, IPC is establishing an Indonesian joint venture company to carry out implementation of the systems.

These renewable energy-based hybrid power systems generate 60-80% of electricity through renewable energy while substantially reducing

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INNERTAP

Incorporates news from the Information Network on New and Renewable Energy Resources and Technologies for Asia and the Pacific (INNERTAP).

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Supplement: Small Scale Wind Energy Systems

New Hybrid Scheme for Rural Electrification – Indonesia

From P. 1

diesel fuel use and carbon dioxide emissions. The hybrid systems use solar-powered photovoltaic cells and wind-powered turbines, backed up by diesel generators which switch on automatically if the other sources of power are insufficient.

The system is designed to operate at full efficiency at all times while meeting wide variations in loads. The generation systems are modular and can be installed on site in four days with additional units easily added to meet increased demand – for example, from the development of small scale industry in a village. The capacity of the units is between 25-50 kW.

In the IPC commercial model, there are no connection fees, and the strategy is to improve commercial viability through a large increase in consumers. Fees for electricity are based on the market price value of the service and current cost of kerosene and battery services. Apart from household wiring, there are no upfront establishment costs that consumers must pay.

At the same time, fees remain low, because of the scale of consumer needs and because the great increase in numbers of consumers at low marginal costs allows average costs per consumer to fall.

"Each household will be connected at no charge to the community microgrid, and will have an electronic prepayment meter that dispenses electricity service based on the amount of electricity that has been purchased and stored in the meter", says IPC's Indonesia director Robb Walt.

"Virtually all consumers have the financial means to obtain basic lighting, security, information and entertainment services, and then have the flexibility to buy and use as much electricity as they wish and can afford, subject to a peak power limit of 450 VA."

The pre-payment Desa (Indonesian for "village") meter eliminates all traditional metering and billing and the prepayment system assures virtually 100% revenue collection for the utility in advance of electricity use.

"Consequently, it is more economical to use flexible power generation, distribution and sales technologies that provide a level of service that matches each consumer's existing willingness and ability to pay, while meeting the priority energy needs of all rural households," concludes Walt.

(Source: Extracted from "Indonesia's new scheme for rural electrification", *Power in Asia*, Issue No. 164, 14th November 1994, pp.4-6)

Solar Battery Charging Station – Thailand

Thailand's Department of Energy Development and Promotion (DEDP) and the Japanese organization, New Energy and Industrial Technology Development Organization (NEDO) have jointly installed a solar battery charging station on Yao Yai Island, Phang-nga province.

The solar cell station is worth 22.5 million Baht (equivalent to about US$ 0.9 million) and has been set up at Ban Prue Nai Sub-district, Koh Yao District in Phang-nga province. It is the second step of a solar cell installation project from DEDP and NEDO after the first station at Ban Bon Khao Kang Riang, in Kanchanaburi. Benefiting from the project are 147 households.

According to Prathes Sutabutr, the DEDP's Director-General, the second solar cell station can supply 40 kilowatts. The main part of the station is 780 photovoltaic modules of 53 watts each with an array support structure, a battery charging controller unit of 75 channels, and 500 lighting kits including a 120 Amp/hour battery for each household in the village. The station also includes a room for keeping control equipment and measuring devices, office buildings, staff dormitory and battery charging complex.

The service potential of the station is 75 units per day: 50 units for people and 25 units reserved for overcast days when there is not enough sunlight to produce electricity.

Each family receives the service once per 10 days and it also has a fluorescent light for use in the home for approximately 4 hours per night, depending on the electric power in the battery unit.

DEDP also assists people on the island in service management by dividing them into 50 groups. Each group has 10 families and one leader, who is responsible for taking all battery units from their group for recharging during 7 am to 8 am, and returned during 5 pm to 6 pm.

This station benefits people on Yao Yai Island where there is no electricity supply. People on the island have to use electricity from batteries and when the batteries have expired they are sent to the mainland for charging in Phuket province. With the new solar cell station people on the island can have their batteries charged locally.

The photovoltaic power generation system on Yao Yai Island is one of many research projects of NEDO, said Naoto Tashiro, NEDO Deputy Director of Solar Power Department. Such solar cell stations have also been installed by NEDO in Nepal, Mongolia and Malaysia for various research activities.

In Nepal, NEDO researches the highland weather conditions, where there are wide temperature fluctuations. The solar cell station in Nepal supplies the energy to pump water into storage tanks.

In Mongolia where people are very mobile, NEDO provided them with a portable photovoltaic power generation system. This system is being tested for the possibility of making them lighter and more compact and improving their portability and reliability.

(Source: Extracted from "DEDP, Japanese group install solar battery station" by Kittikorn Wiratworapong, *The Nation*, February 28, 1995, p.F8)

Cost Effective Photovoltaics in Kenya

Today more than 1 MW of photovoltaic power has been installed in Kenya. Around 20,000 households have purchased solar energy for their homes compared to the 17,000 connected to the official rural electrification program (REP).

Demand for photovoltaic systems has grown exponentially since the mid 1980s when Kenyan entrepreneurs realized that photovoltaics could meet rural demand to operate electric lights, radios, televisions, or stereos often at a low cost than grid connections, systems driven by generators, and the use of kerosene and (drycell) batteries. The market grew as mainly rural-based electricians linked up with urban businessmen, and formed business agreements with solar electric suppliers, primarily based in Nairobi, who supply this market.

Cost Competitive

Solar electric systems are successful despite the absence of credit facilities and despite the taxes and import duties, which, combined, amount to more than 30% of the final price users pay. At present, the household solar systems range from $ 150 for a 10 W one-light system to $ 1500 for a 100 W five or six-lamp system with radio and television connections. The systems are flexible in design and can be configured to the user's wishes. More solar panels can be purchased at any time if the user wishes to increase electrical output.

Solar systems are price competitive with the rural grid and the genset (a small kerosene/petrol generator set) assuming a low level of electricity consumption and an "equal" level of service. Like the grid, the genset option is capable of satisfying a higher demand for power and energy than the rural user normally makes. The capital cost is similar to a 50 W solar electric system, but gensets need imported fuel to operate and their service life is much shorter. Annualized costs of a 750 W genset (amortized over 5 years) plus fuel and maintenance (to deliver 40 kWh/month, at the pump price) amount to $ 195. The annualized cost to the consumer of a grid connection with a higher wattage capacity (amortized over 30 years) and electricity consumption of 40 kWh/month at the prevailing tariff amounts to approximately $ 51. By comparison, the cost is about $ 61 for the 50 W solar photovoltaic system, assuming a service life of 20 years and the purchase of a new battery every other year. Rural households would easily spend this amount on drycell batteries and kerosene for lighting – it represents less than 5 liters of kerosene and 10 drycell batteries per month – but get a low service for it. Therefore, in the case of a light load, a grid connection and a solar electric system are comparable from a users' point of view. For lighting only, solar power is the more attractive option. The cost of lighting (the average incremental cost per klmh, or kilo.lumen.hour) is some 10% lower for the solar electric system than for the grid: 2.0 vs 2.2 KSh/klmh. The cost of providing equivalent lighting from kerosene wick lamps is 10 times higher than either the grid or the solar systems.

Since most rural households will not have their homes connected to the electricity grid in the foreseeable future, photovoltaics will often be the next best alternative. This remains true only so long as a householder's appetite for electricity remains limited to a few light points plus a radio and/or a TV.

Better Policy

Better access to electricity can make a big difference to the quality of rural life. Many rural people do consume conventional modern energy, but they do so in small amounts. They also pay for it dearly: drycell batteries provide electricity for about $3 to $10 per kWh. A candle or a kerosene wick lamp does give a high quality light, but households need about 60 or 20 of them, respectively, to obtain the same amount of light emitted by a single 60 W incandescent lamp or a single 12 W compact fluorescent. People who use candles or kerosene therefore typically limit themselves to using only enough light points to enable walking around the home. Rural households will never obtain a level of service even comparable to the urban population unless they get access to electricity in a different form than drycell batteries.

Obviously, households with a solar electric system at the moment are not among Kenya's poorest. They are part of the middle income class. But they are in exactly the same target group that receive large subsidies under the REP. The REP, run by Kenya Power and Lighting Company (KPLC), involves a subsidy for each new rural connection. These subsidies are largely funded by the Kenyan Government and aid donors.

The cost of bringing power to the vicinity of new rural customers under the REP is on average KSh 55,000 (US$ 720). New rural customers only pay KSh 2,500 (US$ 38) each as connection fee, though new customers have to pay for the step-down transformer (possibly shared with neighbors) and the cost of the distribution wires to their homes as well as in-house wiring. This policy of reduced connection fees would be justifiable if there were a provision in the electricity tariff to claw back the subsidy. However, that is not the case. Rural consumers have a preferential electricity tariff, cross-subsidized by urban consumers. This public policy preference position – subsidies for the REP and taxes for PV equipment – does not make sense.

The REP is a slow-track method of electrification. While the KPLC has succeeded in electrifying all 42 district headquarters, little rural electrification has occurred outside of these towns. In fact, less than 30% of urban and 0.5% of rural Kenyan households have access to electricity.

Although the actual numbers and

Cont. P 4

World Bank Solar Initiative

In response to an increasing number of requests for support of renewable energy (RE) projects, the World Bank has begun a solar initiative, building on work already in progress under bilateral funding through ESMAP (Energy Sector Management Assistance Programme) and similar programs in the Bank such as the Asia Technical Department's Alternative Energy Unit.

The initiative has essentially two objectives. First, it will take a proactive role in project development, strengthening the World Bank's own involvement in and commitment to RE projects. Second, the initiative seeks to play a coordinating, strategic, and catalytic role in promoting accelerated research, development, and demonstration of commercial and near-commercial RE ideas by building a network of partnerships and collaborations with major international organizations and countries already active or strongly interested in the successful introduction of RE technologies in the energy market.

Proactive Project Development

At a first level of priority, the solar initiative will seek to accelerate large potential RE projects that are already considered economic but – for various reasons, including the World Bank's own inertia in this field – are not yet in the lending portfolio. A second priority will be large-scale projects and technologies that are still marginally more expensive than alternatives but could meet World Bank investment criteria through GEF intervention. Opportunities are already being investigated in the following settings:

China

The objective of ongoing RE work in China is to identify a suitable package of investments that can be proposed for Bank lending (as was done recently for India). A reconnaissance mission in March 1994 recommended an 8- to 10-month preinvestment study, and the Bank's responsible units have tentatively agreed on a work program. Funding from donors (including ESMAP) is being sought. The China project has attracted much attention, because introduction of RE on a large-scale could diminish China's heavy dependence on coal and the nation's consequently substantial contributions to global greenhouse gas emissions.

Mexico

Support is planned for preparation of an investment project that would establish a hybrid solar-thermal/gas combined-cycle power plant of a total capacity of more than 100 MW (possibly, 200-300 MW). A prefeasibility study, financed by a Rockefeller Foundation grant, has been carried out by consultants and is being reviewed by the World Bank and the Mexican government. Private investors have shown significant interest in an independent power production venture with GEF support.

Brazil

A biomass-gasification/combined-cycle power plant has been identified, and preparatory work has been done. Brazil has shown a strong interest in RE projects, and screening work for additional projects is planned.

Small-scale applications are also an important objective of the project development efforts. These applications will focus on using photovoltaic (PV) cells for power production to service lighting, water pumping, refrigeration of vaccines and other basic needs in dispersed locations.

Strategic, Coordinating, and Catalytic Role

Institutional and technological inertia favors well-established, traditional energy projects. Moreover, unfamiliarity with RE's technological, economic, environmental, and financing requirements impedes more rapid dissemination of RE proposals. The solar initiative will work to remove these obstacles. Several activities are planned, as detailed below.

Internal Workshops

The initiative will sponsor a series of meetings aimed at raising the awareness of World Bank staff and managers of the growing potential for

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Cost Effective Photovoltaics in Kenya

From P. 3

details differ, similar circumstances are found in many other African countries. Despite substantial amounts of money that have been invested in the African power sector, only a minority of African households are able to enjoy modern services provided by electricity.

Rural households would benefit if the Kenyan Government removed at least four significant impediments to the solar power market. First, a more rational (comparable to rural electrification program equipment) import duty and tax regime should be applied. Second, competition should be further encouraged by opening the market to all potential investors. Investors are presently hampered by restrictions on access to foreign exchange. Third, financing mechanisms should be put in place to make solar electric equipment more accessible to a larger share of the population. Fourth, technical standards for solar electric systems should be established and applied. Solar electric companies have been compromising technical standards to off-set the increase in price after the recent devaluations of the Kenyan Shilling. More frequent equipment failures may have a long term negative impact on the development of the market.

(Source: Extracted from "Solar energy answer to rural power in Africa" by Robert van der Plas, *FPD Note* No. 6, The World Bank, April 1994, 4 p.)

World Bank Solar Initiative

From P. 4

exploiting RE resources, encouraging staff to include RE in energy sector work and pressing them to consider RE projects more systematically as candidates for investment. The workshops will provide updates on technical, economic, and financial aspects of the RE technologies, analyses of past experience, and assistance in techniques of evaluating projects according to Bank and GEF criteria. The renewable energy seminar held at the World Bank on October 26, 1994 was in part organized for this purpose.

Regional Seminars

Seminars directed at developing country public and private sector groups interested in commercializing RE would also be conducted by the World Bank and GEF. These seminars, focusing on local needs, conditions, and projects, would be held at regional centers to maximize local participation, to initiate and strengthen the process of technology transfer, and to build strong local ownership.

Reports and Updates

A series of World Bank reports will be prepared with the following goals:

- Updating information in each technology, including project designs, costs, recent experience, institutional arrangements, and lessons learned;
- Providing guidance on financial and institutional arrangements needed to ensure successful preparation, implementation, commissioning, and operation of RE projects;
- Articulating strategic actions to move development of RE to full commercialization.

International RD&D

The solar initiative will make an effort to provide focus to current international RD&D in solar energy to make it more responsive to the needs of developing countries. The World Bank's strategic role in this area will be refined through consultations with other international organizations, research establishments and government agencies. This would require development of an international network to obtain the necessary information and suggestions, receive support, and effect the coordination desired.

Possibilities for Cooperation

The solar initiative has solicited the participation and support of international organizations, bilateral donors, government agencies, NGOs and research establishments. An encouraging example of such support is a recently signed Memorandum of Understanding between EPRI and the World Bank that will enlist valuable EPRI resources – in the form of specialized staff, analytical tools and technical information – in RE work.

(Source: Extracted from "The World Bank Solar Initiative: Objectives and Work Plans" by A.G. Adamantiades and E. Terrado, *The ESMAP Connection*, Vol. 2 No. 2, December 1994, pp.12,13,16)

Trisolar Thermal Sterilizer

The Trisolar solar sterilizer was designed to sterilize medical equipment in areas with no electricity or gas and limited wood supplies, such as in many Third World regions.

This patented device is based on an off-the-shelf pressure-type medical sterilizer. Three evacuated tube solar collectors with an inbuilt heat pipe are attached to the pressure cooker to collect solar energy and conduct heat to the cooker.

The World Health Organisation (WHO) stipulates that the sterilizer must reach 121°C for 15 minutes. On a fine day from an initial ambient temperature of 20°C this will take 1.5 hours. Subsequent batch cycles take 45 minutes, meaning that about 8 sterilisation cycles can be done per day in fine weather. This effectively recycles 600 needles and syringes per day.

The Australian Red Cross was first to place a Trisolar unit in the field at their solar hospital in Cambodia. World Vision has now placed one each in Malawi, Zambia and Tanzania where they are undergoing all-season field trails for twelve months before being able to receive final WHO approval.

The device has been developed over the last 6.5 years by the Trisolar Foundation. This is a non-profit organisation based in Perth, Western Australia, set up in 1987. Trisolar's aim is the research and development of thermal solar energy in the fields of cooking, sterilization, purification of water and refrigeration for the benefit of the underprivileged in remote areas.

A portable thermal ice maker is now also being researched as it is an essential part of the immunisation programme to transport and keep more vaccines in remote areas. In India one large aid group admitted that the failure rate of the vaccines in remote villages was as high as 30% because of the inability to keep the vaccines cold once their ice packs had melted.

Much of the work on Trisolar's devices has been donated by local businesses. The Foundation has the free use of a small workshop within Orbital Engine Company's Balcatta research and development facility.

For more information contact:

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Trisolar Foundation Trust
31 Brazier Road
Yanchep, WA 6035
Australia
Tel & Fax: (09) 561 2314

(Extracted from "Thermal Solar Sterilizer" by Bill Wales, Solar Progress, Vol. 15, No. 3, Spring 1994, p.6)

Seawater Desalination with Solar System

Shiroki Corporation and Industrial Research Institute of Kanagawa Prefecture have jointly succeeded in seawater desalination with solar heat.

A solar system developed by the Industrial Experimental Station has been used as the heat source of a distillation system using low-pressure steam. An experimental plant has succeeded in separating a 3% sodium sulfate aqueous solution (artificial seawater) into a 6% sodium sulfate aqueous solution and fresh water. The running cost including the fuel cost has decreased substantially, and the company plans to commercialize the system within two years.

The experimental plant is an application of the vaporization technique that is one of several fresh water generation technologies. Low-pressure steam of 110°C generated by boiling seawater with the solar system is piped into a sealed container, then cooled with water and the seawater further vaporized to obtain distilled water by utilizing the temperature and pressure differences generated in the cooling process.

Until now, fossil fuel has been used as the heat source for seawater vaporization, and a depressurizing system was also necessary. The new system produces fresh water with low-pressure steam, so the depressurizing system becomes unnecessary, and the use of the solar system reduces the running cost substantially. The cost of a ton of fresh water based on the existing vaporization method or reverse osmosis method is ¥200-300/t, but using the solar system enables the cost to be reduced to about ¥100/t.

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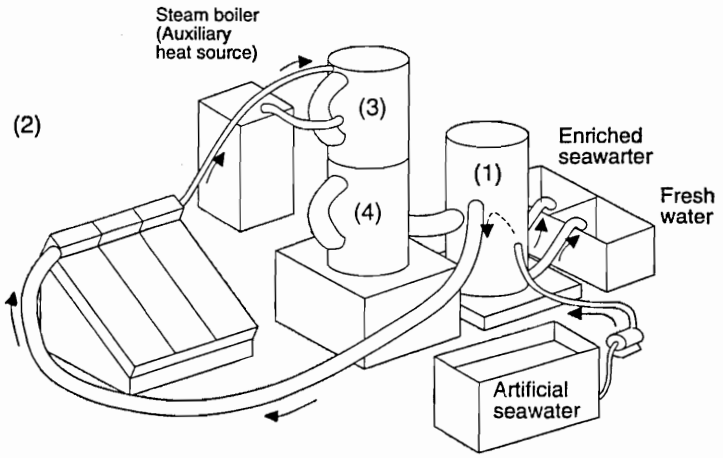
(Source: Extracted from "Seawater Desalination with Solar System", *New Technology Japan*, Vol.22, No.9, December 1994, p.36)



(1) Condensing column: Supplies driving force to the utility drum, and steam from the utility drum is condensed and converted into fresh water.

(2) SK-U13: Seawater is heated to about 110°C for remove air contained in seawater.

(3) Deaeration column: Seawater is boiled to remove air contained in seawater.

(4) Utility drum column: Steam is generated in conformance with the condensing column pressure drop.

ProSolar Project Launched – Philippines

The Philippines Department of Energy (DOE) and the German Agency for Technical Cooperation (GTZ) launched the ProSolar: "Pailaw Mula sa Araw" (in Philippine this means "Electricity from the Sun") project at the Tagalog Pavilion, Nayong Pilipino, October 5, 1994. It aims to provide electricity to some 1,000 rural households through the solar home systems (SHS) with the active participation of private companies, NGOs, LGUs (local government units), consultancy firms and financing institutions.

ProSolar is a pilot activity conceptualized in response to the government's efforts to alleviate the poor living conditions in remote and unelectrified rural areas, and to bring to these places the technological gains of the research and development work on solar energy.

The project also expects to sustain the commercialization of PV (photovoltaic) electrification through the participation of the private sector. It also addresses the long-term plan to answer the electrification imbalance in the off-grid remote areas.

Financial incentives will be provided to private companies to encourage them to develop, package and implement area-based PV electrification projects. The provision of incentives will be based on the guidelines and criteria jointly developed by the DOE and GTZ.

Criteria for the accreditation of project sites are rural areas which have above-average income earners, low electrification rates and low power demands, easy accessibility and acceptable peace and order situations. Focal sites of the project are Region III (Provinces of Tarlac and Nueva Ecija), Region IV (Provinces of Quezon, Batangas, Mindoro and Palawan) and Region XI (Provinces of Davao del Norte, Davao del Sur and South Cotabato).

(Source: Extracted from "Pailaw Mula sa Araw" Launched!", Energy Infonet News, Vol.1, No.3, December 1994, p.1)

ULOG Solar Cookers

"Solar Energy for All" is the motto of the ULOG group, an informal group of about 20 volunteers in Switzerland committed to making solar energy available to the people of the world. The ULOG group was founded by Ulrich Oehler in 1980 to realize this objective. During the past twenty years, the group has successfully developed standard and family-sized solar oven cookers for tropical as well as non-tropical conditions. It has also developed SHCK, the Solar Hybrid Community Kitchen, which serves more than 40 people.

Assembly Instructions

To make the cookers acceptable to communities, the group produced a simple design that can be manufactured and disseminated locally. The cooker costs little, is easy to use, and can be used to cook local cuisine. It comes with an installation instruction booklet, and people can see an instructional video film in a choice of several languages to help them build a solar oven. The assembly instructions also give information about what a solar cooker can do and cannot do, how long the cooking times are, how the oven should be cleaned, how the oven works, etc. There are also detailed recipe books for local foods.

The ULOG group offers ready-to-use and partly assembled models in two sizes with instruction and accessories. In Switzerland, they hold one- or two-day courses in which people can learn how to assemble the solar ovens.

Success

At present, more than 6,000 Swiss households own a solar oven! Switzerland has probably the highest density of solar cookers of all of the countries of the world. The one cooker per 1,000 inhabitants saves as much energy as all of the PV-installations in the country. In Basel, the solar cooker can be used on 100 to 150 days per year. On average, one can prepare about 250 cooked meals in that time, which saves about 500 kWh per year.

The solar ovens' biggest successes are in Senegal, Kenya and Sudan. Several thousands of solar cookers have been built in these countries by the ULOG and other project groups as well. At the end of 1994 there were about 20 SHCKs, Solar Hybrid Community Kitchens, in India, Sudan, Kenya, Peru and Europe. SHCKs are used for, e.g., monasteries, hospitals, schools, and refugee camps.

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(Source: Extracted from "ULOG Solar Ovens in Basel and Worldwide – Solar Energy For All", Sustainable Energy News, No. 6, September 1994, p. 16)

Europe's Largest PV Power Plant

Europe's largest PV power plant, rated at 3.3 MWp, is nearing completion at Serre, Italy. The Photovoltaic Power Systems (PVPS) Programme of the International Energy Agency is working on all aspects, and sizes, of PV including stand-alone systems for islands and isolated communities and PV integrated into buildings which are also connected to the grid. The overall aim of the Programme is to accelerate the use of PV by utilities and other energy users. Multi-megawatt PV power stations are part of the strategy. IT Power has also been involved in all aspects of the PVPS Programme.

(Source: "Utility Scale PV Power", IT Power News, No. 14, September 1994, p.1)

Cars to Run on Coconut Oil – South Pacific

In the South Pacific, cars will soon be running on the sweet smell of coconut oil under a research project aimed at giving islanders a cheap alternative to imported fuel, a member of a research team said.

Under a new technique developed in Australia, oil extracted from coconuts will be pumped into the tanks of diesel-powered cars and vans in a trial in Fiji this year, said Dan Etherington of the Australian National University.

Other than a second fuel tank no modification is needed to the vehicles. A blend of diesel and coconut oil can be used without altering them at all.

"This gives them an alternative fuel which is in constant supply throughout the year," he said. The islands normally import fuel by ship in drums, which is expensive and sometimes unreliable.

Coconuts were once the mainstay of South Pacific island economies and still grow in abundance.

The research by the university team, he said, "is to empower local people to use the oil that is essentially pouring down from their trees". Etherington added that a machine was being built to enable villagers to extract the oil themselves.

Coconut oil performs nearly as well as diesel fuel, but "the difference in the fumes is that coconut smells very pleasant," he said.

(Source: Extracted from "South Pacific cars to run on coconut oil" by AFP, Sydney, *Bangkok Post*, Wednesday, February 22, 1995, p.9)

100 MW PV Power Plant Proposed

Enron Corporation – the largest natural gas company in the US is proposing to build a 100 MW photovoltaic power plant in the southern Nevada desert. The plant is expected to cost US$ 150 million.

What has most surprised commentators about the project is the price at which Enron intends to sell power from the plant: 5.5 cents/kWh in about two years. This makes it directly competitive with fossil fuelled power plants.

Some of the US's leading solar power experts say Enron's optimistic goal probably is reachable. The cost of solar power generation has quietly declined by two-thirds. Far from depending on some wondrous breakthrough, the experts say, Enron can offer commercially competitive solar power by inexpensively mass-producing solar panels and then employing thousands of them in the Nevada desert.

Recently, Enron formed a partnership with Amoco Corp. to build and market thin-film solar energy "multi-megawatt" power systems that will be marketed to utilities internationally. A manufacturing facility capable of producing more than 10 megawatts of large-area, multi-junction amorphous silicon PV modules annually, probably will be located in Nevada and will supply the new power plant with panels.

Even the most optimistic supporters of solar power have doubted that they would see commercially competitive production before the next century. The Worldwatch Institute, an environmental group in Washington, DC, said last year that solar cell electricity, now as low as 20 cents/kWh, might reach 10 cents by 2000 and 4 cents by 2020. Yet Enron is pledging to deliver the electricity at 5.5 cents/kWh in about two years. The national average retail price is 8 cents.

Enron's 100 megawatt plant will be more than a dozen times the size of any other that employs photovoltaic power cells. The plant wil cover more than 7.5 million square feet, over 170 acres, with photovoltaic panels.

The company has already won preliminary backing from the US Department of Energy, which tentatively plans to buy Enron's solar power as long as the rate is truly competitive with the power from conventional sources. Government officials say Enron's success will encourage the spread of solar power generation here and abroad.

Federal officials say the Enron project could introduce commercially competitive technology without expensive government aid. In fact, the solar industry already has grown, with the shipments of solar cells up more than tenfold since 1980, as repeated technological advances have lowered their cost.

(Source: "Bold Move Will make Solar Competitive", *Wisconsin Energy News*, Vol.16, No.1, p.3)

Engine Runs on Pure Vegetable Oil

The first initiatives for more ecologically friendly cars are not coming from the well established car manufacturers. These companies, in spite of their enormous research and development capacity, are just in the process of starting to develop prospective solutions to replace a vehicle technology that, in reality, has not changed during the last 60-70 years.

An example of a new solution from a smaller company is the Elsbett engine. It was developed by a talented German engineer, Ludwig Elsbett, who established Elsbett-Konstruktion in 1964 – an institute for the development of engines – situated in Hilpoltstein near Nürnberg, Germany.

The Elsbett engine runs on pure vegetable oil. This is not possible for a normal diesel engine, because the glycerol from the oil will deposit half-burned hydrocarbons in the cylinders of the engine. It is possible to remove the glycerol from the oil by a chemical methyl ester treatment. The treated oil, which can be used in normal diesel engines, is known as biodiesel or RME (Rapeseed Oil Methylester). Unlike vegetable oils used in cooking, RME is poisonous and contains carcinogens.

Elsbett has developed motors for many different purposes. Presently, a few hundred cars are running with Elsbett engines in Bavaria. They are running on pure rapeseed oil that is aviable from special filling stations, where it is sold for about 0.80 DM/litre. The engine for cars has 3 cylinders with a total volume of 1,500 cm^3 and is equipped with a turbo-charger. At the institute in Hilpoltstein, cars are rebuilt by changing the original engine to an Elsbett engine. In addition to the car engines, Elsbett makes small plant-oil-fuelled cogeneration systems for heat and electricity.

Perspectives

The Elsbett engine has far-reaching possibilities, especially in the tropical developing countries, where this technology will be very valuable because it uses natural plant oils. All over the tropics there are plants with high oil contents from which the oil can be derived locally. The ordinary oil-palm can give 7,000 kg oil/hectare in a year, and many other plants have yields above 2,000 kg oil/hectare.

Technology

To burn the glycerol that is in the plant oil, without the formation of deposits in the engine cylinders, the Elsbett engine has a special injection system combined with a spherical combustion chamber placed in the piston. This construction gives combustion with a high-temperature core surrounded by a layer of colder excess air. In this way, there are low heat losses to the walls of the cylinder and the glycerol is burned without leaving deposits on the walls.

The piston is made of two parts. The upper part, which includes the

Cont. P. 9

Geothermal for Drying Agricultural Products

The Philippine National Oil Company-Energy Development Corporation (PNOC-EDC), through its Energy Research and Development Center (ERDC), is currently implementing the United Nations Development Program (UNDP)-funded project on the Geothermal Agro-Industrial Demonstration Plant. The project involves the installation and techno-economic evaluation of a 1 MW multi-crop drying facility in Palinpinon, Valencia, Negros Oriental, the Philippines.

The process is simple. Low-enthalpy waste geothermal brine for reinjection from the Palinpinon I plant is diverted to the drying plant. This waste brine (with a temperature of 160°C) is not fit for electricity generation but hot enough for drying. The brine enters the plant's primary shell and tube heat exchanger where a secondary fluid (ground water at 80°C), extracts the heat of the brine. The brine is then returned to the reinjection line, while the secondary fluid (hot water at 98°C) flows into the air heater. The air heater is composed of a fine-tubed heat exchanger and a centrifugal air blower. As the hot water runs through the tubes, the blower blows ambient air to the tubes producing hot air (at 75°C) which flows to the dryer. The hot water, after passing through this secondary heat exchanger, is then returned to the primary heat exchanger. The dryer has a 1 m wide x 0.5 m deep x 6 m long trench which distributes the hot air to the drying boxes stacked on top. These boxes contain the fresh coconut meat. There are seven sets of air heaters and dryers.

The process will increase the value of the agricultural products through better control of the moisture content of the dried products and higher product recovery with the improved handling of both raw materials and final products. These products meet the high standards of the export market resulting in a higher selling price.

Coconut meat was selected as the main crop to be dried because of its abundance in the area. Other agricultural products, such as fruits, are also targeted for drying. The experience gained from this project will serve as the basis for replicating the technology in other geothermal areas throughout the country.

(Source: Extracted from "The UNDP Geothermal Agro-Industrial Demonstration Plant", *Energy Infonet News*, Vol. 1, No. 2, September 1994, p.11)

Engine Runs on Pure Vegetable Oil

From P. 8

combustion chamber, has a small surface facing the cylinder walls, and therefore has reduced heat transfer to them. This part, which also holds the piston rings, is made of cast iron, which can stand the high temperatures. The lower part of the piston is made of aluminum, and the total piston has a lower weight than a normal piston made in one piece.

An ordinary car engine has an efficiency below 30%, while that of the Elsbett engine is about 40%. The high temperatures make the engine capable of working with many types of fuels, like rapeseed oil, and used cooking oil as well as ordinary diesel oil. The high efficiency gives a 30% better mileage.

In a petrol engine, 28% of the combustion heat is removed by the coolant. In a diesel engine, this figure is about 30%. In an Elsbett engine only 14-16% of the combustion heat is removed from the cylinder. This is done by oil cooling, which is simpler and more reliable than water cooling. The rest of the excess combustion heat, about 40%, remains in the exhaust gas. The engine can be characterized as exhaust-gas cooled, which makes it especially suitable for cogeneration, because it can deliver more heat at high temperatures (400-500°C).

(Extracted from "Biofuel for Transportation: Adapt the Motors to the Fuel", by Preben Maegaard, *Sustainable Energy News*, No. 6, September 1994, pp.10-11)

CHP Plant Burns Gas and Refuse – Denmark

A combined gas fired combined cycle CHP plant and municipal refuse burning CHP plant is now under construction at Sønderborg in Denmark. As well successfully disposing of municipal refuse both from an economical and environmental perspective, the plant will supply electricity and district heating requirements over an extensive area.

The plant will be built, owned and operated by Sønderborg Kraftvarmevërk I-S, a partnership company formed by the regional power company Sønderjyllands Højspændingsværk (SH), the district heating company Sønderborg Fjernvarme AmbA and the regional refuse treatment company I/S Alssund Affald, a partnership between 7 local municipalities.

Sønderborg is located in the southern part of Jutland on the Island of Als only 30 km from the Danish/German border. The CHP-plant will be located 2 km north of Sønderborg. The total investment budget including electric and district heating transmission lines is 515 million DKK.

By the incineration of 55,000 tons of refuse and the combustion of 30 million m^3 of natural gas per year the plant will produce 183,000 MWh electric power and 221,000 MWh hot water (40/80°C) for district heating.

The plant consists of 5 main machinery components: gas turbine generator, exhaust gas boiler, refuse incineration plant, flue gas cleaning plant, and steam turbine generator.

(Source: Extracted from "Sønderborg CHP plant burns gas and refuse", *Modern Power Systems*, Vol. 14, Issue 9, September 1994, pp.47,49,51.)

Energy Bonanza from Undersea Ice

Ice that burns? Yes, and so much of it that it could meet America's natural gas needs for decades. But scientists have yet to figure out how to mine it without causing an environmental disaster.

Methane trapped in the pores of ice forms a frozen compound called gas hydrate. Vast deposits are held at high pressure 1,500 feet (450 metres) under the ocean floor on continental shelves around the world.

"It looks like dry ice, but if you put a lighted match to it, it will burn," said David Howell of the US Geological Survey. "It's actually ice that burns."

By some estimates, twice as much carbon energy is contained in gas hydrate as in all fossil fuels combined. Harvesting that energy bonanza may be one of the great engineering challenges of the age.

Gas hydrate forms under the seabed or under permanently frozen soil when methane, produced by biological action, collects as bubbles within water ice over hundreds of thousands of years.

Released from the pressure of the deep, the ice disappears within minutes. "If you bring it to the surface, it bubbles and fizzes. It's difficult to study something that is fizzing away in front of you", said Charles Paull of the University of North Carolina.

There are serious environmental concerns about tampering with the hydrate deposits. "Methane from the hydrate reservoir might significantly modify the global greenhouse," said William P. Dillon of the US Geological Survey.

Paull is scientific leader of an expedition that will drill off the Carolina coast later this year to explore a Rhode Island-size hydrate deposit that may contain 1,300 trillion cubic feet (39 trillion cubic metres) of methane. That's enough gas to supply the United States for about 70 years.

Paull said an airtight container will be lowered into the deposit, filled with the ice and then sealed to keep the material at high pressure. It then can be brought up and studied in pressure chambers.

Researchers have proposed several ways of harvesting hydrate energy. All involve making the gas escape from the ice while it is still in place under the ocean floor. The gas could then be captured and piped to the surface. There is doubt, however, that any of the methods will work.

(Source: Extracted from "Methane trapped in undersea ice may provide energy bonanza", AP from Atlanta, *Bangkok Post*, Wednesday, February 22, 1995, p.26)

Efficient Electric Motors Save Energy

Lord Arran, UK's Environment Secretary, recently announced that a jointly funded research project will make possible a significant reduction in the UK's carbon dioxide emissions and boost industrial competitiveness by reducing electricity consumption.

Savings in electricity costs over the next decade, estimated at £186 million, represent a boost for industry and reduced carbon dioxide emissions by 4.5 million tonnes. The Energy Efficiency Office (EEO) is setting up an information and advisory service to help industry to achieve maximum advantages from more efficient use of motors.

Lord Arran said: "Industry and government are collaborating effectively on this project, and together they are achieving a major breakthrough for British technology. Higher efficiency electric motors are starting to reach the marketplace and will significantly reduce electricity consumption without incurring any of the cost penalties traditionally associated with such technology.

Not only will this contribute to meeting the Government's commitment to reducing carbon dioxide emissions but it will help industry in two important ways. Firstly, electricity cost savings will be felt right across industry and commerce; secondly, the participating businesses will benefit from a lead in world markets which will earn this country valuable export orders.

The EEO is providing 33% of the funding for the four year, £12 million research programme into higher efficiency induction motors. The industrial participants are Brook Hansen, electric motor manufacturers, and Orb Electrical Steels, the Anglo-Swedish joint venture.

Professor David Walters, technical director of Brook Hansen, saw the opportunity in 1989 to achieve reductions in energy consumption and in carbon dioxide emission by developing more efficient motors which would not carry an investment premium. As well as advances in motor design and production methods, such a breakthrough would also call for improved materials.

Discussions with the EEO and Orb Electrical Steels followed and the result was the establishment in 1991 of the current research programme. "We are now approaching the point where we are able to deliver motors which meet the target of higher efficiency without cost penalty."

By March 1994 the programme had resulted in design and materials improvements leading to the availability of early production motors in the range above 30 kW which are close to achieving the target improvement in performance of three percentage points.

(Source: Extracted from "Higher Efficiency Electric Motor", *Energy Digest*, Vol. 23, No. 3, 1994, pp.26-27)

SMALL SCALE WIND ENERGY SYSTEMS

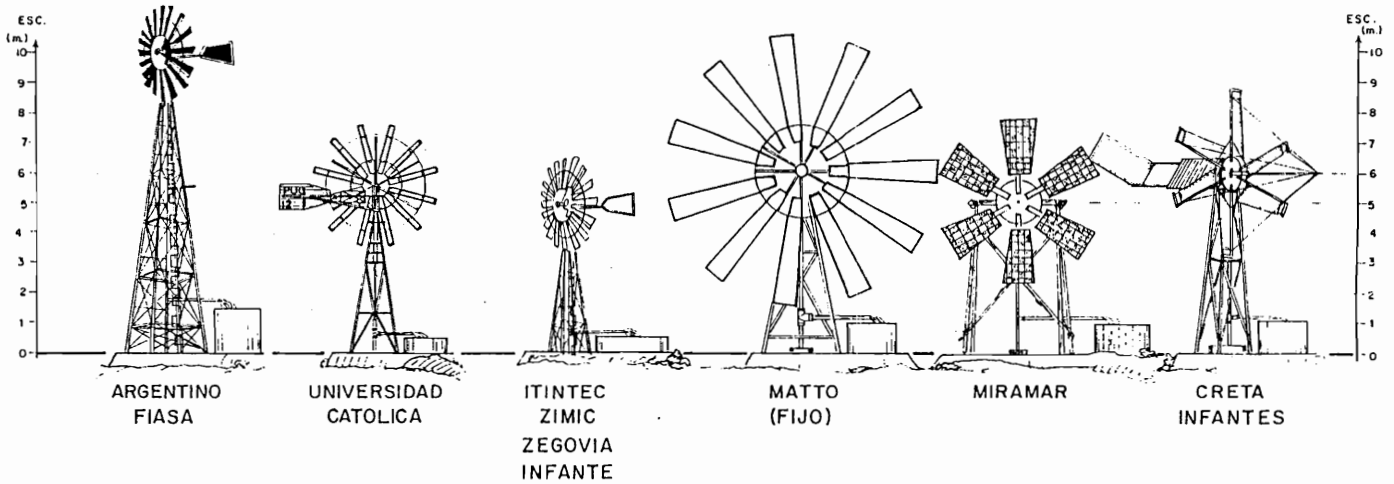
Published with financial support from the Netherlands Minister for Development Cooperation
Editors: Goezinne & Veldkamp, Renewable Energy Consultants

EDITORIAL

This issue we have three articles dealing with field experience with windpumps. We think they are especially interesting because the authors not only write about successes, but also write candidly about things that went wrong, both on the technical and on the social level. We think such information is extremely important for the success of future projects. One should appreciate this openness.

Dick Veldkamp/G&V

Windmills in Peru



Since 1985 the Support Group for Development in Rural Areas (GRUPO) from the Pontificia Universidad Católica del Perú in Lima, has been working in renewable energies (solar, wind and micro hydropower) for water pumping and electrical supply. The Peruvian coastline is a desert zone crossed by some rivers whose water comes from the Andes; most of these have no water for at least 3 months every year. However, there are annual average wind speed of 4-6 m/s here; what's more, in areas near valleys there is underground water at 5-40 m. This makes windmills an excellent option for farmers in the Peruvian coastal zone.

Our experience in windmills for water pumping started in 1989 when the drawings of the 12PU500 Dutch windmill came into our hands. It was in 1990 when we installed our first windmill to take out water from 20 m underground. At present, the 12PU500 with modifications is what we call the MCTB500. The basic changes were done in the pump: the piston is no longer wood but steel, with a double leather seal and a double check valve, and the pump rod has an upper guide with a ball bearing between the tube and rod. These changes have given good results and up to now we have built and installed 16 windmills in different places in Peru of which 12 are along the coast. Although the cost of the MCTB500 varies from US$ 2,800 to US$ 3,500, the windmill has preference amongst farmers mainly because of the continuous following and maintenance, making them highly reliable. The flow pumped by the windmill makes it adequate for the watering needs of their parcels (1-4 ha).

Also there are other success cases: in two different places in Peru, with two different types of windmill. Between Piura and

Cont. P. 2

Editorial Note

In our coverage of the 'Workshop on Prospects for International Collaboration on Windpumps' (see RERIC News Vol. 17 nos. 3 and 4) we did not mention that the workshop was sponsored by the UK Overseas Development Administration and the Dutch Ministry of Development Cooperation, that it was organised by IT Power, and that conference facilities were kindly provided by Cranfield University, UK. We regret this omission. Ed.

Windmills in Peru

From P. 1

Chiclayo, in the north of Peru, is the region called Bajo Chira, where a small town named Miramar is located. Hundreds of artisanal windmills in this area are called by this name. The tower of such machine is built using local eucalyptus wood and the rotor of 6 m diameter from rugs of reed. In the 80s these windmills were improved in a GTZ-project. They transferred the technology to local enterprises and the farmers were able to get credit to buy these machines. Under these conditions windmills became widely known due to their low cost (US$ 1,200). With the easy use of underground waters (between 5 and 10 m) and an average wind speed of 4-6 m/s resulting in a water supply of 4-6 litres/s the machines were soon considered the best for these areas.

In 1992, the Fund for Agricultural Development (FONDEAGRO) requested from GRUPO a technical evaluation of these windmills so as to start a new credit programme. Our final report recommended improvements in the windmills and recognised its advantages over other designs. Unfortunately changes in the Peruvian economy provoked the disappearance of this institution, together with the Agricultural Bank (1992/3), leaving farmers without credit possibilities. GTZ's project was never concluded and the company that received the technology is no longer dedicated to it. Most of the windmills installed are now out of use due to lack of maintenance.

In the 70s, ITINTEC (the then Peruvian Institute of Technical Standards) spread the use of plans of an 'American' windmill. Many manufacturers built and sold machines based on these drawings, but without much success. Nevertheless there was an important success in Arequipa (a southern mountain area in Peru) due to the good maintenance offered by the manufacturer to the hundreds of windmills installed in a zone called Pachacutec, where he lives. Now this area is saturated with these machines; however because the phreatic level has dropped the feasibility of these windmills, which have to be installed in deeper wells (30-35 m), has been affected. They pump less water and more failures occur in pump and pump rod.

In 1993 the government of Argentina conceded Peru a credit for the acquisition of FIASA windmills. These credits were managed by FONCODES (National Fund for Development). These machines were promoted for drinking water and farmers had no interest in them due to their high costs (US$ 5,000), discarding them as a profitable alternative to their needs. This programme could only install some windmills donated for demonstration, which are at present out of use.

Either large windmills are needed in Peru to pump flows of about 4 litres/s, or machines that work most of the time, and store water. Peru's reality being what it is, can the farmers' needs for watering be satisfied with third generation windmills? We have to try it.

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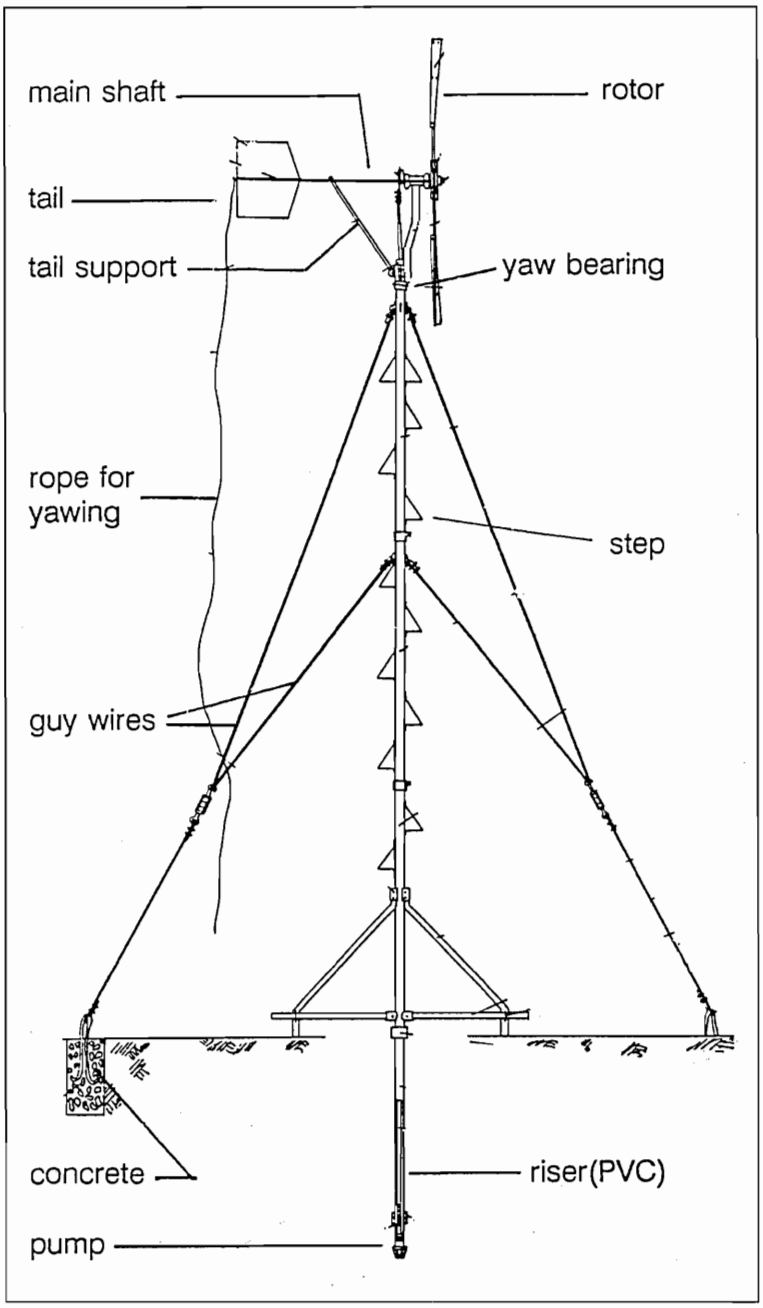
Experience With the Development of a Light Weight Windpump in Chili

The Coquimbo semi-arid interior area traditionally utilizes windmills introduced during the XVIII century by the catholic missions and later developed in local workshops. These windmills are stationary and known by locals as "wind butterflies", with low efficiency rotors due mostly because many are built of corrugated panels intended for roofing material and very large diameter surface reciprocating pumps, which require high starting wind speeds.

The initial idea was to introduce a light weight windpump system

Cont. P. 3



AEE-2 windpump, overview.

Experience With the Development of a Light Weight Windpump in Chili

From P. 2

with an on site cost below US$ 1000. Influenced by the Gaviotas and CWD experiences, the author designed a 'hybrid' of both, with the following characteristics:

- light weight tower that can be taken apart;
- 360° yawing possibility;
- low solidity rotor;
- double-working pump, serviceable from above.

If the AEE-2 model is compared with the previous model the following can be pointed out as fundamental differences:

- the rotor has no automatic control system and can only be yawed out of the wind manually;
- the double-working pump has a metallic support valve with spring;
- transmission to the pump is made of PVC with a metal interior coupled to the pump. In this way the connection is rigid, losing elasticity of the PVC and improving pump output.

Technical Characteristics of the AEE-2

Tower: 2" ASTM steel tubing. Tripod type base in 1" steel, 6.75 m hub height.

Number of blades: 6

Rotor diameter: 2.1 m

Pumping rate: 0.8 m³/h at 10 m head with 5 m/s wind speed.

Pump: double-working, double ring EPDM seal and 3/4" non return valve with spring of 65 mm;

Transmission: 3/8" diameter steel rod, with brass couplings and PVC outside tubing.

Yawing system: manually with tail chain.

Results, Origins and Modifications Carried Out

Table 1 shows observations made by users, the author and the manufacturer, which resulted in the manufacturing of present AEE-2 windmill.

Comments and Conclusions

1. Use of windmills without automatic control for strong winds requires attention of the user when operating with a 6 m tower. The danger of strong winds can be reduced by lowering the tower height or placing the machine in a site protected by obstacles (e.g. trees).

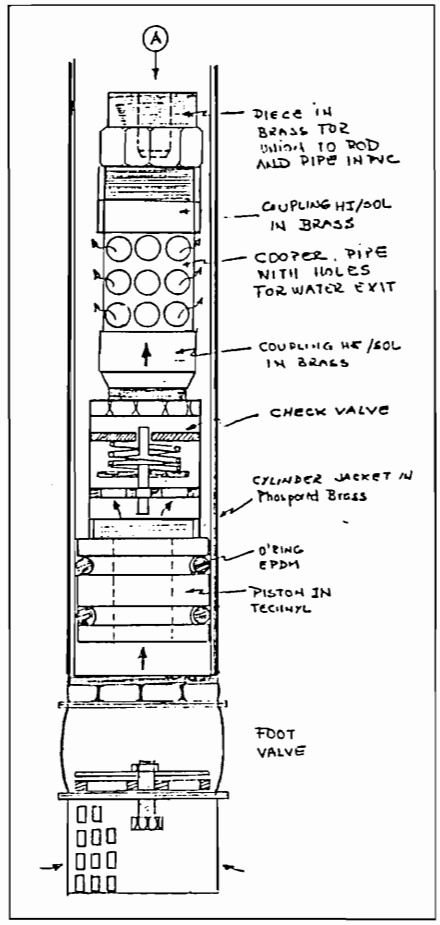
2. If a tower that can be taken apart is preferred, it is recommended no couplings with thread be used, as the groove weakens the tube's resistance, turning it into a weak point in the system.

3. A tower for high winds must avoid cables (which slacken) and use round steel rods instead.

4. Small but significant details which can only be seen on site merit comment. For instance that support for the technicians' feet must be adequate. For longer work periods the steel triangles are not enough. Some steel angle iron triangle should be provided on top of the tower, or some plate, providing enough standing area.

5. The rigidity of mechanical systems subject to fluctuating tension/compression fast charges in windmills merits research, as results can be disastrous if there is no provision for elasticity in some of the components involved (pump spring, flexibility in the transmission rod, air chambers). A difference can be seen in the pumped flow, with respect to the Gaviotas model, but it is unclear whether this is due to the improvement in the volumetric efficiency in the double working pump (because of the increase in the transmission rigidity), or rather because of a better use by the rotor of high winds.

6. One of the problems difficult to solve is wear of the piston seals. It is possible that the windmill's extraction rate is above the well's recuperation rate. Under these conditions, the pump may get dry and seals tend to wear fast. A possible solution to this problem is developing pumps with hydrodynamic seals, which could be used with this type of windmill if problems with control and eccentricity of the transmission rod are solved.



Double working pump.

Table 1. Failures detected and corresponding modification.

Component	Failure detected	Cause	Modification
Rotor	Wear or breaking of blade support plates	Excessive forces on rotor and bolts	Plate made of forged steel
Tower	Excessive wear of yaw bearing	Rocking due to imbalance of rotor and tail	Steel plate between tail and rotating head
	Breaking of connection in tower	Excessive loads on tower caused by slackening of guy wires	Tower made in one section, or with a different coupling
Transmission	Uncoupling of transmission rod	Turning the head unscrews the couplings	Use of pressure washers
Pump	Breaking of non return valve (no spring)	System rigidity too large; valve hits valve stop	Incorporate spring in valve stop
	Water outlet section broken	Pump rod forces too large	Copper couplings replaced by brass

Acknowledgements

We wish to thank the Centro de Experimentación y Capacitación en Tecnología Apropiada TEKHNE (an NGO) for their support on the preparation of this article.

Javier S. Gho
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Condor Unlocking Potential of Philippines

Condor is a manufacturer of a 3 m diameter windpump in the Philippines. The company started in the early 80s, but it wasn't until the 90s that their product started to take off. The 'Condor' is a simple windpump designed for domestic use with micro irrigation of vegetable growing farming systems. Before 1988 the company operated from the owner's house; a small workshop 'out the back' was the site for single machine production. In 1988, the owner decided to invest in batch production and moved the workshop accordingly. The new workshop had 8 factory trained production workers and one technical graduate, and could produce about 10 windpumps a month. Now it has installed more than 400 windpumps in the last 7 years.

A big boost for the company came in 1990 with the Greenwells programme, which promoted better domestic water supply linked to micro irrigation. In the five years 1990 to date, the programme has been installing electric and windpumps, about 360 in all. The idea is to demonstrate alternative irrigation systems to the farmers. The programme is in an area that has 4 m static water levels for the boreholes. Condor has participated strongly in this programme.

Simple Design

The Condor is a simple design, that can be operated and maintained at farmer level. Nobody denies that Condor windpumps do break down sometimes. However, by making the whole system with village level technology, the farmer can easily repair any fault. Because of this the overall down time for such a windpump over several years is generally less than for a more robust machine that requires centralised repair (with the associated problems of transport and waiting).

One of the reasons that the windpump does break every now and then, is the strong winds on the island. Fortunately there is a correlation in the Philippines between the wind and the need for irrigation water: the strongest winds are during the driest times. But the Condor has no automatic furling or other storm protection. For much of the time this presents no problems. Like the farmers on the Isle of Crete who use sail cloth machines, the Filipino farmer operating a Condor starts the system in the morning and shuts it down at night. To do this the farmer unlocks and locks the tail. The farmers see this as no different from having to start a petrol pump, and then keep an eye on it while working in the fields. It would seem that while the manual furling and unfurling is not an inconvenience to most of the users, some breakdowns of Condors could be avoided with an automatic safety system. Of course, more sophistication would mean more expense. At the moment the 3 m diameter system costs about US$ 230 in materials and US$ 115 for the labour. Condor retails at $ 640-770 installed depending on the details and location of the system.

Unlocking the Capital

So why are there not thousands of Condor windpumps? The answer seems to lie partly with the company and partly with the banking institutions. On the company side – this is a low key private company. It suffers from the difficulties many small companies suffer from. Lack of capital for production means that the company survives from batch to batch. With more capital, mass production techniques and thus higher turnover, the company could easily give a good return to an investor. The small company also suffers from its inability to give adequate customer service and feedback. Often the company fails to match the windpump to the customers site. They have very little time or manpower to be able to adapt the design to the specific local conditions. Similarly the smallness of the company limits its ability for feedback. It cannot afford to do extensive testing of the windpumps to see the water outputs, and monitor whether customers are using that water in the best possible way. Ideally the company could package sound farming advice with their product, thus making it more attractive.

Unlocking Credit for the User

The Philippines is one of the few countries with an extensive and planned programme for promoting the use of renewable energy technology. And yet apart from the Greenwells programme on the Island of Panay there is virtually no credit support for farmers wishing to purchase windpumps (the Greenwells programme actually donates the windpumps for strategic demonstrations). How can a farmer be expected to pay for the windpump? Why is it that the financial institutions, particularly the agricultural banks are so slow in recognising the potential of wind power? One of the reasons lies in the fact that few of the farmers own title to their land. This gives them a problem in offering security to a bank, and perhaps they themselves slightly favour the portability of a petrol pump, which has become more attractive due to a tariff reduction. Another reason is that there is still no reliable independent monitoring to prove the benefits of windpumps.

Credit Where Credit is Due

50 Condor continue with their effort to transform the landscape, to give food security using sustainable energy. They have made an impact: over 400 farmers unlock their windpumps each morning and allow the cool breeze to bring the water to the surface. Isn't now time for the banks to recognise the achievement and unlock funds for the manufacturer to invest in better production, and the farmer to obtain security free credit?

Personal Comment By the Author

Lack of working capital for suppliers and the lack of credit for users are two of the major constraints holding back widespread use of windpumps. It seems strange that the Philippines, which are so committed to renewable energy should fail to give its farmers some access to rural credit. Part of the answer is this: financial institutions are by their nature quite conservative (with some exceptions). In the past decade a number of windpump programmes have been promoted that then failed to sustainably replicate the technology. This has had a serious effect on the image of windpumps in the mind of the general 'Aid and Development' community. Also I believe that windpumps have had a fragmented and bad press, while some other technologies have had a coordinated and good press. Some technologies have been adopted by large manufacturers with the resources for lobbying the financial institutions. How can a company like Condor find the time and resources to do the same? So it falls to the international professional community to promote these viable technologies and lobby with good accurate information, true test results, clear presentations, what is and is not possible for a windpump. Isn't this what these pages are attempting to do?

Simon Batchelor/Gamos

Citation is encouraged on the condition that the source is indicated.
Reactions or other contributions are welcomed. Please write to:
Goezinne & Veldkamp, P.O. Box 775, 7500 AT Enschede, The Netherlands.
Fax: +31 53 31 03 30. Tel: +31 53 32 70 27. Telex: 44846 bchs nl.

Responsibility for the articles rests solely with the authors. Contributions should preferably not be longer than 300 words. For longer articles please contact the editors. The editors reserve the right to shorten reactions and articles.

Commonwealth Science Council

A Brief History

Formal co-operation between Commonwealth scientific organisations began in 1936, with a Commonwealth Scientific Conference. A Commonwealth Scientific Committee was established in 1958 to provide information and advice to the scientific agencies of the Commonwealth, and to help Commonwealth donor countries allocate assistance to developing countries.

As membership of the Commonwealth Scientific Committee grew, so did recognition of the specific needs of developing countries. This led to a revision of the Committee's activities into a programme for expanded scientific collaboration among Commonwealth members. This programme, and a new name – the Commonwealth Science Council (CSC) – was endorsed at the Commonwealth Heads of Government meeting of 1975.

Structure

The Commonwealth Science Council of today is an inter-governmental organisation with 36 members (Australia, Bahamas, Bangladesh, Barbados, Botswana, Britain, Brunei Darusslem, Canada, Cyprus, Dominica, Ghana, Grenada, Guyana, India, Jamaica, Kenya, Lesotho, Malawi, Malaysia, Malta, Mauritius, Namibia, New Zealand, Nigeria, Pakistan, Papua New Guinea, Seychelles, Sierra Leone, Saint Lucia, Sri Lanka, Swaziland, Tanzania, Trinidad & Tobago, Uganda, Zambia, Zimbabwe). The present Chairman is Dr. S.K. Joshi, from India's Department of Scientific and Industrial Research. CSC headquarters are in London, at the Commonwealth Secretariat, where the CSC Secretary also serves as Science Advisor to the Commonwealth Secretary-General.

The Council consists of senior scientists or science executives from all member countries; meetings are held about every two years to review the programme of activities.

Global Network

CSC's extensive global network of Commonwealth scientific institutions offers unique opportunities for nurturing the resources and expertise of member countries. In particular, the CSC provides a framework for south-south co-operation, enhancing the transfer of appropriate technology. Activities focus on practical applications of science, and on strengthening national science and technology infrastructures.

Each year, CSC holds regional and global workshops, across a range of subjects, which bring together Commonwealth scientists to share experiences, undertake training, or develop research projects. Special emphasis is placed on sustainable, environmentally sound development.

Flagship Programmes

At its last meeting, CSC identified three common areas of deficiency and opportunity – Biodiversity, Water Resources and Energy – amongst its members, on which resources are focused. These Flagship Programmes provide a broad framework for CSC work. The energy programme is described below.

Energy

The CSC's energy programme has encompassed a wide range of activities including solar heating and cooling, gathering of meteorological data for solar and wind energies, and energy conservation. The emphasis is on practical activities with potential for impact in the medium term.

For millions of people in the Com-

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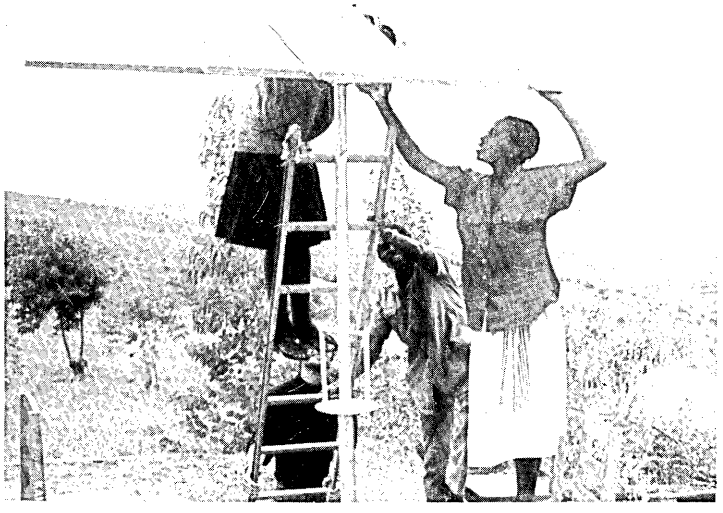

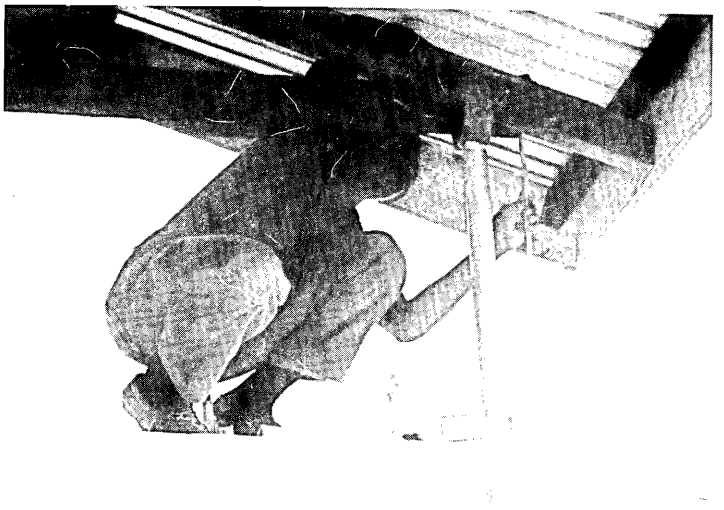

Installation of KARADEA solar training facility.

Commonwealth Science Council

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monwealth (and elsewhere) connection to an electricity grid is a remote dream, and there is a strong need for low-cost alternatives. In Tanzania, for example, over three quarters of the population do not have electricity. The CSC is collaborating with the Karagwe Development Association (KARADEA), a rural Tanzanian NGO, to develop solar power as a clean and cheap source of energy for rural areas of this region.

Many renewable energy programmes have failed in the past when technology has been provided without the involvement of local manpower and industry, so that there has been no capacity for maintenance and repair of equipment. CSC funding is providing local people in Tanzania with practical training in solar photovoltaic technology. To date, 18 trainee technicians have installed, repaired or upgraded several local PV systems, including systems in village shops and at a Rwandan refugee camp. The training activities are based at the KARADEA solar training facility, which CSC is helping to develop as a regional centre. The most promising students from a course to be held there later this year will be offered apprenticeships in a solar business in the region, to consolidate their practical and business experience.

CSC, with Energy Alternatives Africa and a Massai NGO, is also carrying out field trials of commercially available solar lanterns, and will investigate possibilities for local production of the most robust and popular designs.

CSC is also promoting solar drying techniques in small agricultural sectors, and helping to identify opportunities to use other forms of alternative energy, such as biomass or wind.

These activities are in keeping with CSC's aims to improve standards of living for local people, by developing indigenous capacity through the acquisition and practical application of science and technology.

Publications

CSC seeks to ensure that knowledge generated from its activities is fully disseminated, and currently has around 90 titles in print. These include technical reports, reviews, practical handbooks and manuals. A quarterly newsletter, "Commonwealth Scientist", is available free to libraries, and a Biennial Report of activities is produced.

For further information, contact:

The Information Officer
Commonwealth Science Council
Marlborough House, Pall Mall
London, SW1Y 5HX
United Kingdom
Tel: (44)(0) 171 747 6219
Fax: (44)(0) 171 839 6174

IFC Involvement in Renewables

The International Finance Corporation (IFC) is the private-sector arm of the World Bank Group and the largest multilateral source of equity and private sector investments in developing countries. It lends directly to private companies and makes equity investments in them, without guarantees from governments, and attracts other sources of funds for private-sector projects.

Since 1956, IFC has provided more than $14 billion in financing for 1,290 companies in 109 developing countries.

In July 1992 IFC created an Infrastructure Department in response to the growing demand for its services in this area. The Department's Power Division handles electric power generation projects including projects using renewable energy resources such as hydro, geothermal, biomass, and new technologies such as wind energy.

Hydro projects have recently been funded in Belize (25 MW), Chile (450 MW and 22 MW), and Costa Rica (11 MW). Geothermal projects are under review in Antigua, Guatemala, and Nicaragua. Wind power funding proposals have been received for projects in Costa Rica, Guatemala, Honduras, Mexico, and Uruguay. Biomass or photovoltaic (PV) projects have been considered in Brazil, Costa Rica and Jamaica. IFC has also made an investment in PV manufacturing in China.

The environment has been one of IFC's most urgent priorities and it is encouraging private sector involvement in the development of GEF assistance strategies for the private sector. As part of these efforts, as well as in relation to its power investments noted above, IFC is actively pursuing potential investments in renewable energy.

IFC can provide non-recourse project finance services:

- Debt/equity investments in commercial technologies in developing countries.
- GEF grants to "buy down" capital cost difference for qualifying technologies alongside conventional IFC project financing.

IFC can also provide services for manufacturing, investment and corporate finance:

- Debt/equity investments in manufacturing/assembly of commercial technologies in developing countries.
- GEF grants to support investments in manufacturing/assembly investments for precommercial technologies.

IFC is also considering establishing a Renewable Energy/Energy Efficiency/Private Equity/Venture Capital Fund that could provide the following:

- Equity financing for smaller renewable energy projects (5 to 20 MW) and for promising new applications such as off-grid power using solar and other renewables.
- Bilateral and GEF funds to assist with the "soft costs" of project preparation, to assess the technical and institutional risks of qualifying projects or technologies.

(Source: Extracted from, "IFC Involvement in Renewables", *The ESMAP Connection*, Vol. 2, No. 2, December 1994, p.11)

New Energy and Industrial Technology Development Organization (NEDO)

NEW ENERGY AND INDUSTRIAL TECHNOLOGY DEVELOPMENT ORGANIZATION

The New Energy and Industrial Technology Development Organization (NEDO) was established in October 1980 after the second oil crisis. Its purpose is to act as an implementing agency of the Japanese Government in fields related to technological development. NEDO is unique in that it accomplishes this by combining funds, human resources, and technology from the public, private, and academic sectors into one cohesive, effective working structure.

NEDO's activities can be divided into four major areas. The first is the development and promotion of oil-alternative (non-nuclear) energy technology, such as solar, geothermal, and clean coal technology. Energy conservation is also promoted. Through various international projects, NEDO's success in this area is being felt not only in Japan but throughout Asia. Research and development of industrial technology is NEDO's second major area of activity. NEDO's third and fourth areas of activity include the rationalization of Japan's domestic coal mining industry and the production of industrial-use alcohol, respectively.

NEDO's Asian Representative Office

Recently, NEDO opened its Asian Representative Office in Thailand. This is the fourth overseas representative office of NEDO and the first whose main focus is dealing with developing countries.

The activities of NEDO's Representative Office in Thailand will include research, development and verification of technology related to oil-alternative energy sources, research and development of industrial technology, and the rationalization of energy use. This office will endeavor to foster cooperation in these activities with other bodies in the Asian region.

Some of NEDO's Activities

Solar Energy

The technological development activities in the field of solar energy include studies on photovoltaic power generation technology, which directly converts the sun's light energy into electricity, and industrial solar system technology, which catches solar energy as heat.

In order to promote the development and commercialization of photovoltaic power generation systems, NEDO is involved in developing technology to produce thin polycrystalline solar cells, thin film solar cells, super high efficiency solar cells, and high quality compound semiconductors. In addition, research and development activities for PV system peripheral devices and their utilization technologies are being undertaken.

In order to promote industrial technology which utilizes solar heat NEDO is pursuing activities for commercial scale development of technologies that seem promising but which the private sector will not invest in because of perceived risks.

Coal Energy

To promote the increased use of coal, a major alternative energy source to oil, the development of technology to convert coal into a clean and easily-utilized energy form is being conducted. In particular, liquefaction and gasification technology, considered the most promising coal conversion technology, is being developed with the aim of commercial scale use in the future.

Because the use of coal results in the release of SOx, NOx and CO_2 in large quantities, the issues of acid rain and other global environment problems have to be addressed before smooth expansion of coal use can be realized.

Geothermal Energy

For the purpose of utilizing geothermal energy, NEDO is implementing various projects which include resource exploitation (the potential geothermal resource regions in Japan and investigation of energy conditions), exploration technique development, development of excavation and collection processes, and technological development (such as research and development of binary cycle power plants and hot dry rock energy).

Energy Conservation

In addition to the introduction of new energy, Japan, which is poor in natural resources, needs to actively promote energy conservation. NEDO is focusing efforts to improve existing technology related to energy use in order to stabilize long term energy demand.

NEDO is involved in the development of highly efficient energy conversion and energy conservation technology, such as fuel cells capable of high efficiency power generation, and also efficient energy storage and utilization technology, such as high performance batteries.

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Book Review

Passive and Low Energy Building Design for Tropical Island Climates

Prepared by N.V. Baker / ECD Partnership, London
The Commonwealth Secretariat,
Commonwealth Science Council
Marlborough House, Pall Mall, London SW1Y 5HX,
United Kingdom
ISBN 9-85092-312-3, May 1987, 197 p.

This technical handbook aims to assist the architect and engineer with energy conservation for buildings in tropical island climates. Two cooling strategies are identified: avoidance, where passive techniques are applied to reduce the need for mechanical cooling; and reduction, where air-conditioning is required, but passive techniques are employed to keep its use to a minimum.

The following topics are covered, including in most cases quantitative analytical procedures: climate and micro-climate; thermal comfort; building envelope specification; shading design; daylighting; ventilation and air movement; advanced passive cooling techniques; energy calculations; case studies; and basic building physics.

This publication includes an energy calculation method (PACE) for evaluating the performance of different passive measures to establish their cost effectiveness. It includes tables of data and printed worksheets for the PACE method, and over 150 illustrations throughout the text.

Apart from the issue of energy conservation, many of the techniques described in the handbook are equally applicable to low cost housing where their adoption would ensure acceptable comfort at minimum cost.

The handbook is available at £8.00 from Commonwealth Science Council, Marlborough House, Pall Mall, London SW1Y 5HX, United Kingdom.

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New Energy and Industrial Technology Development Organization (NEDO)

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Other Energies

In recent years, waste materials have been recognized as having the highest potential among undeveloped energy sources. In order to diversify energy-supply sources, NEDO is developing technology to utilize alcohol and biomass energy by employing results from the latest research.

Introduction, Promotion and Diffusion of New Energy and Energy Conservation

NEDO is conducting a new energy power generation field test project in which photovoltaic power generation systems and fuel cell systems are experimentally installed at user sites (museums, schools, public halls, etc. for photovoltaic power generation systems; hotels, hospitals, offices, etc. for fuel cell systems) and test-operated under actual load conditions to collect and analyze operation data.

This project aims to make the practicality of photovoltaic power generation and fuel cell systems widely known among the general public, and thereby contribute to the promotion of those systems.

For further information contact:

Asian Representative Office, NEDO
Sintorn Building Tower II, 8th Floor
130-132 Wittayu Road
Lumpini, Pathumwan
Bangkok 10330
Thailand
Tel: (66-2) 256-6725-6
Fax: (66-2) 256-6727

2nd AIT Training Course on Solar Photovoltaic Systems for Rural Electrification

4-15 December 1995, Asian Institute of Technology, Bangkok, Thailand

Objectives and Description

To provide intermediate level training in the technology for PV based rural electrification. The course will cover solar system design for various types of domestic and industrial use. Installation will be emphasized as well as maintenance and trouble shooting of panels, controllers, batteries, inverters, lights, refrigerators and DC/AC converters for radio and tape player use. Central systems for rural electrification will also be introduced.

Participants

Persons with basic training or experience in photovoltaic technology as applied to rural electrification and who have, or will have responsibility for system design, installation, maintenance and repair of photovoltaic systems for rural electrification. 15 - 20 persons.

Fee: US$ 1500

For further information please contact:

Prof. E. Karmazsin
Coordinator-Energy Park
Asian Institute of Technology
GPO Box 2754, Bangkok 10501
THAILAND.
Tel: (66-2) 524-6212
Fax: (66-2) 524-5439

Book Review

From P. 14

Solar Dryers – Their Role in Post-Harvest Processing

Contributed by B. Brenndorfer, L. Kennedy, C.O. Oswin Bateman, D.S. Trim, G.C. Mrema and C. Wereko-Brobby
Printed and published by
The Commonwealth Secretariat, Commonwealth Science Council
Marlborough House, Pall Mall, London SW1Y 5HX, United Kingdom
ISBN 0-85092-282-8, 1987, x+298 p.

This manual presents an introduction to the basic theories of solar drying and outlines the principal operating features of the main solar dryer designs, including a detailed description of the construction and operation of the three most popular types of solar dryer. Information is included on the theory and design of flat-plate solar collectors which are an integral part of many dryers. It provides guidelines on experimental methodology and the techno-economic evaluation, development and extension of solar dryer technologies. Case studies are presented on drying theory, dryer design and economic analysis for selected end-uses.

It is important to realise that solar drying, or any drying technique for that matter, is not an operation carried out in isolation and therefore sections have been included on pre-drying processes and techniques, methods of quality assessment and analysis, and storage and packaging techniques.

The book may be purchased at £7.50 from Commonwealth Secretariat Publications, Marlborough House, London SW1Y 5HX, United Kingdom.

Publications Received

ENERGY CONSERVATION

* *Passive and Low Energy Building Design for Tropical Island Climates*, prepared by N.V. Baker/ECD Partnership, London, published by The Commonwealth Secretariat, Commonwealth Science Council, Marlborough House, Pall Mall, London SW1Y 5HX, United Kingdom, May 1987, ISBN 9-85092-312-3, 197 p.

SOLAR ENERGY

* *Solar Dryers – Their Role in Post-Harvest Processing*, contributed by B. Brenndorfer, L. Kennedy, C.O. Oswin Bateman, D.S. Trim, G.C. Mrema and C. Wereko-Brobby, printed and published by The Commonwealth Secretariat, Commonwealth Science Council, Marlborough House, Pall Mall, London SW1Y 5HX, United Kingdom, 1987, ISBN 0-85092-282-8, x+298 p.

Training Courses/Conferences

Conference and Exhibition "Hydropower into the Next Century"
5-8 June 1995
Barcelona, Spain

The conference is jointly organized by The International Journal on Hydropower & Dams and Status Meetings Ltd. Official languages will be English, Spanish and French and simultaneous interpretation will be provided.

The conference aims to address both technical and administrative issues relating to the planning, design, and implementation of hydropower schemes and refurbishment/upgrading projects. Innovative case studies and reviews will illustrate recent technological achievements and progress in hydropower research and development. A major element of the proceedings will focus on social and environmental issues, the link between hydropower and society, and the positive influences of hydro development that are often understated.

For further information contact:
The International Journal on Hydropower & Dams
Aqua≈Media International
Westmead House
Westmead Road
Sutton, Surrey SM1 4JH
United Kingdom
Tel: +44(0) 81 643 4727/5133
Fax: +44(0) 81 643 8200

ECOS '95 – International Conference on Efficiency, Costs, Optimization, Simulation and Environmental Impacts of Energy Systems
11–14 July 1995
Istanbul, Turkey

Papers dealing with theoretical and/or applied aspects of the following seven topic areas are invited:

- Thermodynamic and thermo-economic analysis of energy systems;
- Simulation, optimization and design of energy systems;
- Improvements in the use of

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Training Courses/Conferences
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fossil fuels and renewable energy;
- Environmental impacts of energy-intensive processes;
- Energy management and economics;
- Energy systems for the future; and
- Classical and non-equilibrium thermodynamics.

For details contact:
ECOS '95 Conference Secretariat
Prof. Y.Gögüs
F.B.E. School of Natural and Applied Sciences
Middle East Technical University
TR-06531 Ankara
Turkey
Tel: (90-312) 210-1000
Fax: (90-312) 210-1110 (1113 or 1115)

Training Course on Micro-Hydro Power
3-23 September 1995
Cebu, Philippines

The course is organized by SIBAT (Philippines), the Intermediate Technology Development Group (IT) and a consortium of European agencies – the Mini Hydro Power Group (MHGP). The course is designed for rural development planners, engineers and technicians.

Topics to be covered include:
- Energy in integrated rural development;
- Associated socio-economic issues;
- Site survey techniques;
- Feasibility studies;
- Hydrology;
- Intakes, canals;
- Settling/forebay tanks;
- Penstocks;
- Turbine design and local manufacture;
- Drives;
- Alternators and induction generators;
- Electronic load controllers;
- Transmission lines;
- Contractual considerations;
- Economics, subsidy and credit policy;
- Tariff structures, participative planning;
- Ownership and management;
- Operation and maintenance; and
- Distribution techniques (electronic cut-outs).

For further information contact:
Coordinator
Micro-Hydro International Course
Intermediate Technology
Myson House, Railway Terrace
Rugby, CV21 3HT
United Kingdom
Tel: 44-788-560631
Fax: 44-788-540270
Tlx: 317466 ITDG

Workshop on Materials Science and Physics of Non-Conventional Energy Sources
18 September-6 October 1995
Trieste, Italy

The workshop will be conducted by the International Centre for Theoretical Physics (ICTP), Trieste, Italy. The emphasis will be on those aspects of materials science and technology which are particularly relevant to solar energy conversion and storage. Concrete projects and realizations, as well as environmental, economic and social aspects will be adequately considered.

For details contact:
International Centre for Theoretical Physics
Workshop on Materials Science and Physics of Non-Conventional Energy Sources
P.O. Box 586, I - 34100 Trieste
Italy

Training Course "Grid Connected Wind Energy Converters"
September 1995 - August 1996
Wilhelmshaven, Germany

The course is conducted by the Carl Duisberg Gesellschaft e.V. (CDG) on behalf of the Federal Ministry for Economic Cooperation and Development of the Federal Republic of Germany.

The course consists of two main parts, a German language course of about six months and the specialist course on wind energy which will be held in the German language at the German Wind Energy Institute in Wilhelmshaven (DEWI).

Theoretical Part

The theoretical part of the continuation course consists of several learning packages which deal with the main subjects of wind energy. The course packages are:
- Basic course on wind and wind energy converters (WECs);
- Climatical and infrastructural site evaluation;
- Technical concepts and control of WECs;
- Net integration and special conditions of weak grids;
- Data acquisition for wind and power measurements;
- Planning methods for the application of WECs and windfarms;
- Preparation of specifications and system requirements;
- Foundation, installation and commissioning;
- Economic evaluation on micro and macro economic basis; and
- Operation and maintenance of WECs.

Practical Part

The practical part of the continuation course will take place on the DEWI wind test site near Wilhelmshaven, where two 500 kW and two 30 kW wind energy converters are installed. It involves works and measurements with the DEWI Wind-Diesel-System which allows to simulate the behaviour of a weak grid. In addition wind and power measurements can be exercised on the test site including the training of the standard data evaluation methods. The DEWI also offers the participation in actual measurement and WEC installation campaigns for customers, if those happen during the respective training period.

For further information concerning the organization/administration of the course contact:
Mr. Knecht
Carl Duisberg Gesellschaft
E 11, Lützowufer 6-9
10785 Berlin

Germany
Tel: +49 30 2548 2110
Fax: +49 30 2548 2218

AISEC-5 – The 5th Arabic International Solar Energy Conference
13-16 November 1995
Manama, Bahrain

The 5th Arabic International Solar Energy Conference organized by the Bahrain Centre for Studies and Research (BCSR) aims at promoting scientific research and keeping abreast of scientific advancement in this important field in Bahrain, the Arabian Gulf community and the Arab World.

Conference topics include:
- Solar radiation measurement and modeling;
- Solar heating and cooling;
- Passive solar architecture;
- Photovoltaic systems;
- Indirect solar energy: Hydrogen energy systems, biomass and biofuels, wind energy, others;
- Solar energy economy and policy;
- Solar energy education;
- Solar energy and environment;
- Solar astronomy;
- Active and hybrid solar systems;
- Solar energy and water resources; and
- Meteorology, fundamentals.

For details contact:
Conference Secretariat, AISEC-5
Bahrain Centre for Studies & Research
P.O.Box 496, Manama
State of Bahrain
Tel: (0973) 754 757
Fax: (0973) 754 678
Tlx: (490) 9764 BCSR BN

Planning for Energy and Environment
15 May-17 June 1995
Enschede, Netherlands

This international workshop is organised by the Technology and Development Group (TDG) of the University of Twente (UT), in close cooperation with the Division of Social Sciences of the International Institute for Aerospace Survey and Earth Sciences (ITC).

The workshop will address the planning implications of key issues in environmental planning and management – questions of priorities for resource and energy use, population and economic development, responsibilities for environmental pollution.

The workshop consists of the following modules:
- Policies and planning for sustainable energy & environment;
- Environmental assessments;
- New approaches in forestry;
- Energy in agriculture; and
- Energy & environmental issues in industry & transport.

For details contact:
The Course Administrator
Technology and Development Group
VOK/CT 1799
University of Twente
P.O. Box 217
7500 AE Enschede
The Netherlands
Tel: 31-53 893539/894377
Fax: 31-53-340822

The 6th ASEAN Conference on Energy Technology
28-29 August 1995
Bangkok, Thailand

The conference, which is organised by ASEAN Sub-committee on Non-Conventional Energy Research (ASEAN SCNCER), National Research Council of Thailand (NRCT) and King Mongkut's Institute of Technology Thonburi (KMITT), aims at reviewing and disseminating the latest technologies on energy utilization, conversion and management.

Conference topics include:
- Energy Conservation and Management;
- Renewable Energy;
- Energy Policy and Planning; and
- Environmental Issues Related to Energy Utilization.

For details contact:
Assoc. Prof. Chullapong Chullabodhi
Conference Chairman
6th ASEAN Conference on Energy Technology
c/o School of Energy and Materials
King Mongkut's Institute of Technology Thonburi (KMITT)
Bangmod, Rasburana, Bangkok 10140
Thailand
Tel: (66-2) 427 8094
Fax: (66-2) 427 9062
(66-2) 427 8077

International Symposium on Energy, Environment and Economics
20-24 November 1995
Melbourne, Australia

This symposium will serve, at an international level, as a forum for an exchange of knowledge, ideas and plans for the future in the policy, efficiency, economics and environmental effects of energy production, utilisation and conversion. As the world becomes a freer and more challenging market, the significance of energy grows as its conversion and use underlies most human activity. Energy issues are emerging in a widening range of industries striving to ensure profitability whilst addressing environmental concerns. No longer can the consequences of energy use be seen to be a national or a regional issue. As well as providing specialized streams, this symposium will provide the opportunity for exchange and learning in overlapping disciplines.

For further information contact:
The Secretary
Symposium on EEE
Faculty of Engineering
The University of Melbourne
Parkville, Australia 3052

Renewable Energy for Rural Development
28-30 August 1995
Bangkok, Thailand

The conference is organised by ASEAN Solar Energy Network (ASEN) as part of the Fourth ASEAN

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BOSTID Publications Available from RERIC

The Board on Science and Technology for International Development (BOSTID), U.S. National Research Council, has agreed to offer their publications available at RERIC/AIT free of charge. To obtain copies of BOSTID publications listed below, please contact: RERIC, AIT-CLAIR, P.O. Box 2754, Bangkok 10501, Thailand. The requesters are required to pay for the following air-mailing and handling charges:

Asian countries: US$10.00 per copy; All other countries: US$15.00 per copy.

BOSTID PUBLICATIONS

General

- U.S. Science and Technology for Development: Contributions to the UN Conference. 1978. 226 pp.
- Directory of U.S. Courses in Biotechnology for Developing Country Scientist. 1984. 282 pp.
- Fisheries Technologies for Developing Countries. 1987. 167 pp.
- Science and Technology for Development: Prospects Entering the Twenty-First Century. 1988. 79 pp.
- Conserving Biodiversity: A Research Agenda for Development Agencies. 1992. 127 pp.

Health

- Opportunities for Control of Dracunculiasis. 1983. 65 pp.
- Manpower Needs and Career Opportunities in the Field Aspects of Vector Biology. 1983. 53 pp.
- Comment Lutter Contre la Dracunculose. 1984. 72 pp.
- Workshop on Opportunities for Control of Dracunculiasis. 1985. 177 pp.
- The US Capicity to Address Tropical Infectious Diesease Problems. 1987. 225 pp.

Energy

- Proceedings, International Workshop on Energy Survey Methodologies for Developing Countries. 1980. 220 pp.
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Technology Options

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- Saline Agriculture: Salt-Tolerant Plants For Developing Countries. 1990. 143 pp.
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Innovations in Tropical Forestry

- Firewood Crops: Shrub and Tree Species for Energy Production. Volume I, 1980. 236 pp.
- Firewood Crops: Shrub and Tree Species for Energy Production. Volume II, 1983. 56 pp.
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- Calliandra: A Versatile Small Tree for the Humid Tropics. 1983. 56 pp.
- Casuarinas: Nitrogen-Fixing Trees for Adverse Sites. 1983. 118 pp.
- Leucaena: Promising Forage and Tree Crop in Developing Countries (Second Edition). 1984. 100 pp.

Managing Tropical Animal Resources

- The Water Buffalo: New Prospects for an Underutilized Animal. 1981. 118 pp.
- Butterfly Farming in Papua New Guinea. 1983. 36 pp.
- Crocodiles as a Resource for the Tropics. 1983. 60 pp.
- Little-Known Asian Animals with a Promising Economic Future. 1983. 133 pp.

Plants

- Amaranth: Modern Prospects for an Ancient Crop. 1983. 81 pp.
- Jojoba: New Crop for Arid Lands. 1985. 102 pp.
- Lost Crops of the INCAS. 1989. 415 pp.

Training Courses/Conferences

From P. 17

Science and Technolgy Week. The theme for the conference is Renewable Energy for Rural Development and papers anticipated covering solar and heat pump drying, photovoltaic water pumping, energy for agro-industry, remote area power supplies, etc.

For further information contact:

Secretary
ASEAN Solar Energy Network
P.O. Box 91, Ratburana
Bangkok 10140
Thailand
Tel/Fax: (66-2) 428 4014

Diary of Events

* **9-13 May 1995, Beijing, People's Republic of China**

BICWE '95 - Beijing International Conference on Wind Energy & Regional Workshop

For details contact:
Ma Chenhui
BICWE '95 Secretariat
Information Research Institute of Electric Power
MEP, Liupukang, Dewai
Beijing 100011
People's Republic of China
Tel: +86 1 401 3166
Fax: +86 1 201 6165

* **16-18 May 1995, Amsterdam, Netherlands**

Power-Gen Europe '95

The third Power-Gen Europe Conference and exhibition will address current business trends and opportunities in the European power generation industry.

For details contact:
POWER-GEN
Postbus 9402
NL-3506 GK Utrecht
The Netherlands
Tel: +31 30 650963
Fax: +31 30 650928

* **20-21 May 1995, Tehachapi, CL, USA**

Tehachapi Wind Fair

For details contact:
Kern Wind Energy Association
208 S. Green St., #5
P.O. Box 277
Tehachapi, California
USA
Tel: +805 822 7956
Fax: +805 822 8452

* **11 – 16 June 1995, Snowbird, UT, USA**

14th North American Meeting of the Catalysis Society

For details contact:
Fransis V. Hanson
Department of Chemical and Fuels Engineering
University of Utah
3290 MEB, Salt Lake City
UT 84112
USA

* **12 – 15 June 1995, Atlanta, GA, USA**

1995 IEEE Power Electronics Specialist Conference – PESC 95

For details contact:
Dr. Hans Puttgen
School of Elec. & Computer Eng.

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RERIC's New Publications

1. ***Solar Timber Seasoning Kilns Developed by the Asian Institute of Technology*** (by R.H.B. Exell), AIT Research Report No. 279, 1995, 34 p.

   Price: Asian countries = US$15.00 per copy by air-mail
   All other countries = US$20.00 per copy by air-mail

2. ***Global Warming Issues in Asia,*** Proceedings of the Workshop on Global Warming Issues in Asia, 8-10 September 1993, Bangkok, Thailand (edited by S.C. Bhattacharya, A.B. Pittock and N.J.D. Lucas), 1994, 543p.

   Price: Asian countries = US$50.00 per copy by air-mail
   All other countries = US$65.00 per copy by air-mail

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Bangkok 10501
Thailand

From P. 19

Georgia Institute of Technology
Atlanta, GA 30332-0250
USA

* **19-21 July 1995, United Kingdom**

BWEA 17, British Wind Energy Association's Annual Conference

For details contact:
Dr. J.A. Halliday
BWEA, Lincoln's Inn House
42 Kingsway
London WC2B 6EX
United Kingdom
Tel: +44 171 404 3433
Fax: +44 171 404 3432

* **31 July – 4 August 1995, Istanbul, Turkey**

New Energy Systems and Conversions

For details contact:
The Conference Secretariat
Kongresist International Convection Management Inc.
Elmadag, Cumhuryet Cad. 193/6
80230 - Istanbul
Turkey
Fax: (90-212) 233 7678, 246 5490

* **22-25 August 1995, London, United Kingdom**

International Conference on Greenhouse Gases: Mitigation Options

For details contact:
Andrea Smith
IEA Greenhouse Gas R&D Programme
Mitigation Options Conference
c/o CRE, Stoke Orchard
Cheltenham GL52 4RZ, Glos.
United Kingdom
Tel: (+44) 242 680 753
Fax: (+44) 242 680 758

* **5-7 September 1995, Helsinki, Finland**

The Economics of Wind Energy

This is a Special Topic Conference on the economics of wind energy organised by the European Wind Energy Association (EWEA) in cooperation with Finnish Wind Power Association (FWPA).

For details contact:
Mr. Erkki Haapanen
Finnish Wind Power Association
FIN-35600 Halli
Finland
Fax: +358 4282 0648

* **9-11 October 1995, Nice, France**

Uprating & Refurbishing Hydro Powerplants

For details contact:
The Conference Desk
First Europe Communications
43-45 John Street
London EC1M 4AN
United Kingdom
Tel: +44(0) 171 490 3318
Fax: +44(0) 171 490 3319

* **29 October – 3 November 1995, Columbus, OH, USA**

ESMO 95 – 1995 IEEE 7th International Conference on Transmission and Distribution Construction, Operation and Live-Line Maintenance

For details contact:
Mr. T.C. Wong
c/o American Electric Power Service Corp.
1 Riverside Plaza
Columbus, OH 43215
USA

* **20-24 November 1995, Maputo, Mozambique**

Int. Africa Conference: Sustainable Energy for Development

For details contact:
Jose de Abreau, AITP
Av. Amilcar Cabral 212
P.O. Box 1574, Maputo
Mozambique
Tel: 2581 4759 38
Fax: 2581 4759 40

* **4 – 8 December 1995, Clearwater Beach, FL, USA**

Thermal Performance of the Exterior Envelopes of Buildings IV

For details contact:
Oak Ridge National Laboratory
Thermal Envelope Conference
P.O. Box 2008, Bldg. 3147
Oak Ridge
Tennessee 39831-6070
USA
Att: Pat Love

The Regional Energy Resources Information Center (RERIC) is one of the four specialized information centers of the Center for Library and Information Resources, Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

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Development of a Low Cost Solar Water Heater in Vietnam

Being a tropical country, Vietnam can utilize a crucial amount of solar energy potential to meet the energy needs of the country. The best climatic conditions for the utilization of solar energy are to be found mainly in South Vietnam followed by the Central Region of the country. Despite the high value of solar radiation in the summer, the Northern Region (including Red River Delta) is influenced by bad weather condition (rain and cloudy sky) at other times. The prevailing diffused radiation thus puts limitations on the utilization of solar energy.

Up to now, solar applications are not widespread, and one future aim is to create an awareness of its potential. In the past, there has been some use of solar applications like solar water heater, solar cooker, solar dryer, PV-modules etc, but, in most cases, these components are still under experimentation.

Focusing systems, like the solar reflector (parabolic) cooker, or highly sophisticated solar tower plants, should be installed mainly in the region below 17 degrees latitude because of their need of direct radiation. An important factor is the introduction of simple and cheap solar applications.

One of the main activities of the Renewable Energy Research Center (RERC) in Vietnam is to undertake research in solar energy in the field of appropriate technology. The solar energy group of RERC has designed a highly efficient solar water heater (SWH) with integrated storage.

The collector consists of collector cum-storage tanks which are designed as small units each of 30 liters (0.1 m x 0.1 m x 0.3 m) capacity. Three tank units have been combined to get a volume of 90 liters. Inside the tank, a wavy metal or a plastic plate is linked under the absorber surface. The water heating mechanism is based on the thermosiphon effect. With solar radiation, the space between the absorber surface and the wavy metal plate decreases which makes the heated water rise to the upper part of the tank. Natural circulation within the tank then occurs with the cold water from the top taking the lower space.

The RERC solar water heater has many advantages like its simple design, its high efficiency, and its low price (130 US$/m^2). Since 1994, more than 40 systems of 1 m^2 have been installed on an experimental basis in Hanoi and in Ho Chi Minh City. RERC aims to set up a production line for this new model of SWH sometime in the future.

(Contributed by Mr. Tran Quoc Qian, Renewable Energy Research Center (RERC), Hanoi National Institute of Technology, Hanoi, Vietnam)

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Some Basic Facts About Wind Energy

- According to the U.S. Department of energy, the world's winds could supply as much as 3,900 quadrillion BTUs (or quads) of energy each year--more than 10 times current world energy demand.

- Today there are approximately 16,000 utility scale wind turbines operating in the U.S. These turbines generate about 3.5 billion kilowatt-hours of electricity each year, which is enough to serve the residential power needs of a city the size of San Francisco, Boston or Detroit.

- Over the last decade, the cost of wind-generated electricity has dropped by more than 80 per cent. New utility-scale wind projects are being built for as low as 3.9 cents per kilowatt-hour.

- Wind projects are being developed in nearly every region of the U.S.--the Northwest, Great Plains, Southwest, Northeast and California.

- About $3.5 billion is invested in the U.S. wind energy industry, where watt-for-watt, dollar-for-dollar, that investment creates more jobs than any other utility scale energy source.

- The worldwide wind energy market is conservatively valued at $2 billion to $4 billion by the year 2000.

(Source: Wind Energy Fact Sheet, American Wind Energy Association, Washington D.C., USA, February, 1995)

WIND POWER PROJECTS CURRENTLY OPERATING IN THE U.S.

Location	Power Purchaser/User	Capacity	Annual output (The average U.S. family consumes 9,300 kWh of electricity per year.)
Lewis County, NY	Niagara Mohawk Power	0.7 MW	million kWh (since 1992)
Buffalo Ridge, Minn.	Northern States Power	25.0 MW	3.7 million kWh (5/94-12/94)
Holland, Minn.	Northern States Power	0.2 MW	201,000 kWh (1994)
Marshall, Minn.	Marshall Municipal Utilities	0.6 MW	652,000 kWh (1994)
Allendorf, Iowa	IES Utilities	0.3 MW	not available
Waverly, Iowa	Waverly Light & Power	0.1 MW	116,000 kWh (1993)
NE Amarillo, Texas	Southwestern Public Service	0.9 MW	800,000 kWh (1994 est.)
Dallas-Ft.Worth, Texas	TU Electric	0.9 MW	1.3 million kWh (1994)
Tehachapi Pass, Calif.	Southern California Edison	638.0 MW	1.4 billion kWh (1994 est.)
San Gorgonio Pass, Calif.	Southern California Edison	263.0 MW	750 million kWh (1994 est.)
Solano Country, Calif.	Pacific Gas & Electric	60.0 MW	6.8 million kwh (1994)
Altamont Pass, Calif.	Pacific Gas & Electric	691.0 MW	1.1 billion kWh (1994 est.)
Solano Country, Calif.	S.M.U.D.	5.0 MW	7.4 million kWh (7/94-12/94)
Kahuka/Oahu, Hawaii	Makani Uwila Power Corp.	12.0 MW	not available

Guidelines for Wind Energy in the UK

The British Wind Energy Association (BWEA) has published Best Practice Guidelines for Wind Energy Development which has been designed to assist the development of appropriate wind energy projects in the UK.

The Guidelines result from an innovative process in which help with setting criteria and with drafting was invited from groups with diverse views on wind energy. The Royal Society for the Protection of Birds (RSPB), Scottish Natural Heritage and the Countryside Council for Wales were members of the panel alongside other organizations which included international environment groups, local authorities and specialist agencies.

The Guidelines have been drawn up with the objective of providing clear guidance on the environmental and planning issues that should be considered for wind energy projects and the

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dialogue that should be undertaken. They are directed at wind energy companies, but they are also expected to be relevant to local authorities and local communities.

Wind energy is seen as a clean source of renewable energy. There are currently 27 wind farms either operating or under construction in the UK. These comprise over 460 wind turbines with a total capacity of 160MW and they represent an industry investment of about £170 million. They are capable of saving about 400,000 tonnes of carbon dioxide each year and producing in the region of 420,000,000 units of electricity annually, enough to meet the domestic electricity demands of about 260,000 people.

The government has set a target of 1,500MW of renewable energy capacity by the year 2000, approximately 5 per cent of the UK electricity demand. The Non-Fossil Fuel Obligation is the main mechanism for achieving this target. It provides financial support for renewable energy projects partly to secure the environmental benefits of renewable energy and to act as a 'kick start' mechanism for the embryonic renewable energy industries.

Copies of the Guidelines can be obtained from BWEA, 42 Kingsway, London WC2B 6EX.

(Source: Energy Digest, Vol. 24, No. 1, 1995, p.19)

Wind and Water: The Poldaw Windpump

For centuries people have used the power of the wind for lifting water. Many of the windpump designs developed about a hundred years ago have proved to be very robust and reliable, and it is believed that as many as a million windpumps today are still providing water in many of the world's remote areas. The problems which have been encountered, particularly in developing countries, are those of high initial cost, difficulty of local manufacture, and the need for regular maintenance. These characteristics are inherent in the designs, which have not evolved substantially during this century --until recently that is.

The Poldaw windpump is a product of a modern windpump design, tailored to the needs of developing countries, which has gone through the design and testing stages, and is now entering production in small factories in different parts of the world.

Design Criteria

The major advance which this machine represents is the low capital cost for its size, while maintaining high strength and reliability.

Robustness and reliability are paramount, and ideally the machine should require zero or very little maintenance.

The design should use readily available low-cost materials, and should require the minimum of labor and equipment to manufacture.

The use of expensive machinery such as milling machines and gear cutters must be avoided if possible.

Installation and maintenance should be simple, quick, and safe.

The size of the machine must be sufficient to give a useful output of water. As a minimum this should be at least three or four times the output of a handpump, as anything smaller would have very limited market appeal.

Technical Specifications

Most of the material is steel angle sections, steel tubing and steel plate and sheet. Little machining is required, only turning and drilling, and the only critical dimensions are the seatings for the ball-bearings. Use of a few simple jigs and fixtures ensures accurate manufacture and interchangeability of parts.

Only three standard flanged ball-bearings are used, and the remainder of the moving parts are supported by various wood, plastic, and rubber bearings and bushes. This minimizes the cost of bought-in components.

The total weight of the machine including a 6-meter high tower is 400 Kg, and easy, safe installation is ensured by assembling the machine with the tower lying down, and then winching the whole assembly upright.

Maintenance is limited to greasing the three ball bearings at least once a year, and touching up or repainting every few years. With attention to the paintwork (or the optional galvanized finish) the lifetime of the machine will be at least 20 years.

Any reciprocating (piston) pump can be used, with size appropriate to the depth of well. A range of low-cost shallow well pumps has been designed to complement the windpump. The aerodynamics of the wind rotor have been optimized to provide high torque at low speeds. This low speed operation permits the use of a simple low-cost direct drive transmission (no gears) without any risk of dynamic problems.

With appropriate pumps, the machine will start working in winds as low as 6mph (3m/second) and the automatic storm protection mechanism furls the windpump at speeds of 30 mph or more. The mechanism acts by allowing the rotor to turn edge on to wind, thus presenting the minimum area and minimizing the wind forces. When the wind drops, the machine automatically returns to normal operation. Optional extras include a galvanized finish for extra corrosion resistance, and tower extensions for sheltered sites where more height is needed to expose the rotor fully to the wind. The tower extensions also provide a wider base which can be useful for straddling open wells.

(Source: Appropriate Technology, Vol. 21, No. 4, March 1995, pp. 34-36)

An Intermediate Solution to Pelton Turbine Manufacturing in Rwanda

The Rwandan dissemination organization ARDI (Association for the Promotion of Integrated Development) in Kigali had previously initiated the setting up of micro-hydros in remote areas of the country. Their purpose was to drive hammer mills for the production of maize and sorghum flour. Given heads of not more than 20 meters, crossflow turbines manufactured in Kigali were the best choice.

For the new dissemination program, financed by the German Agency for Technical Cooperation (GTZ), potential sites were identified to generate 10 to 20 kW with heads of slightly more than 50 m. Exploitation of such sites was considered even more appropriate since Rwanda produces PVC pipes that can be used for the penstock. But the manufacture of Pelton turbines required various demanding technologies which clearly called for the import of the turbines from the industrialized countries. This was, however, not the purpose of the program, nor was it possible within the available budget. With the help of the Austrian turbine manufacturer, EFG, an intermediate solution was found in which a simple though effective Pelton turbine was developed. The aim was to gradually reduce the imported content of Pelton turbines and increase the local content.

The turbines to be used in Rwanda had to be similar in mechanical design to the hammer mills used, in order to reduce spare part requirements and to facilitate maintenance. The design permits a gradual reduction of the imported content, according to the manufacturing possibilities in the user country: cover, base frame, nozzle and, eventually the runner. Thus, this highly efficient turbine becomes economically very attractive. The turbine produces 20 kW at a net head of 54 m and waterflow of 50 l/s. This particular design can be used for a head between 30 to 180m, flow between 30 - 70 l/s and power generation between 8 - 110 kW. Efficiency is approximately 86% for low head and is up to 90% for high heads.

(Source: Extracted from Hydronet, Vol. 1, 1995, pp.8-9)

The Zambian Charcoal Industry

Charcoal is the most important household fuel in urban Zambia. It meets the energy needs of about 83 per cent of urban households. With an urbanization level of 42 per cent, charcoal is the major source of energy for more than a third of the population.

Charcoal Production

The charcoal used in central Zambia is produced from miombo woodland by the traditional earth kiln method. This method involves tree felling by hand or power saws, cross-cutting, kiln building and covering, wood carbonization, kiln tending and breaking to recover the charcoal.

This traditional technique of charcoal production is estimated to convert 20-25 per cent of wood mass to charcoal (oven-dry basis). The promotion of steel kilns by the forest department has had little success with small-scale producers.

Charcoal Use

The majority of households in the urban areas of central Zambia live in low cost, residential areas. Only about 11 per cent of these households have access to electricity compared to 61 per cent and 92 per cent in medium and high-cost residential areas, respectively. In addition, 60 per cent of households living in electrified homes use charcoal for cooking and water heating because of the lack of suitable electric stoves. About 75 per cent of urban households in central Zambia are wholly dependent on charcoal for cooking and water heating with an average consumption of 1,370kg per year, while households that are semi-dependent on charcoal use 972kg per year.

Ecological and Health Impacts

Tree felling has a serious effect on wildlife through the loss or fragmentation of habitats. Roads constructed for charcoal transportation bring harmful engine exhaust fumes. Total CO_2 emissions in Zambia are estimated at 33.5 million tons per year, and the contribution of urban charcoal burning in central Zambia at 1.6 per cent of this. Although this is a small contribution, 99 per cent of the CO_2 accumulates because photosynthetic fixation in deforested areas removes only one per cent in the year following deforestation.

In 1987, traffic emissions of nitrogen oxides were estimated at 6,500 tons. Emissions from charcoal burning in central Zambia were estimated at 2,900 tons in 1990. Charcoal burning released about 54,000 tons of volatile, organic compounds in 1990. All these substances may react in the atmosphere to form smog and ozone which are harmful, polluting substances.

It was found that exposure to smoke and gases were significantly different among firewood, charcoal and electricity users. Firewood users were more strongly exposed to particulates while charcoal users had higher exposure to carbon monoxide (CO). CO exposure among 31 per cent of charcoal users exceeded the WHO Europe recommended maximum levels as

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compared to 17 per cent of firewood users and only two per cent of electricity users.

In spite of the higher exposure to pollution, investigation of health effects among urban fuel users failed to substantiate a connection between the use of wood fuels and respiratory impairment. It was found that the activity perceived as most problematic was working at the burning kiln, exposure to ashes, smoke, gases and heat during kiln breading are contributing to the discomfort of charcoal producers.

The Economics of Charcoal

Out of Zambia's total primary energy supply of approximately 5.85 million tons of oil equivalent in 1990, charcoal accounted for about 33 per cent. However, in terms of final energy consumption, when conversion losses are taken into account the contribution of charcoal to national energy budget reduces to about 11 per cent, which puts it level with the major commercial fuels namely electricity and petroleum.

The demand for transportation and marketing of charcoal nationwide is high. In terms of income and employment generation, the charcoal industry is one of the most important industries in Zambia. It is estimated that charcoal production provides full-time employment for about 41,000 people in rural areas. A further 3,500 are employed in transportation and 1000 in marketing and distribution. An increase in capital investment in the form of equipment such as power saws and improved kilns, may raise the production cost while reducing employment in charcoal production. Another benefit of the present charcoal production method is that it involves very little foreign exchange.

Comparison of electricity and charcoal as domestic fuels

(Source: Hibajene and Kavema 1993 (project report No. 4))

Electricity	Charcoal
Advantages	
Versatile, has many end-uses	Minimal investment
Clean, Convenient	Little foreign exchange required
Temperature control	Provides employment to urban and rural poor
Time saving	Traded in quantities suitable to low disposable income
Efficient for cooking and lighting	
Stimulates productive home activities and studies	
No local environmental damage	
Disadvantages	
Requires major investment and skilled maintenance	Contributes to deforestation
Requires foreign exchange (70% in Zambia)	Dirty in use
Contributes to rural-urban migration	Slow to ignite and clook
Can be interrupted, sensitive to disturbances	Erratic availability (seasonal)
Dangerous in the kitchen	Stoves less fuel efficient than electric
	Kitchen Health Hazard

(Source Boiling Point, No 35, March 1995, pp. 21-23)

ETE 21 RESUME

ETE 21 (Energy, Technology and Environment, a Circle to Promote Rational Action for the 21st Century) has just completed its Mid'90s Resume. A networking approach was adopted to capture the vast wealth of information available worldwide from the extensive research and development program being carried out by governments, research institutions, industry and universities. ETE 21 organized a series of fourteen think-tanks around the world in both developed and developing countries, involving a multidisciplinary group of experts. Care was taken to ensure that these groups reflected a wide range of views in order that the study would be impartial and objective. Both technological and public policy were tested against the opinions and experience of other specialists and "recycled" during two integration meetings hosted by MIT in Cambridge, U.S.A. and ECN in Petten, The Netherlands.

The conclusions and options identified in the Mid '90s Resume are drawn from a global perspective, and provide a menu from which individual countries or regions can plan their actions for the next century. Each country or region will possess an "inheritance" --their existing energy/ technology asset base, their natural resource base--and their ability to take actions will be related to their particular economic situation and political structure. The co-ordinators are available to provide a briefing for decision makers and analysts in national, regional and local levels of Government, international institutions, and industry and commerce on the broad outcomes of the study, and to engage in a dialogue on country-specific issues.

Contact the joint co-ordinators: Hans DuMoulin, Compton Rise GU9 8EG, U.K., Fax +44 (0)1252 723923; or Michael Clegg, Foresters, SL5 8AW, U.K., Fax + 44 (0)1344 872735.

(Source: Renewable Energy, Vol. 22, No. 5, 1995, pp.465)

"Biogas Technology to Address a Unique Feedstrock" Within the Food Industry

The Solar Energy Research and Training Center (SERT) of Naresuan University, Phitsanulok, Thailand is expanding its work in the field of renewable energy utilization. A major new focus will be the utilization of local food industry wastes, to procure biogas for rural energy and at the same time clean up the environment.

SERT realizes that Thailand's food processing industry is rapidly expanding, producing high volumes of wastes that are, generally, improperly treated before disposal. The district of Bangkrathum, Phitsanulok, has an extensive 10,000 tonne banana-drying industry which produces waste consisting of 2,500 tonnes of banana peelings per year. This labor intensive industry is performed by over 200 families or co-operative working groups, scattered throughout this district of Bangkrathum.

A typical practice of these rural working groups is to deposit the banana peeling wastes at roadsides, water channels and house-yards. As a result, unattractive mounds of banana peelings undergo aerobic and anaerobic fermentation, releasing unpleasant odors, attracting flies, providing unsatisfactory working/health environments, and finally releasing methane and carbon-dioxide to the atmosphere.

The German Agency for Technical Co-operation (GTZ) has provided financial and technical assistance to support a demonstration project employing biogas technology to dispose of the discarded banana peelings in an environmentally friendly manner. The implementation of biogas technology to address the banana peeling wastes problem will potentially provide improved decentralized energy supplies with independent cooking and lighting applications.

Other economic outputs of the demonstration will be the procurement of quality fertilizer and possible fish feeds. Both will require minimal processing on site, to be applied locally or on a commercial basis to procure a saleable product. The project will serve as an effective example of environmental protection which can be widely disseminated throughout the region.

SERT recognizes that the project involves several integrated components such as the procurement of biogas, compost and fishfood, and furthermore views the demonstration as a first step to initiate dissemination of the technology. SERT has therefore integrated the participation of local government organizations into the project work so as to achieve maximum success and widespread understanding of the project's objectives.

The project will commence in late 1995, and further information can be acquired from SERT.

(Contributed by John O'Donoghue, Project Coordinator, SERT, Naresuan University, Phitsanulok, Thailand)

Co-generation Plant Modified

The Ustí Co-Generation Plant in the Northern Bohermian city of Most in the Czech Republic will have a five-part retrofit which will increase the efficiency and environmental standards of the plant. The first part of the project involves desulfurization, the half-wet additive method used should result in a decrease of SO_2 in smoke gases down to below 400 mg/Nm^3 and of solid particulate to under 50 mg/Nm^3. The second phase of the project involves the simple purchase of two new condensation turbines. This investment was included in the project for economic and efficiency reasons: currently the Ustí Plant operates with a reserve of about 100 MW. The turbines will make it possible to use the already existing steam capacity without building new supply sources.

These measures will reduce the concentration of carbon monoxide in smoke gases to below 150 mg/Nm^3. Another technological measure is the installation of control technology from Honeywell (US). The control system will improve the overall efficiency of the co-generation plant's operations, but it is difficult to quantify these benefits.

The final stage of the project will reduce emissions of nitrogen oxides. Installation of this equipment began in 1994 and will be put into operation sometime during 1995. The measure is expected to reduce the concentration of NO_x by at least 55 per cent, to under 350 mg/Nm^3. The project will include several other minor measures to accommodate the modifications described above.

(Source: News at SEVENs, Vol. 3, No. 3, 1995, p. 5)

Renewable Energy Based Power System

As a result of commitments made at the 1992 Rio Conference on Environment and Development, many industrial countries are attempting to stabilize their emissions of CO_2, the main `greenhouse' gas responsible for global warming. Some have gone even further, and plan substantial reductions of CO_2 output. This will be achieved largely through increased energy-use efficiency, and a switch of energy sources to those which produce less CO_2 ,among them the renewable sources: solar, wind, hydro, tidal, wave, biomass, and geothermal.

The Open University (OU) in the UK has recently produced *'Renewable Energy: A resource pack for tertiary education'*. This contains two large ring-binders of study text and course documents, together with a set of 80 slides, a videotape, and six floppy disks containing simulation exercises with all the necessary data.

The `renewables', of course, are quite a mixed bag and have different properties. Some generate heat, some electricity, some both. Some are continuous, others intermittent. A national or regional energy policy would combine various renewable sources so that they could complement one another. This can work even on a village scale where sun, wind, and hydro are mixed to give a 90 per cent renewable-electricity system which can be considerably more reliable than the public supply.

Undoubtedly, one of the most useful features of fossil fuels is that they are `self-storing', holding their energy compactly until it is required. In contrast, the intermittency of many renewable sources is often held against them. But intelligent planning of the energy system can overcome most of the difficulties. In the UK, for example, it has been shown that the national electricity system could absorb up to 20 per cent wind-energy contribution, with no real difficulty, although wind is a particularly erratic source.

`Lunar Energy'

Another intermittent but predictable source is tidal power which in a way, we could describe as `lunar energy'. Tidal systems generate electricity between 8 and 16 hours a day. These hours can be accurately predicted from tide-tables but, of course, they will occur at different times of the day, and will not necessarily coincide with peak demand of electricity. On a regional basis, however, they could be combined with other sources to make up a reliable supply. A modular tidal system which could be installed on quite a modest scale has been designed by the Tidal Electric company in the United States, which is currently discussing possible applications with the Indian Government. The concept is very simple, and consists of concrete tanks spanning high and low water. As the tide comes in, gates are opened, and water flows into the tanks through turbines to generate electricity. At high tide, the gates are closed, trapping the water. At low tide, the gates are reopened, releasing the water and generating further electricity.

Filling the `Gap' with Fuel Crops

The use of combinations of intermittent resources for generating electricity is bound to create `gaps' or shortfalls in the supply of electricity. Although, these `gaps' are conveniently filled in by conventional fuels, a renewable alternative of biomass has a potential to do the same. Biomass, which can be harvested where and when convenient, and stored, can be used to provide heat directly, or can be converted to electricity.

Biomass accounts for 35 per cent of total energy consumption in the developing countries while, in the industrial countries, it is only 3 per cent. Although the yield per unit of land is far less than, for example, wind farms or photovoltaics, when it is combined with other land use considerations, it starts to look very promising. In the European Union, where overproduction of food is taking place, growing of energy crops could become a major alternative, and a useful source of income for farmers.

Particular interest is focused on `Short-Rotation Coppicing' (SRC). Coppicing is the practice of cutting back trees periodically, and allowing them to regrow from the cut stump. Growth is usually faster than that of older trees, and the wood is softer and can be harvested with lighter machinery. The material is harvested every three years, chipped. and then fed to gasifiers or other conversion plants--ideally, a combined heat-and-power unit.

There are potential environmental problems with fuel crops, but SRC offers benefits also. Cultivating soil is a major cause of soil erosion but, because coppice plantations are permanent, the ground need never be ploughed. Furthermore, the tree roots help to stabilize the ground and retain moisture. Trees need little if any chemical treatment, and provide substantial habitat for wildlife, especially if the planting patterns are designed with ecological factors in mind.

The economic potential for biomass fuels depends to a large extent on the price of energy. In the UK, for example, if the price doubles, biomass would outweigh all the other renewable sources combined. In the long-term future, it may take over from fossil fuels as the main way of `filling the gaps' in a renewable-based electricity supply. It could also alter the appearance of the landscape, which is always a source of controversy; but in many areas the change would be a positive one.

(Source: "Northern News", Appropriate Technology, Vol. 21, No. 1, June 1995, pp.26-27)

Agricultural Waste Gasification in the Philippines

A Woodwaste/Agriwaste Gasification Pilot Plant, a joint undertaking of Industrial Technology Development Institute (ITDI) and the Engineering Advancement Association of Japan (ENAA), has been constructed and operated to produce 70-100 kW of electric power from wood and agricultural waste in the Philippines.

The operation of the plant involves the following major procedures: preparation of the waste material, i.e., cutting up and predrying them; feeding the material into the reactors; gasification, which involves the partial combustion of the raw materials on a fluidized bed at a temperature of 750-900°C; purification of the resulting low-calorific gas; and combustion of the product gas and generation of electricity. Waste water produced in the process is treated in a bioreactor for organic contaminants and stored in a tank.

The technology would be particularly applicable in the rural areas where agricultural wastes abound. Its wide use can even help in the dispersal of small and medium industries to the countryside.

The ITDI-ENAA pilot plant has also given Filipino researchers and students first-hand information on current trends and state-of-the-art instruments for gasification, fluidizing systems and wastewater treatment. Experts feel that the Philippine energy program will definitely benefit from this undertaking. And once this technology is commercialized, it will provide an alternative power generation source to the 50 per cent of the Philippine communities which remain unelectrified, to the agro-industrial establishments where most wastes are produced, and to areas with an abundance of biomass.

(Source: Energy Alternatives, Vol. X, No. 2, 1994, p.3)

Poihipi Recycles Geothermal Turbines

New Zealand distribution company Mercury Energy has taken a 51 per cent interest in a privately owned geothermal power project, being developed by McLachlan family interests, that will reuse turbines and generators from a geothermal plant in the USA.

Mercury, which will also manage the development of the project, will purchase all the electricity output. The plant is expected to be completed by the middle of next year.

Known as the Poihipi Project, the plant is based on resource consents obtained during an eight year development period and, despite considerable opposition from the state owned electricity generator ECNZ which operates the Wairakei geothermal plant, the latter draws steam from the same geothermal field.

The new plant will have an output of 50 MW. It is based around two turbines and generators which were operated by the US utility Pacific Gas and Electric at the Geysers geothermal field near San Francisco. The machinery has been refurbished by the manufacturer, Elliot Co, before shipment to New Zealand.

There will initially be six or eight production wells for the plant with two more for reinjection of geothermal fluid. Each well is around 500-1000 m deep. Two wells have already been drilled and are producing high steam flows. There are plans to expand the project, with further wells and turbines, once additional resource consents have been obtained.

(Source: Modern Power Systems, Vol. 15, Issue 6, June 1994,p.12)

New Energy-Efficient House in the Czech Republic

The Czech Republic can now boast of a new model, low-energy building. An experimental structure designed and built by VUES Brno, this house was sponsored by the Ministry of the Economy of the Czech Republic as part of a national program entitled, "Energy Savings". It has two stories and an approximate area of 15 x 20 m. Using a combination of innovative and renewable energy sources, this building reduces the energy consumption registered in classical buildings by 80%.

The Ecohouse, as it is called, uses various technologies to achieve its remarkable energy savings: a solar liquid and solar air system including large-volume storage tanks and heat pumps; a solar photovoltaic system and small wind power plant, including storage batteries and the corresponding converters; energy recovery from the heated air and water: and super-insulation of the entire building, including the windows. Optimal use of these energy sources is ensured by an adaptive control system, and the building's long-term parameters will be measured by a monitoring system.

The Ecohouse was conceived as an experimental building that should verify technical energy savings calculations. The building should provide comprehensive data on the building's energy parameters and serve as a model for the construction of other energy efficient buildings. For more information, contact: Dr. Milan Siegl, VUES Brno, Phone: 42-5-4532-1113; Fax: 42-5-4521-1144.

(Source: News at Seven, Vol. 3, No. 2, March 1995. p.1)

Publications Received

ENERGY

* *Annual Report 1994,* Published by Energy Sector Management Assistance Program (ESMAP), Washington D.C., U.S.A., 49 p.
* *Annual Report 1994,* Published by Energy Research Development and Information Center (ERDIC), The University of New South Wales, Australia, 1995, 99 p.
* *Korea Energy Review Monthly*, April, 1995, Published by Korea Energy Economic Institute, Kyungki-Do, Korea, 64 p.
* *Korea Energy Review Monthly, May/June, 1995*, Published by Korea Energy Economic Institute, Kyungki-Do, Korea, 64 p.
* *Synerjy Winter/Spring 1995,* Published by SYNERJY, New York, U.S.A., 32 p.

Energy and Environment Information System (EEIS) in Thailand

Regional Energy Resources Information Center (RERIC) of the Center for Library and Information Resources (CLAIR), Asian Institute of Technology (AIT) serves as the Primary Contact Point (PCP) of the EEIS in Thailand. EEIS is a United Nation Industrial Development Organization (UNIDO) supported industrial information system with particular focus on energy and environment information for small and medium scale industry sector. EEIS is an extension of the UNIDO Industrial and Technological Information Bank (INTIB) network.

For details contact:

Regional Energy Resources InformationCenter (RERIC)
Asian Institute of Technology (AIT)
Email : enreric@ait.ac.th
Telephone : (66 2) 524 5866
Fax : (66 2) 524 5870

RESEARCH ACTIVITIES

The Energy Program, School of Environment, Resources and Development, Asian Institute of Technology

Potentials of Photovoltaics and Wind Energy in India (Considering Andhra Pradesh for Photovoltaics and Kakulakonda for Wind Energy as Case Studies)

Researcher: Erram Radhika

Research Committee Members: Prof. E. Karmazsin (Chairperson)
Prof. C.P. Gupta
Dr. G.V. Dang
Mr. J.B. Heredia

Because of the continuing high growth of power demand and the inadequate generation capacity, concerns about the local and global environmental impacts of conventional generation technologies have compounded the predicament of India's chronic energy generation deficit. As part of the effort to address this situation, this study explores the prospects of non-conventional energy technologies to help close the chronic power deficit without the environmental consequences of conventional technologies.

This study gives a comprehensive view of two non--conventional technologies wind energy and solar photovoltaics, highlighting the windy regions in India where wind-farms can be installed in large scale and the solar radiation data all over India. The existing projects sponsored by the government and private sector were also examined, exploring the present and future prospects of these resources in the country.

Two regions are detailed in all aspects, Kakulakonda for setting a wind-farm and APSEB for examining various possible grid-PV integrated systems. Practical data such as indigenous suppliers, local technical manpower and incentives provided by the Government of India are also studied to get a practical usability of the work.

Implications of Carbon Tax and Efficient Power Generation Technologies for Utility Planning: The Case of Pakistan

Researcher: Muhammad Arfan

Research Committee Members: Prof. S.C. Bhattacharya (Chairperson)
Dr. R.M. Shrestha (Co-chairperson)
Dr. Surapong C.

This study was carried out to analyze the economic and environmental implications of applying Efficient and Clean Technology, Emission Control Devices as well as Carbon Tax on the Utility Planning. Economic implications have been based on the total cost of expansion and long run

average cost of generation. Environmental implications due to hydroelectric power plants and thermal power plants have been analyzed.

Consideration of efficient and clean generation technologies helps in abatement of the pollutant gases from thermal power plants as well as reduces the electricity generation cost. A reduction in the electricity generation cost of 4.88-5.16 per cent would be achieved by such technologies. The emissions of the different pollutants from thermal power plants will also be reduced as a result.

In case of coal power plants with FGD, although the emissions from thermal power plants reduces, the cost of electricity generation increases. The cost of electricity generation would be 0.64 percent higher in case of constraints on the number of combined cycle.

Carbon tax can serve to mitigate CO_2 emissions. The implications of carbon tax of values $5, $50, and $100 per ton of carbon have been analyzed in this study. The implementation of carbon tax would reduce the emissions of CO_2 as well as other gases. The electricity generation cost, on the other hand, increases with the implementation of carbon tax. The electricity generation cost will increase by 34-40 per cent in case of $100 per ton of carbon as carbon tax.

Study on Potential of Cogeneration in Thailand Pulp and Paper Industry

Researcher: Anan Dangchum

Research Committee Members: Mr. J.B. Heredia (Chairperson)
Dr. Surapong C.
Dr. H. Pastjin

Long term optimization by means of technical, economic and financial analysis of energy supply systems for four factories shows that steam turbine cogeneration is the best solution for paper factory among four demonstrated alternatives (steam turbine cogeneration, gas turbine cogeneration, diesel generator with waste heat boiler and low pressure boiler with external electricity supply). Economic and financial evaluation also shows that self generated electricity is cheaper than that supplied from the Electricity Generating Authority of Thailand (EGAT). This result also exists in other three alternatives.

Linear programming was applied for short term optimization with maximization of net benefit as an objective function. The results were obtained to an acceptable level of accuracy by using this technique. Linear programming is found to be one of the suitable tools for supply level optimization especially in the existing system.

Barriers to End Use Electricity Efficient Technologies: The Case of India

Researcher: C. Lalith Kumar

Research Committee Members: Dr. R. M. Shrestha (Chairperson)
Dr. B. Mohanty
Dr. K. Ramanathan
Dr. X. Chen

This study investigates technological, financial, legal and institutional barriers to end use efficiency improvements in the electricity sector in India. The study consists of two main parts. One is the analysis based on the sample survey conducted in and around Hyderabad which is served by Andhra Pradesh State Electricity Board. The other part is based on the analysis of the secondary data and interviews conducted with selected professionals in the related areas.

Poor power quality was revealed to be a major barrier for effective functioning of energy efficient technologies both in the household and industrial sectors. Some of the energy efficient items like high pressure sodium vapor lamps were not adopted because of inferior quality of the associated equipment like ballasts, fixtures manufactured by small scale sectors as these items are reserved for exclusive manufacture by the small scale sector. Lack of awareness, high initial price and lack of technical demonstration were some of the major barriers found in this survey for energy efficient improvements.

Most of the industrial finance schemes were confined to southern and western regions. The study revealed that there is a lack of energy saving company at the regional level for formulating, advising, coordinating and implementing energy efficiency programs. Labeling in the present form is not serving the purpose of educating the consumer.

Long-term Optimization Strategies for CO_2 Emission Abatement in the Energy Sector: The Case of S. R. Vietnam

Researcher: Duong Quang Thanh

Research Committe Members: Prof. T. Lefevre (Chairperson)
Dr. X. Chen
Dr. B. Mohanty
Dr. R.M. Shrestha

Owing to the rapid economic growth, energy demand has increased rapidly. Vietnam has to find the pathway for sustainable energy development. However, such a strat-

egy should be developed with consideration for the requirements of environmental protection, especially in complying with international protocols about CO_2 emission abatement.

Therefore, in this research the energy flow optimization model expended by environmental modules (EFOM-ENV) is applied to Vietnam energy system. By using EFOM-ENV model, energy strategy including fuel switching, substitution of energy conservation technologies and application of emission-reduction technologies are considered.

In order to forecast energy demand up to the year 2010, which is projected in two scenarios i.e. high case and Business as Usual (BAU) case, the Energy Demand Model for the Developing Countries (MDEE-S) is also used in this study.

Results from this study have shown the high growth of final energy demand and also of primary energy supply in Vietnam in the next two decades. The best way for reducing CO_2 emissions will be an improvement of energy efficiencies in both energy production and energy consumption sectors.

Book Review

New Designs for Rural Electrifiction Private-Sector Experiences in Nepal

Allen R. Inverson
NRECA, International Programs Division
1995, xiii+74p.

This publication, prepared by the International Programs Division of the National Rural Electric Cooperative Association, describes and assesses the technical and organizational innovations introduced by the Butwal Power Company of Nepal to reduce the cost of, and increase the benefits from, electrifying rural subsistence communities. These include the following:

- a new distribution voltage which considerably reduces the weight and bulk of transformers which have to be carried over mountain trails,
- designs for distribution poles which can be easily carried by porters to isolated communities,
- ready-made wiring harnesses to increase safety and reduce the initial cost to consumers,
- new low-wattage cooker designs to permit using electricity to displace fuelwood while increasing load factor on the system,
- a power-based tariff and use of current cutouts to reduce the administrative cost of electrification and encourage higher load factors,
- reliance on electricity users' organizations to shoulder the burden of operating rural systems, and
- the use of motivators to encourage maximum consumer connections and benefits

The book stresses that little effort is focussed on assessing whether designs and standards developed for urban centers are the most appropriate to meet the needs of rural populations, whose principal electricity use is for lighting and whose peak demand is, and will realistically remain, very low. In addition, considerable criticism has been leveled at the high costs commonly associated with extending the grid into rural areas. While some of this has been well-founded, high costs are not intrinsic to grid extension. Furthermore, because of economies of scale, electricity generated at large renewable or fossil-fuel-based powerplants is relatively low-cost. Automatically dismissing grid extension as unaffordable may deprive rural consumers of this form of energy which is inexpensive and available in sufficient quantity to contribute to meaningful employment generation and the economic development of their areas.

The experiences documented in this book illustrate that extending the grid to serve small consumers can cost less than $150 per consumer and that quality three-phase lines can be built over hilly terrain for under $4,000 per kilometer. Annexes in the publication include an analysis of the cost of alternative distribution voltages and a comparison of the costs and attributes of grid extension with those of isolated diesel generation, micro-hydropower plants, and household photovoltaic systems.

Solar Energy for Rural Communities: The Case of Namibia

by Gil Yaron, Tani Forbes Irving, and Sven Jansson
Intermediate Technology Publication Ltd.
103-105 Southampton Row, London WC1B 4HH, UK,
in association with SSD, MRC, University of Namibia

ISBN 1-85339-242-1, 1994, 144 p.

In Namibia, as in many other developing countries, a high proportion of rural communities lack access to the national electricity grid. A major reason for this is the fundamental problem of providing a service, which cannot recover its costs, to areas of low population density.

Yet rural households, small businesses, schools and clinics have energy needs which are not currently being met. Where traditional forms of energy supply have been used, such as wood burning, there have been increasing problems of environmental degradation.

Little use has been made of solar energy to meet the needs of rural communities. This book investigates the potential for photovoltaic (PV) and, to a lesser extent, other solar energy technologies to meet these energy needs. Issues such as the impact on rural development, economic viability and consumer willingness to pay, social acceptance and technical performance of alternative solar energy options have been discussed. Although the focus of attention in this book is the case of Namibia, the methodology adopted and detailed review of international experience make this book relevant to all those interested in solar energy for developing countries.

The structure of the book is as follows. Chapter 2 presents an overview of Namibia. Chapter 3 investigates the relationship between problems identified by rural households and their lack of electricity. The economic viability of PV and other decentralized sources of energy in comparison with grid extension is also analyzed in this chapter. And having demonstrated a role for solar energy systems under certain conditions, alternative systems on offer are then investigated in Chapter 4. The issue of rural household energy and its implications for PV systems is the subject of Chapter 5. The results of the household surveys gives a good picture of rural energy use and expenditure and they are used to calculate the ability to pay for PV systems. In addition, Chapter 6 covers the role that solar power can have in pumping water for rural communities and a comparison with other sources of energy in Namibia. The lack of electrical power is a common problem encountered by schools, clinics and small businesses in rural areas. In many such cases, PV represents the cost-effective means of providing this electricity and is now being used in a number of places. Chapter 7 assesses these users' experiences with PV and seeks to identify the future role of PV for rural clinics, schools and small businesses. Chapter 8 begins with an overview of the problems that woodfuel loss brings and then considers the extent to which solar cooking could potentially ameliorate this problem. The policy implications which flow from this study are set out in Chapter 9. The emphasis is on PV, but the arguments are rather general and apply in large measure to the introduction of all renewable energy technologies to rural communities.

Motors as Generators for Micro Hydro Power

by Nigel Smith, Intermediate Technology Publications Ltd.
103-105 SouthHampton Row London WC1B 4NH, UK

ISBN 1 85339-286-3, 1995, vii+83p.

Micro-hydro is a valuable energy source for rural electrification schemes and rural industries, with applications in village lighting, mechanized food processing, and the supply of power to small-scale industrial activities. It has traditionally been used for grain processing throughout the world and has played an important role in modernization and industrial development in Europe and North America.

This book by Nigel Smith is a guide to the use of induction motors for electricity generation in remote locations. It has been written as a practical handbook for engineers and technicians involved in designing and installing small water-power schemes for isolated houses and communities.

The book has been divided into eleven main chapters and six appendices each covering aspects such as the advantages and disadvantages of induction generators, their construction and operation, and the different components of the motor design and installation. The use of example problems to explain the theoretical aspects should prove very helpful to readers.

This book is the outcome of the author's own practical experience along with the experience of manufacturers and installers of induction generator units working in village locations in a number of countries.

Training Courses/Conferences

Wind Energy in Canada : An Action Plan to 2000 October 1-4, 1995 Ontario, Canada

The Conference, in addition to the seminar and technical papers, will include "think tank" sessions.

The Think Tank issues include :

- The Canadian Wind Resource
- Developing a National Wind Atlas - Who Pays, How Much?
- Regional and National Targets for Wind - What Are They?
- Bringing our Customers up to Speed
- Economics Then and Now
- Selling Green Power
- Getting a Handle on the Environmental Benefits
- Identifying Market Distortions
- Building Alliances: Farmers, Natives, Environmentalists, Other Independent Producers
- The Political Agenda - Where to Focus
- The Technology
  - Track Record to Date
  - Clearing up the Misconceptions
  - Constraints and Future Promise

Who should attend :

Wind Energy Developers
Potential Users
Small and Large Business
Community Leaders
Native Peoples
Municipal Utilities
Governments Regulators
Lenders, Financiers
Environmentalists
Distributors
Manufacturers

For more information, contact:
CanWEA - 1 800 9-CanWEA
Outside Canada
Tel: (403) 289 7713
Fax: (403) 282 1238
or Jeff Passmore
Conference Coordinator
Tel: (613) 566 7005
Fax: (613) 233 9527

Uprating & Refurbishing Hydro Powerplants 9-11 October 1995 Nice, France

The topics to be covered in this World Conference are as follows

Refurbishment Planning

- Condition monitoring and diagnostic techniques; safety assessment of critical machinery components; reassessing the safety of civil works; comparing deterioration with original design performance.
- Selecting the optimum time to refurbish.
- Scope of the project, repair, rebuild, uprate or replace?
- Analyzing the different levels of refurbishment.
- Design criteria.
- Financing arrangements.

Machinery

- Turbines: repair versus replacement, optimum performance stratregies;on-site machining of runners; performance testing of refurbished units; repairs following accident or failure.
- Governors: upgrading/replacing turbine governing systems.
- Generators: stator rewinding, improving insulation; rotor refurbishment; improving per formance; ventilation systems; auxiliary equipment.
- Control: installation of modern control systems; increasing automation.

Civil Works

- Dams: heightening to increase reservoir capacity and generation; re-assessing safety; im proving stability; reconstruction following failure; geosynthetics in refurbishment schemes.
- Flood discharge works: repair/upgrading of spillways; repair of bottom outlets; repair of stilling basins.
- Tunnels, and penstocks: up grading as part of overall refurbishment; reconstruction following damage/failure.
- Sedimentation control.
- Retrofitting: adding hydro capacity at existing civil works constructed primarily for other purposes.

Environmental Consideration

- Supplementary measures during refurbishment to improve ecological/environmental aspects.
- Measures to improve ground water conditions; river training works.
- Modifications to river bed/banks; landscaping.
- Establishment of recreational areas; creation of ecological/conservation areas; shallow water habitats for flora and fauna; nesting/breeding places.

Projects

- Papers on recent experiences in Albania, Romania, India, Thailand and the Philippines will be particularly welcome.

For further information contact :
Nice 1995 Conference Desk
First Europe Communications
43-45 St John Street
London EC1M 4AN
England
Tel: +44 (0) 171 490 3318
Fax: +44 (0) 171 490 3319

International Symposium on Energy, Environment and Economics
November 20-24, 1995
The University of Melbourne, Victoria, Australia

Energy, Environment and Economics are the key elements for a sustainable future.The three `E's' are the Subject of an International Symposium which will provide a forum for the exchange of information and ideas concerning the efficient and economic production, utilization and conversion of energy and its environmental effects.

Five leading international authorities will deliver keynote addresses in the important areas of:

- Financing environmentally friendly energy initiatives,
- Implementing energy technologies in rapidly developing countries,
- Environmental protection through government regulation and market incentives,
- Regional opportunities for participating in greenhouse gas mitigation, and
- Fuels and transport for the future.

For further information contact:
EEE Symposium Secretariat
Department of Mechanical and Manufacturing Engineering
The University of Melbourne
Parkville Vic 3052, Australia
Tel : (03) 9344 6748
Fax : (03) 9347 8784

2nd Annual Renewable Energy South Asia'96
12-14 February 1996
New Delhi, India and
3rd Annual Renewable Energy Asia Pacific'96
August/September 1996
Jakarta, Indonesia

These events consist of three days for both the conference and the exhibition which are dedicated to Solar Photovoltaics & Thermal, Wind Power, Biogas/Biomass and Hydro projects in the Asia Pacific region.

The conferences focus on marketing strategies, project financing, policies and incentives for the implementation of renewable energy projects in the Asian countries.

The exhibitions are for manufacturers, distributors, suppliers, consultants, government and non-government agencies, financing institutions and associations. Exhibitors will display their latest in renewable energy and energy efficient products and services to a large gathering of international specifiers, buyers, regulators, financiers, end-users, government officials and non-government organizations.

For further information on both events contact:
Ms. Cassy Kurtzman
Alternative Development Asia Ltd,
5/F, #3 Wood Road, Wanchai
Hong Kong
Tel: +852-2574-9133
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Renewable Energy Conference and Workshop a combined conference with the 4th Conference on Applications of Solar and Renewable Energy, and the 2nd Conference on Solar Electricity: Photovoltaics and Wind
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The purpose of the conference and exhibition is to promote information exchange on renewable energy and environmental protection technologies available throughout the World. The theme of the Conference will be the application of the appropriate technology of renewable energy to improve the environment.

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* **Energy Conservation**
Economics, Policy and Energy Efficiency.

* **Environment**
Policy and Planning for Environmental Protection, Waste Water Treatment, Air Quality, Noise Pollution.

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Dr. F. Abulfotuh, NREL
1617 Cole Blvd., Golden
Co 80401-3393, USA
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15-21 June, 1996
Denver, Colorado, USA

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* Solar Thermal Applications
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* Energy Efficiency, Energy Saving in Transportation and Energy Conservation

* Economics, Policy, Insurance & Financing, and Institutional Issues
* Global, Regional and Local Environmental Issues

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or
Professor Ali Sayigh
Congress Chairman
147 Hilmanton
Lower Early
Reading RG6 4HN, UK
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- Hydrogen energy
- New thermal measurement techniques
- Nuclear energy
- Renewable energy sources and technologies
- Thermal energy storage technologies
- Thermal systems and energy analyses

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Trabzon 61080, Turkey
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Email:
energy96@risc01.bim.ktu.edu.tr

Diary of Events

* **8-13 October 1995, Tokyo, Japan**

Wind Energy Council 16 th Congress

For details contact:
WEC Committee, Shuwa-Kamiyacho Building, 4-3-13, Toranomon, Minato-ku, Takyo 105, Japan
Tel: + 81 3 3437 4821
Fax: + 81 3 3437 4678

* **9-12 October 1995, New Delhi, India**

Water & Energy 2001, Int. R&D Conference

For details contact:
C.V.J. Varma, CBI & P. Malcha Marg, Chanakyapuri, New Delhi 110021 India
Tel: + 91 11 301 5984
Fax: + 91 11 301 6347
Email: cbip@cbipdel.unnet.in

* **17-19 October 1995, Prague, Czech Republic.**

Energy Efficiency Business Week, 4 th International Conference &Exhibition

For details contact:
SEVEn, Slezska 7
120 56 Prague 2 Czech Public
Tel: + 42 2 242 475 52
Fax: + 42 2 242 475 97

* **9-11 November 1995, Althens, Greece**

Renewable Energies for the Meditteranean Area

For details contact:
T. Tsoutsas, CRES, GR-19009 Pikermi, Greece
Tel: + 30 1 603 99 00
Fax: + 30 1 603 99 04/11

* **29 November- 2 December 1995, Hobart, Australia**

Solar'95 (ANZSES) Renewable Energy: The future is now

For details contact:
SOLAR'95
Victoria Dock, Hobart
Tas 7000, Australia
Tel: + 61 02 341 424
Fax: + 61 02 344 464
Email:murse@probitas.cs.utas.au

* **22-24 January 1996, Madras, India**

Renewable Energy South Asia'96

For details contact:
Cassy Kurtzman
Alternative Development Asia Ltd (ADA Ltd)
5F, 3 Wood Road, Wanchai, Hong Kong
Tel: + 852 2574 9113
Fax: + 852 2574 1997

* **25-29 March 1996, Berlin, Germany**

4 th European Conference on Solar Architecture and Urban Planning

For details contact:
DG XII, 200 rue de la Loi, B-1049
Brussels, Belgium
Tel: + 32 2 299 11 11
Telex: 24877 COMEU B

* **20-24 May 1996, Goteborg, Sweden**

1996 European Union Wind Energy Conference and Exhibition

For details contract;
Ms. Anne Baubin
European Commission
Rue de la Loi, 200
SDME 3/20
Tel; + 32-2-295 9985
Fax; + 32-2-296 0621

* **3-7 June 1996, Beijing, Chaina**

Exergex'96 6 th International Energy Conference and Exhibition

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Beijjing, China
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* **15-12 June 1996, Colarado, USA.**

World Renewable Energy Congress IV

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RERIC's New Publications

* ***Solar Timber Seasoning Kilns Developed by the Asian Institute of Technology*** (by R.H.B. Exell), AIT Research Report No. 279, 1995, 34 p.

Price: Asian countries = US$15.00 per copy by air-mail
All other countries = US$20.00 per copy by air-mail

* ***Global Warming Issues in Asia,*** Proceedings of the Workshop on Global Warming Issues in Asia, 8-10 September 1993, Bangkok, Thailand (edited by S.C. Bhattacharya, A.B. Pittock and N.J.D. Lucas), 1994, 543 p.

Price: Asian countries = US$50.00 per copy by air-mail
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Power from Waste: A First of its Kind in Thailand

A refuse incineration power plant is being built at Chiang Mai, Thailand's second largest city. The plant ordered from Kvaerner Enviropower of Gothenberg, Sweden is to be completed in record time to coincide with the 50th Jubilee of the HM King of Thailand. With a circulating fluidized bed incinerator designed to burn 160,000 te/a of domestic refuse and generate some 20 MW of electricity, the plant will be the first of its kind in the country, and it is estimated that some thirty similar installations will be needed in the longer term.

Project leader Per Zachau says that "the need for such facilities in Thailand, and in the region as a whole, makes the contract a highly significant breakthrough creating major opportunities for Swedish leading edge technology in the environmental sector."

The deal includes a reciprocal purchase clause between the Thai Government and Kvaerner Enviropower of a novel kind - covering the establishment of a technology transfer scheme between the University of Umeå in Sweden and the University of Chiang Mai. Under the terms of the agreement, an emission technology research center will be built in Chiang Mai, with the aim of making the Thai institution a leading regional authority in the field.

To facilitate field measurements for the new plant as well as for existing coal fired power plants, Kvaerner will contribute to the purchase of mobile test stations for measuring NO_x,SO,CO,CO_2 and dioxins.

The Chiang Mai Plant

The $69 million project in Chiang Mai will be co-firing municipal refuse with lignite in a circulating fluidized bed combustion system. Raw refuse from the city of Chiang Mai in the north of Thailand will be delivered to the plant, where bulky, non-combustible material as well as ferrous materials will be separated prior to combustion.

The maximum refuse handling capacity of the plant will be 20 te/h or 160,000 te/a, but it is estimated that it will take 15 to 20 years before quantities of this order are processed. The plant will operate 24 hours per day, 7 days per week. Planned boiler operation is 8000 hours per year, net of scheduled maintenance.

The incoming waste and lignite is passed through two separate preparation systems which include equipment for size reduction and magnetic separation. The refuse will be fired in Kvaerner's own design of fluidized bed boiler along with lignite fuel. In energy terms the fuel split corresponds to 30% MSW (municipal solid waste) and 70% lignite

One ton of prepared domestic refuse has roughly the same energy content as half a ton of coal, and it is now feasible to convert about a third of the thermal energy content in the waste to electricity. A typical family of three could be supplied with 10%of its electricity needs by burning its own domestic refuse.

Emmision Control

The plant will be equipped with dry flue gas cleaning with hydrated lime, and activated carbon injection together with furnace limestone injection to reduce sulphur emissions and a fabric filter baghouse to limit particulate emissions.

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Solar Energy in the Next 5 Years

As a result of the Rio and Berlin conferences on the Earth's climate, there is now a growing interest in finding ways to limit greenhouse gases worldwide. The use of solar energy will thus become increasingly important in the next few years as new developments in technologies and markets unfold.

According to Dr. David Mills, Vice President, International Solar Energy Society, the main technologies and markets to watch in the next five years are:

* Continued very rapid expansion of cost-effective wind generation in suitable areas; wind will become a large industry by the turn of the century

* Larger scale production of liquid fuels from biomass, particularly from biomass waste products

* Low cost seasonal load matching domestic hot water and space heating systems should begin to reach market by 1997, achieving cost parity in areas with low cost gas and electricity and greenhouse emissions 5 times below direct heating systems using similar fossil fuel

* PV concentration systems for co-generation aimed at small applications in high fuel cost areas, starting by the year 1999

* Industrial steam systems introduced just before 2000, able to compete against natural gas

* Introduction of inexpensive 24 hour village cooking systems by the turn of the century

* Solar thermal electric/gas hybrid systems achieve cost parity with natural gas generation by about the year 2001, forming a new reliable base technology for grid power

* Large desalination projects are introduced based upon wind or solar thermal electricity

* Low cost thin film photovoltaic systems begin supplying power below the cost of most diesel and small village generation systems by the year 2001

* Sale of lower cost thin film PV/accumulator charging units for home charging of electric vehicles by the year 2001 (yielding strong pollution benefit)

* Large projects which mix renewable generation (solar thermal electric and biomass, PV and wind, PV and Hydro) to begin in 2001

* Long term mega-projects to replace coal fired generation in India and China are begun in 2003.

(Source: *International Solar News*, Issue No. 1, October 1995, p. 3)

Power from Waste: .....
(contd. from p. 1)

The plant is designed to comply with the EU emissions standards for refuse burning plants, and will therefore be well within the corresponding limits for coal fired installations.

At present Chiang Mai does not have an efficient refuse handling system. Most waste is dumped on refuse tips or burned in residents' back yards. The new power-from-waste plant is to be installed mainly for environmental reasons. An extensive information program has been launched to present the public with an objective picture of the environmental performance and social consequences of the plant.

This was considered to be important in the light of complaints about the performance of old lignite fired power station units in the area.

(Source: *Modern Power System*, September 1995, pp. 51-54)

Photovoltaics Provide Electricity to Rural Communities in the Philippines and Thailand

Many rural communities in the developing countries do not have access to electrical power. Photovoltaic power generation is especially suitable for such communities because solar energy is clean and inexhaustible, and photovoltaic systems are simple and relatively easy to maintain.

Two such systems are now in place in the Philippines and in Thailand. In the Visayas region of the Philippines, Solar Resources Inc of Wilmington, Massachusetts has entered into a joint venture with three Philippine companies to install and monitor 18 residential photovoltaic demonstration systems to provide electricity to rural families for lighting and radio or television. In Thailand, the New Energy and Industrial Technology Development Organization (NEDO), a Japanese quasi governmental organization engaged in the research, development and demonstration of new energy and alternative energy technologies is conducting a project to demonstrate photovoltaic power generation systems for battery charging stations, in cooperation with the Thai Government's Department of Energy Development and Promotion (DEDP) and the Ministry of Science, Technology and Environment (MOSTE).

The Philippine Project

Solar Resources Inc, in a joint venture with three Philippine companies, is attempting to overcome the institutional barriers that block acceptance of renewable energy systems in remote or rural areas. The goals of Solar Resources include the establishment of local distribution, installation and servicing for the village photovoltaic systems. The response to an initial maintenance training course offered

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to Philippine electric co-operative technicians was very positive. The company plans to work in tandem with the co-operatives throughout the project to allay any perception of the joint venture as a competitor.

The demonstration consists of 18 installations of 48 Wp for rural homeowners, small businesses, and community centers. Each installation comprises ASE America modules, 10 A Solar Resources charge regulators, 110 A deep-cycle batteries, and two to three 15 W fluorescent lights. The charge controller has a plug for a 9 V radio and a 12 V television.

Future installations may include dedicated photovoltaic-powered battery charging stations for selected communities. Some hotels and businesses that promote ecotourism but lack grid access are targeted under the project expansion. These larger systems will probably use solar-wind hybrid systems to provide lighting and water pumping. Hybrid systems may also be suitable for Philippine barangay halls or community centers.

Performance and Costs

Solar irradiation at the project site is in the range 4.64-5.92 kWh/m²/day. In order to obtain the highest level of sun exposure, some trees were cut back and the photovoltaic panels elevated on steel poles.

During the sunny season between November and May, each 48 Wp system produces about 290 Wh per day. During the rainy season, each system produces about 240 Wh per day. The systems can power three fluorescent lights for three to four hours per day, a radio for 3 hours daily, and a black-and-white television for 2 hours.

The monthly rental fee for a photovoltaic module, mount, charge regulator and wiring is US $5.75. This is higher than the typical charge of $2.50 per month to a Philippine family for kerosene lamp fuel and $1 monthly for dry cell batteries. However, Solar Resources forecasts that the monthly photovoltaic system payment will drop after about 8 years, reducing the average rental cost over a 20 - year system life to about $4.03. The monthly fee includes maintenance services.The monthly rental provides a revenue to the joint venture. This is used for finance charges (60%), operating expenses (26%) and maintenance (8%), leaving a net profit margin of 6%. Simple payback is 8 to 10 years.

The Thai Project

The NEDO initiated project in Thailand has two photovoltaic systems in operation: a 4 kW prototype system and a 40 kW demonstration system. The aims of these systems are to develop measures for local electrification in remote areas, and to improve the efficiency and reliability of photovoltaic systems, by collecting and analyzing the various operational data obtained from the two photovoltaic systems.

The 4 kW prototype system was installed in Bon Khan Kang Rieng, about 200 km west-northwest of Bangkok, to provide 147 households with power for battery charging. Operational since May 1993, the system is equipped with 56 units of 71.27 W photovoltaic modules and 8 units of charging controllers, plus equipment for meteorological observation and data logging. Charging 16 sets of 12 V batteries (110 Ah, 20 hour rate) takes about 1 day. Thus, the 147 households served by this charging station are divided into 10 groups and each group charges its batteries every 10 days in rotation.

The 40 kW demonstration system in Yao Yai Island, about 15 km east of Phuket Island, was built to serve 500 households and to generate enough power to charge the batteries, even on low solar radiation days in the rainy season. On the basis of the prototype's system performance, the Yao Yai system is designed to lower the line loss. Thus, the voltage at the photovoltaic alleys is set at about DC 250 V, and the system converts DC to AC (square waves: 184 V, 200 - 300 Hz) and is connected to a large number of batteries through chargers. In this way, the loss of efficiency of the whole system can be reduced.

The charging station has 75 charging points and stores 100 sets of fully-charged batteries (enough for 2 days) as standby for low solar radiation days. Therefore, the station can always provide users with fully-charged batteries and there can be some flexibility in the recharging schedule.

The photovoltaic system, which is located centrally to four adjacent villages, began operation in February 1995. DEDP staff are stationed there to manage and maintain the system, and can supply information to the users.

(Source: *CADET Technical Brochure No. 26*, and *CADDET - Renewable Energy Newsletter*, Issue 3, 1995)

Worldwide Database on Small Hydro

An effort is underway to establish a comprehensive worldwide database that could be used to identify both existing small hydro facilities and potential for additional development.

The structure of the database is currently being determined, as is the computer software that will be used. Designers of the new database will study existing small hydro databases around the world to learn what data already is available and to identify what new fields of information might be useful. The new database is expected to be available for use in 1997.

The Canada Centre for Mines and Energy Technology (CAN-MET), Department of Natural Resources Canada, is fulfilling Canada's role as operating agent for the agreement's five-year small hydro effort. France and Italy are assisting in the small hydro program, and a number of other IEA countries are in the process of

(contd. on p. 4)

Local Capability Development in the Hydro Industry of Nepal

The 12 MW Jhimruk hydro plant in western Nepal, which exploits a 200m head between the Jhimruk and Madi rivers at a point where they flow within 1.5 km of each other, recently began operation. This scheme, which is part of the Jhimruk Hydro Electric and Rural Electrification Project, has an interesting organizational structure, and is the product of many years work on smaller schemes.

The ownership and management structure of Jhimruk has its roots in the structure created, by His Majesty's Government of Nepal (HMGN) and the United Mission to Nepal (UMN), to build and operate a 1 MW scheme, Tinau, near to the small industrial town of Butwal, where much of Nepal's hydro manufacturing activity has grown up. The companies formed at that time have subsequently grown and developed, and undertaken a range of projects.

The Jhimruk project has three principal objectives:

* to generate electricity for the national grid, with emphasis on dry season peaking capacity;
* to provide electric power to four hill districts; and,
* to develop Nepal's capability to plan and construct hydropower projects, and to manufacture and repair equipment for these, by strengthening the three Nepali organizations involved: Butwal Power Company Ltd as owner, and its subsidiary BPC Hydroconsult handling the design; Himal hydro and General Construction Ltd as civil contractor; and, Nepal Hydro & Electric Ltd as equipment manufacturer.

Himal Hydro is known for its tunnelling work, where it has used labor-intensive methods to produce very low cost constructions with a good safety record. BPC Hydroconsult designed the scheme, using the River Research Laboratory at Pulchowk, Lalitpur, to perform the model studies. Nepal Hydro & Electric (NHE) collaborated with Kvaener Energy, who built the turbine runners. The horizontal Francis turbines are 4 MW units, the housings for which were built in Nepal. NHE collaborated with ABB Energi for the Transformers, generators and switchgear.

Construction began in November 1989 and the scheme began generating on 17 August 1994. The total cost was approximately US$20 million, that is, about US$1700 per kW installed, a figure well below the cost of larger schemes implemented by foreign contractors in Nepal.

This very deliberate program of steadily developing local capacity may be a useful model for other developing countries which see a significant future for hydropower.

(Source: "Mini Hydro: Policy and Practice", *Hydronet, Micro Hydropower Network*, 1/95)

Worldwide Database .....
(contd. from p. 3)

joining the effort. Additionally, China's Hangzhou Regional Center for Small Hydro Power has joined the program as an associate member.

The small hydro program identifies several other tasks in addition to development of an international small hydro database. These tasks include development of an international information database devoted to activities and programs related to small-scale hydropower development. The other tasks include reviewing current methodologies for small hydro resource assessment and recommending improvements; and assessing successful low-cost small hydro technologies and their further development and application.

(Source: *SHP News*, No. 3, 1995, p. 3)

Wind Power Boom in India

India now has just under 557 MW of installed wind power capacity up and running. Reporting on installations upto September 1995, the Ministry of Non-Conventional Energy Sources (MNES) also reveals that nearly 509 MW of the total has been completed by the private sector. In the 1990-1992 fiscal year private sector installations amounted to no more than 9 MW.

During the first half of the current financial year, private firms have installed 206.350 MW, compared with 235.535 MW for the whole of the 1994-1995 financial year. Another 200 MW is expected in the ground by March, bringing the total amount of wind installed in one year in India to some 435 MW. This rate of development far exceeds that in any single European country at the moment and is reminiscent of the hey days of the California wind rush in the early 1980s.

India's fiscal policy has however created a roller coaster ordering process of wind turbines from manufacturers in the West. India's financial year starts in April. If machines are installed before September, the company is entitled to a 100 percent tax depreciation for that year - it can write off the total cost of the machine against tax. If installed before the end of March next year, 50 percent depreciation is allowed for the current financial year, and 50 per cent depreciation again for the next year.

Widespread fears that these lucra-

Harnessing Renewable Energy Resources in India

Introduction

India's electricity demand has exceeded supply for many years. Installed capacity is around 76 GW, with a peak shortage of 19% and a suppressed demand growth of 10%. This deficit is expected to continue for the next 15 years or more. Consequently, the role that renewable energy sources can play in increasing the generating capacity is quite evident.

The Government's Role

A number of ministries, agencies and autonomous bodies of the Government of India (GoI) are concerned with renewable energy. The main remit is with the Ministry of Non-Conventional Energy Sources (MNES), covering both grid-connected and decentralized applications. The objectives of MNES include promoting research, development, demonstration and dissemination of renewables, framing policies for achieving objectives and implementation targets, and providing subsidies, soft loans and other fiscal incentives.

Some GoI fiscal incentives are aimed specifically at mobilizing private sector investment in wind power, and have resulted in over 1000 MW of private sector proposals being submitted. The incentives also favor the establishment of indigenous production, with tax levied on certain imports (either on selected components or full assemblies). Although incentives vary from State to State and between technologies, the following generally apply:

* 10% -15% Government subsidy on capital costs of energy equipment
* 100% depreciation of equipment permitted during its first year of operation
* 100% foreign equity participation permitted
* a five-year tax holiday for any new industry generating or distributing electricity
* soft loan facilities, normally available through the Indian Renewable Energy Development Agency (IREDA)
* premium prices payable for power from renewable sources
* advantageous power-wheeling and power-banking arrangements.

Funding Sources

The public sector is still the main source of funding in the power sector in India. The important agencies involved are :

* IREDA.

This is GoI's principal implementing agency for the deployment of renewables in a commercial context. In effect IREDA operates as a specialized development bank, encouraging private sector participation via concessionary finance for renewables development. Broadly, IREDA's criteria are that projects must be technically feasible, economically viable, commercially possible and politically acceptable. IREDA has received credits and grants from the World Bank, the Global Environment Facility and other development organizations.

* State Electricity Boards (SEBs).

Since the power industry was nationalized in 1947, each State has had its own electricity board responsible for power generation, transmission and distribution. Although the public monopoly on grid-connected generation ended in June 1991 (when private sector participation was invited), many SEBs retain control of transmission and distribution. However, they are almost all technically bankrupt.

* State Energy Development Agencies (EDAs).

Each state has an EDA which acts as the focal point of contact for renewables there. The exact form and function of the EDA varies: some are companies or departments of a State Ministry, others are autonomous organizations. EDAs can give up-to-date information on State activities and provide contacts with potential partners.

* Banks

Two of the major State banking groups, the Industrial Credit & Investment Corporation of India (ICICI) and the Industrial Development Bank of India (IDBI), are active in the renewables market. Other, commercial, banks will also lend against projects but probably at the prevailing rate of interest; many developers have preferred to pay this higher rate to avoid bureaucracy. Wholly-owned foreign enterprises may find it difficult to borrow money from some Indian banks.

(Source: *The Magazine of New and Renewable Energy*, Issue 16, August 1995, pp.20-21)

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tive tax breaks could suddenly be withdrawn tends to lead to bouts of "panic order syndrome" on the Indian market. Large industrial companies install wind plants to secure their own power supply in a country where power cuts are all too frequent. But they make their investment in wind energy according to their tax planning for the relevant fiscal year.

The six month cycle of ordering, which obviously the suppliers are not very happy with, is however welcomed by the Indian administrative authorities. The breaks give them time to catch up with the paperwork and allow the State Electricity Boards to plan for uptake of the power being produced.

(Source: *Windpower Monthly News Magazine*, Vol. 11, No. 11, November 1995, p. 22)

Independent Power Projects in Asia

Demand for electricity in developing Asian countries is rising at over 8 % a year. Asia will require about $400 billion worth of new power investment over the next 10 years, according to the World Bank. Indeed, on current trends, power generation capacity in the developing world will expand over the next 25 years by the equivalent of the entire capacity of Europe, North America and Japan combined - with most of that growth happening in Asia.

Although hundreds of Independent Power Projects (IPPs, where private firms, rather than governments, own power stations) are currently being negotiated in Asia, a mere six are up and running, according to the World Bank. The Bank is predicting that the power failures suffered by millions of Asians will get worse over the next few years.

The Role of Western Energy Suppliers

In the past, electricity demand in rich countries was growing fast enough to satisfy the appetites of the big western suppliers - General Electric and Westinghouse could concentrate on America, for example, and Asea Brown Boveri (ABB) and Siemens could focus on Europe.

But now the World Energy Council predicts that growth in electricity consumption in Western Europe and North America will slow to a mere 1% a year between 1990 and 2020 - compared with over 4% in many Asian countries. The result has been a scramble for contracts in Asia.

Now, with so many of their utilities inefficiently run and deeply in debt, short-on-cash Asian governments are increasingly putting contracts out to competitive tender. As one power-equipment manufacturer complains, "our product is turning into a commodity".

Many Asian governments are asking foreign firms not just to sell them power equipment, but to procure finance too. That means foreign firms becoming involved in IPPs, in which they both build and own plants, selling electricity to local utilities.

In theory, the big private power programs now under way in countries such as the Philippines, Indonesia, and Thailand, should offer a bonanza for foreign firms. IPPs have attracted interest from all sorts of companies, from electricity utilities such as Britain's PowerGen to oil majors such as America's Exxon. But they are proving immensely complicated deals to put together.

Before signing an IPP deal, firms need to secure a series of promises - from manufacturers to provide the equipment, from energy firms to provide the fuel, from lenders to stump up the money, and from utilities to buy the electricity at a certain price for the life of the plant.The last two are often the trickiest. In spite of guarantees provided by development banks, private lenders still fear that utilities might reduce their tariffs or that governments might, as Enron found in India, back out of deals.

In some cases the problem is jealousy. Local politicians and utility bosses do not like ceding power to foreign firms.In others, it is economics. Private firms will invest only if they can charge market rates for their electricity. Yet electricity charges in developing countries are often heavily subsidized - in 1991 they averaged 4 cent per kWh, less than half the marginal costs of supply, according to the World Bank.

Having to pay proper (that is, higher) rates to IPPs would force governments to grasp the political nettle of higher electricity charges for consumers. It would also raise the suspicions of local voters and politicians that foreign firms are ripping them off. Although the first IPPs in many Asian countries were offered to a single company or consortium that happened to have political connections, the trend has certainly shifted now towards competitive bidding in many Asian countries. The newest IPPs will be paid less for their electricity now than predecessors were under deals hammered out several years ago.

One unsurprising result of all this competition is widespread cost-cutting by the western firms. Siemens, which has cut the costs of building gas turbines by a third over the past two or three years, says that unless it reduces its manufacturing costs, it will lose money on many of its orders in Asia. GEC Alsthom has been buying more components from low-cost countries such as Brazil and China, and improving the design of its power plants, reducing their price by 30% in the past two years.

The foreign firms are also having to become more "Asian". Sourcing components locally help firms reduce costs, gives them a better understanding of local markets and regulations and can improve their chances of winning contracts.

ABB is aiming to increase the share of local content in its power-generation equipment from 25% to 50%. Siemens recently struck a series of deals with a Chinese state-owned firm to manufacture large coal—fired power stations. In recent bids for IPPs in Thailand, Japan's Marubeni, Belgium's Tractebel and America's Bechtel all became involved in joint ventures with Thai companies.

The most important lesson, however, for foreign companies is to give up trying to strike private, politically lubricated, deals with governments. The politics of many Asian countries are becoming too democratic, or at least too changeable, to allow such contracts to endure.

(Source: "Western energy suppliers find Asia not as lucrative as expected", *Bangkok Post*, November 6, 1995)

Gender Considerations in Energy Planning

The events of the past 20 years have transformed energy from a specialist technical issue into a matter of public concern. Dramatic increases in oil prices in 1973 and 1974 and subsequent changes in the international oil market resulted in many publications on the subject of energy resource management. However, in the rush to solve energy problems, gender issues were not fully taken into account.

Conventional energy planning, which is heavily reliant on developments in science and technology, assumes incorrectly that the effects of energy technologies are gender neutral. This situation has been exacerbated by a lack of information about socio-economic and gender issues in energy matters.

Prominent positions in both science and technology in general and in the energy sector in particular are held almost exclusively by men. Science and technology is not inherently masculine, but particular sets of values influence both decisions about the direction of scientific inquiry and practical priorities, such as which problems to tackle, which experiments to perform, and which research to support. Energy experts have defined their own models and classification systems, and have focused on high-tech solutions such as oil-fired and nuclear power stations. There has been less work on metabolic energy, and decentralized biomass technologies, for example, are considered peripheral to the conventional energy model. This status quo is biased towards those who have access to high-tech energy resources, and excludes those who supply household energy needs for the majority of the world's population.

A significant proportion of the global economy is dedicated to providing energy services in the form of cooking, heating, lighting, motors, appliances, and industrial processes. Countries in the South depend largely on non-commercial energy and their per capita energy consumption is much lower than that of the North, which uses two-thirds of the world's energy.

Women's Role

Interest in gender and energy can be traced back to the 1970s. Most work focused on fuelwood and stoves programs, and portrayed women as victims of energy scarcity marginalized by development programs, but also as managers of natural resources, innovating to survive. During the 1980s, the realization that cooking in particular consumes the largest portion of total energy (especially of biomass energy) in the South meant that women became the key target group for achieving major fuel savings

Urban women also use and produce energy, but their roles have received much less attention than those of their rural sisters. Urban women can contribute to energy conservation and end-use efficiency programs: they do most of the cooking, have preferences for fuels and appliances, and purchase or influence the purchase of stoves and other appliances. Women influence energy consumption when they use heating, air conditioning, hot water, and electrical appliances; they choose when to use energy, and they use household transport. Women are also the primary educators and formers of their children's future energy conservation (and consumption) habits.

Policies that determine energy pricing, the availability of new energy technologies, electrification, credit, and fuel subsidies, determine women's access to fuels and appliances. Women could advise energy pricing policy makers about preferences, real costs (including labor in searching for fuels, scarcities, and appliances), benefits to fuel users, and acceptable trade-offs.

The Need for Innovations

Gender aspects of issues affecting innovation and diffusion within the energy sector could be classified under four themes: education and training in energy resources management; global energy policy; small and medium-scale enterprises; and poverty and basic needs.

Training materials suitable for women and men at all levels need to be developed to establish or strengthen mechanisms that will involve people in energy policy and planning decisions, and help them make better use of science and technology to further this process. In global energy policies, gender-desegregated research is suggested for the following areas: the impact of different energy policies on women and men; the impact of women on energy policies; and the different perspectives and priorities that women energy planners and policy makers bring to policy making. Women's less-known roles in the energy sector as energy producers, workers, managers, and activists need to be better documented. Women's roles in the wider context of changing rural and urban energy and food systems, and the relationships between local, national, and global institutions and actors, are also important subjects for research.

Many of the small and medium-scale enterprises (SMEs) in which women are involved are labor and energy intensive; typically, many women either produce and sell biomass, or depend on biomass supplies for production. Efforts to improve traditional technologies to reduce energy use have proved complicated, and have on occasions resulted in the marginalization of women producers. More information is needed about the energy choices that women make in small enterprises.

In relation to poverty alleviation, women's interests have been best served as subsistence users of biomass energy in rural and urban improved stoves programs. Improving the efficiency of existing technologies (ranging from appropriate technologies such as grain mills, to more efficient kero-

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Gender Considerations .....
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sene stoves, to the use of renewable energy) can reduce the drudgery of much of women's arduous work, and can release time for other tasks. Men may take over tasks such as distant fuelwood collection with animals or carts, or running grinding mills. These are not necessarily negative developments if the women are able to obtain the cash needed to pay for the services. More research is needed on a number of issues, including total transport demand and human load carrying, the impact on women of reducing the need to use human or biomass energy, and the kind of tradeoffs that women make between fuel collection and use and other survival tasks.

A new model for energy use is needed, built on the understanding that although energy is an integral component of development, increasing energy supplies may not guarantee improved social welfare. It is energy services, not energy per se, that satisfy people's needs, and including gender considerations in a more people-focused energy model will facilitate the accessibility and relevance of these services to more of the world's neediest people.

(Source: "A Crisis in Power" by Elizabeth Cecelski and Judi Wangalwa Wakhungu, *Appropriate Technology*, Vol. 22, No. 1, June 1995, pp. 24-25)

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Small Scale Wind Energy Systems

RERIC is happy to announce that the special section on Small Scale Wind Energy System published with financial support from the Netherlands Ministry for Development Coperation will be resumed in RERIC News from the March issue of 1996.

We take this opportunity to express our grattitude to the Netherlands Ministry for Development Cooperation for the continued support.

RERIC News Editor

Meeting Thailand's Spiralling Energy Needs

Thailand's economic growth is forecast to grow at such a rate over the next 15 years that its balance of energy trade will fall into deep deficit, making the country increasingly reliant on imports to feed the demands of consumers, says a new report by Wood Mackenzie, the UK based energy consultants.

This growth is taking place against one of Asia's most ambitious electricity sector restructuring programs; indeed, the privatization scheme has been necessitated because of the economic growth and the expectation that central power authorities could not continue to handle the burden of financing such growth.

According to Wood Mackenzie, GDP growth averaged 8.4% per year in the 1990-94 period. It will be 8.5% this year and will climb at 6.6% to 2000 and 6.2% and 6% in the 2001-05 and 2006-10 periods.

Primary energy demand will rise by 7.8% to 2000, slowing to 4.4% to 2010. The energy demand forecasts are such that Thailand will need to import nearly 75% of its energy requirement by 2010, against 46% at present.

Wood Mackenzie's report makes it clear that power and transport will be the greediest sectors. By 2010, 36% of total energy demand will be for electricity production while 27% will be for transport. Residential use will account for 22% and industry 15%.

Electrification in Thailand continues to get more popular; it rose at a steady rate of 15.2% per year between 1990 and 1995. This is expected to slow to 13.3% until 2000 and only 5% until 2010. The most important sectors for electricity demand in Thailand are the industrial and residential sectors, with each accounting for about half of all electricity demand in 1993.

The largest industrial electricity consumer is currently the textiles industry where use of electricity is expected to continue to rise. In 1993, the two sectors together consumed 5128 mtoe (million tons of oil equivalent) of electricity (industrial, 2428 mtoe; residential, 2700 mtoe), up from the 1980 figure of 1120 mtoe. Electricity consumption for the two sectors is projected at about 21 000 mtoe for 2010 (industrial, 10 000 mtoe; residential, 11 000 mtoe).

Energy Capacity and Supply Options

Energy planners are well aware that the indigenous production in Thailand is not sufficient to cope with future demand for electricity.

Thailand is primarily a gas province - of the remaining hydrocarbon reserves, 84% is accounted for by gas on an oil-equivalent basis. The reserves of coal that exist are mainly of low quality lignite only.

Furthermore, production of gas and liquids is expected to decline around 2000 or soon after, although decline from the Unocal fields, where most gas is currently derived, is likely to be offset by new production from Bongkot, says the report.

Although production of lignite will continue to increase to 2010, its potential as an electricity generator is becoming increasingly limited due to environmental objections to its use and to its rather low thermal efficiency.

At present gas accounts for half of all electricity generated from power stations; the main ones being Bang Pakong (1375 MW), Rayong (1232 MW), South Bangkok (33 MW) and Khanom (674 MW).

Further planned gas-fired stations include plants at Wang Noi (1200 MW) and Ratchaburi (1800MW CCGT, 2800MW dual fired fuel oil/gas thermal capacity, with gas sources from Myanmar).

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By 2010, gas will account for 41% of power output, reducing coal's share to 49% rather than the 50%-60% level formerly planned by EGAT. The balance will be made up of oil-firing and hydro. Electricity output by 2010 will have soared to an estimated 269 TWh from 90 TWh in 1995 (the figure for 1980 was just 14 TWh).

The use of hydroelectricity generation is set also to decrease due to environmental objections. In fact Thailand has been able to exploit only one-fifth of its hydro potential. Although the country has several major dams, expansion in this area is in doubt due to environmental pressure.

On the upside, hydropower is being imported from Laos and such imports will rise with extensive plans for more hydropower capacity in Laos for which Thailand is virtually the only customer.

In 1993, Thailand imported 65 mtoe of hydropower from Laos and this figure is projected to rise to some 1 100 mtoe by 2010, giving Laos, which already has large hydro resources, an increasing potential as one of Thailand's main sources of energy.

Indeed, besides the Nam Ngum hydro project in Laos, there are a further three hydro powered schemes planned for Laos, as well as a lignite project.

Privatization of the Power Sector

Privatization comes as a major part of the government's strategy for Thailand's power sector. The Thai electricity industry has revealed itself to be particularly attractive to private investors due to its low risk and rates of growth currently forecast at above 10% per year.

There are effectively two streams of privatization policy in Thailand at present. Under the first, independent power producers (IPPs) may bid for the right to build plants in Thailand on a build-own-operate (BOO) basis.

The IPP programme is aimed at installing some 3 800 MW of capacity in the country between 1996 and 2002 and is the largest program of its kind in the world.

So far 65 consortia have expressed interest in joining the IPP scheme and by the year 2002, it is expected that EGAT and its subsidiaries will hold approximately 50% of the power generation market, the rest being in the hands of IPPs and Laos imports. The bids are now under evaluation.

The second scheme for privatization of the energy sector in Thailand is the selling off of existing power station assets. The Electricity Generating Company (EGCO) has been set up by EGAT as a private sector vehicle for power generation--51% of its shares have been sold on the Thai stock exchange, with EGAT retaining 49%.

So far EGCO has acquired the 1232 MW gasfired CCGT plant at Rayong and has the option to purchase the new 674 MW CCGT plant at Khanom.

(Source: *Financial Times, Power in Asia, The Asian Electricity Market*, Issue No. 186, October 2 1995, pp.6-8)

Energy Demand Continues to Outstrip Supply in the Asia Pacific Region

According to the latest assessment of energy trends in the Asia-Pacific region to 2010, brown outs will remain a problem in many areas as demand continues to outstrip supply. This is despite increments in electricity output of over 5% per annum across the region. The following are the main findings of a study by Wood Mackenzie, a UK based energy consultant considered among the most authoritative in the energy industry.

*Energy demand in the Asia-Pacific region is forecast to rise by 74% over the next 15 years. By 2010 demand will have reached 4100 mtoe, twice the level of demand in Europe by then, having increased at 1.2 times the level of GDP/capita growth during the period;

* The region's energy self-sufficiency will deteriorate over the period to 2010. Although a greater number of countries will be energy self-sufficient by 2010 (nine compared to six now), the overall position will fall from 79% to 70%. As a result, net energy imports for the region will rise by 150% to 1200 mtoe;

*Coal will remain the most important primary energy source as it is the most readily available indigenous fuel in the region. Demand will double over the next 15 years, its share of total primary energy demand rising to 46%. China and India will remain the main coal consumer although growth in the iron and steel industry will contribute significantly to future increases in demand;

* While the majority of Asia-Pacific countries are attempting to reduce oil dependency, transport sector growth will hinder this. Oil output will remain flat at best across the region, so demand growth of 3%/yr will create an increasing reliance on imported oil. By 2010 the region will be only 29% self-sufficient in oil, at which time the transport sector will account for 45% of total demand. Oil will then account for 70% of the area's energy imports, with just under 17m b/d being required from outside;

*Availability of supply will be the main constraint on gas demand, which is nevertheless expected to rise by over 5% per annum to 2010. Although production will rise by nearly 70% to reach 360 bn cubic meters (bcm) by the end of 2010, it is forecasted that demand will have more than doubled to over 460 bcm. The

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Energy Demand .....
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growth will be driven by power generation, which will account for over half of gas demand by 2010, with gas contributing 15% of all electricity generated by then. Despite this growth, however, gas will only account for 11% of total primary energy demand as lack of supply and infrastructure slows the development of potential markets;

*High cost and long construction lead-times are the main constraints on hydro development. Although a number of large projects are planned over the next two decades, especially in China, hydro's contribution will remain stable at around 14% throughout the period;

*While electricity consumption remains low by international standards, the rate of new plant development is dramatic. Average per capita consumption of electricity in Asia-Pacific stands at less than one-fifth of the level in Europe due in part to a chronic shortage of supply. Although electricity output is expected to rise by 5.5% per annum over the next two decades reaching 7.4m GWh per annum by 2010, power cuts will remain a problem in many areas as demand continues to outstrip supply. Nevertheless per capita consumption will have almost doubled to 1 700 kWh/yr by 2010.

The difference between countries will remain huge, with nearly 12 000 kWh per person consumed in Singapore as against 81 kWh in Cambodia (UK per capita consumption is 5200 kWh/yr).

(Source: "Asian power races to match demand, says WoodMac Report", *Power In Asia, The Asian Electricity Market*, 18 September 1995, Issue No 185, pp. 1-4)

Per annum growth in electricity output

	Countries	95-00		#	00-05 %		#	05-10 %
1	Laos	37.9	1	2 Cambodia	17.4	1	10 Vietnam	8.6
2	Cambodia	18.6	2	1 Laos	15.5	2	11 Myanmar	8.0
3	Indonesia	13.7	3	10 Vietnam	10.3	3	7 China	7.3
4	Thailand	13.3	4	11 Myanmar	7.8	4	1 Laos	6.8
5	Bangladesh	11.9	5	3 Indonesia	7.7	5	9 Pakistan	6.3
6	Philippines	10.2	6	5 Bangladesh	7.7	6	5 Bangladesh	6.0
7	China	8.9	7	7 China	7.7	7	3 Indonesia	5.9
8	Malaysia	8.9	8	8 Malaysia	7.1	8	12 India	5.8
9	Pakistan	8.1	9	9 Pakistan	6.4	9	2 Cambodia	5.2
10	Vietnam	8.1	10	12 India	5.6	10	8 Malaysia	5.0
11	Myanmar	7.0	11	4 Thailand	5.5	11	16 PNG	5.0
12	India	5.6	12	16 PNG	4.9	12	4 Thailand	4.2
13	Taiwan	4.9	13	14 Singapore	4.8	13	13 Taiwan	4.1
14	Singapore	4.7	14	13 Taiwan	4.2	14	14 Singapore	3.9
15	South Korea	4.4	15	15 South Korea	4.1	15	15 South Korea	3.5
16	PNG	4.0	16	6 Philippines	3.9	16	18 Hong Kong	2.5
17	Australia	3.4	17	18 Hong Kong	3.6	17	6 Philippines	2.0
18	Hong Kong	3.3	18	17 Australia	2.2	18	17 Australia	1.7
19	Japan	2.2	19	19 Japan	2.1	19	20 New Zealand	1.3
20	New Zealand	1.3	20	21 Brunei	1.0	20	21 Brunei	1.2
21	Brunei	0.7	21	20 New Zealand	0.9	21	19 Japan	1.1
				# 1995 ranking			# 1995 ranking	
	Regions	95-00			00-05			05-10
1	South East Asia	11.6	1	1 South East Asia	6.4	1	2 Indian Suncont.	5.9
2	Indian SubCont	6.2	2	2 Indian SubCont.	5.8	2	3 North East Asia	5.2
3	North East Asia	5.7	3	3 North East Asia	5.4	3	1 South East Asia	4.8
4	Australasia	3.0	4	4 Australasia	2.0	4	4 Australasia	1.6
	Asia Pacific	6.2		Asia Pacifi	5.4		Asia Pacific	5.1

Source: Wood Mackenzie

New Energy Policy to Improve Fuel Balance in Bangladesh

A new national energy policy has been announced with the objective to provide energy for sustainable economic growth. The policy is essential to undertake a systematic survey, exploration and exploitation of energy resources throughout the country.

The main thrust of the new policy is to ensure new generation and exploration of energy resources with private participation in different subsectors of the energy sector. Up to 2000, projected demand of commercial energy would be equivalent to 12 mt of oil for which an investment of $2.72bn will be needed.

The new policy recommended that power generation gets 45%-50% of the total available gas, fertilizer production gets 25%-27%, industry gets 13%-18%, and the commercial and domestic sectors get 8%-10%.

Given the present energy imbalance between the East and West zones, optimum development of all the indigenous energy sources, sustainable operation of the energy utilities, rational use of total energy sources, and environmentally sound sustainable energy development programs are among other measures included in the new policy.

It was also recommended that the tariffs on different types of final energy should be fixed on the basis of economic cost. When a decision is made to give any subsidy, it will be made at end users level. Private sector participation in the marketing process of the petroleum products and corporatization of different utilities were also recommended in the new policy.

The new policy also recommended setting up a regulatory authority to be called the National Energy Authority, attached to the Ministry of Energy and Mineral Resources to carry out the regulatory functions like issuing licenses to different agencies both public and private.

(Source: *Power in Asia - The Electricity Market*, 16 October 1995, Issue No. 187, p.14)

RESEARCH ACTIVITIES

The Energy Program, School of Environment, Resources and Development, Asian Institute of Technology

Assessment of Rural Energy Use and Potential in Myanmar

Researcher: Thi Thi Aye

Research Committee Members: Mr. J.B. Heredia (Chairperson)
Prof. S.C. Bhattacharya
Dr. G.V. Dang
Dr. S. Kumar

The pattern of rural energy use in Myanmar was studied. In order to determine the energy consumption pattern of the rural areas, a survey was conducted in three villages: representing the hilly region, the coastal region and the dry zone according to Myanmar's three main regions. The potential energy sources of each region were assessed, and the marginal costs for the potential energy sources were calculated at the current production level. The following results were obtained:

Fuelwood consumption is predominant in rural areas and it accounts for 69.8% of the total energy use. The consumption pattern in rural areas has been changing since the change to a market oriented economy in 1989.

Hydropower, biomass, natural gas and coal are of high potential in Myanmar. The data for some places show that solar and wind energy have a high potential. However, the overcutting of fuelwood is causing deforestation in certain places.

The results from the marginal costs studies show that ricehusk, fuelwood, coal and hydroelectricity are attractive to develop. Solar and wind energy are attractive to install in small scale power systems.

Purchase Price of Independently Produced Power: The Case of Nepal

Researcher: Raj Kumar Thapa

Research Committee Members: Dr. R.M. Shrestha (Chairperson)
Dr. G.G. Dang
Dr. X. Chen
Prof. K. Saeed

Independent Power Producers (IPPs) are a major source of new power generation capacity both in the industrialized and developing countries. They have a potential to meet the large and immediate financing gap by mobilizing direct foreign investment in the power sector. In develop-

ing countries IPPs have tapped new forms of financing in international capital markets. Private sector involvement in the power sector has also led to impressive construction and operational efficiency gains. Properly structured IPPs can also stimulate the development of local capital markets.

The study undertakes several detailed system expansion plans for the hydro dominated electricity supply sector of Nepal for the period 1996-2015. Wein Automatic System Expansion Planning Model developed by the International Atomic Energy Agency has been used to carry out the system expansion plan with and without the contribution of the IPP.

Significant costs of upto 20% of the total cost in the planning horizon were found to be avoided by the utility as a consequence of IPP supply to the grid. Avoided costs have been calculated from the long-run marginal cost perspective and adjusted for financial requirements. The avoided costs of 5.05 cents/kWh were found to be 6.48% lower than that required, 5.40 cents/kWh, to provide the required rate of return on equity of 16%, for the IPP under consideration.

Estimating the Thermal Energy Saving Potential in Industry: The Case of Hochiminh City

Researcher: Le Hoang Viet

Research Committee Members: Dr. B. Mohanty (Chairperson)
Prof. S.C. Bhattacharya
Dr. X. Chen

After a long period of embargo and a longer period of centralized administration of the economy with its subsidized price mechanism, the economy of Viet Nam has started to develop strongly. Hochiminh city is a key economic area of the country. Industry, which plays the most important role in the economy of the city, is the biggest energy consumer with a continuously increasing growth rate.

Outdated and second hand production equipment have lead to high increases in the energy cost of industrial products. It seems timely to estimate the energy saving potential of industry. This is one of the key steps in the consideration of re-investment and renovation and may lead to a reduction of investment or operation costs.

In this study, three industrial sub-sectors including textile, food and non-metal industries have been considered due to their large contribution in terms of gross industrial products, and share in total industrial energy consumption and energy intensity. Three factories for each sub-sector were selected for energy audits.

The energy saving opportunities could be classified as short, medium and long term based on investment requirement and pay back period.

From the energy audit results, and through extrapolation, the study estimates the saving opportunities of the textile industry to be 1.8% using short term measures (mostly housekeeping, combustion tuning, blowdown control, insulation improvement) and 38% using medium term measures (such as combustion efficiency controller, flue gas recovery, heat recovery from hot effluent, heat recovery from condensate, insulation of bare pipe). In addition to these measures, another 6.9% saving can be expected by opting for long term options such as replacement of boilers and furnaces. In the food industry, the saving opportunities could be 3% using short term measures, 45.5% using medium and 8.5% using long term measures. Finally, the saving opportunities of non metal industry could be 0.1% using short term measures, 0.7% using medium term measures and 11.4% using long term measures.

These energy savings would lead to overall sub-sectoral reduction of 2% using short term measures for the textile and food industries and 1% for the non metal industry. With medium term measures, the sub-sectoral energy consumption of the textile industry would be reduced by 31%, that of the food industry by 22% and that of the non metal industry by 15%. The long term measures would reduce 10% of sub-sectoral energy consumption of textile, 2% of food and 1% of non metal industries.

Daylighting and Artificial Lighting Integration: An Experimental Case

Researcher: Prachak Phradmali

Research Committee Members: Dr. Surapong C. (Chairperson)
Prof. E. Karmazsin
Prof. S. C. Bhattacharya

Daylighting possesses a good potential for application in the tropical climate. It can offer the benefit of reduction in electricity for lighting.

This study investigated daylighting in an experimental room in the AIT energy park. Experiments were conducted for four scenarios of daylighting and artificial lighting integration. The four scenarios cover the case of overall uniform lighting and non-uniform lighting arrangement, and two lighting control methods, continuous and step dimming. The resultant savings in energy for lighting ranges from 68% to 86% in comparison to the base case.

The investigation also included an estimation of the net heat gain into the building from daylighting and from electric lighting, which forms part of the cooling for the air-conditioning system. During the course of the daylighting

experiments, a number of fellow students were requested to assist in the evaluation of daylight comfort under all four scenarios of daylighting-artificial lighting integration. Continuous dimming received favourable responses from the subjects. Step-dimming on task areas tended to produce unfavorable responses.

Energy and the Environment in China: Options for Energy Efficiency Improvement and Environmental Pollution Abatement in Energy Intensive and Polluting Industries

Researcher: Wang Yu

Research Committee Members: Dr. X. Chen (Chairperson)
Dr. B. Mohanty
Dr. U. Stoll
Prof. Cunyi Yu

China is among the fastest growing economies in the world. The high economic growth is causing both high growth in energy consumption and environmental degradation.

Iron and steel, cement, and pulp and paper are three of the most energy intensive and polluting industries in China.

The study presents a sector by sector evaluation of technology, energy consumption pattern, energy efficiency and the situation of environmental pollution in the three selected industries. For each industry, an analysis of the determining factors of energy efficiency was carried out. Energy efficiency of each industry was analyzed in relation to technological level, production structure, ownership of enterprises, as well as fuel and raw material mixes. Potentials for improving energy efficiencies of the three industries were assessed by comparing the major energy efficiency indicators with those of industrialized countries. Then a cross-industry comparison on the common and different determinants of energy efficiency among the three industries was conducted.

It is found that the energy efficiency level and the pollution situation of these industries are mainly related to the production scale and ownership status of enterprises, technological level, as well as raw material and energy mixes. A large number of small size township enterprises involved in cement and paper production lowers the energy efficiency and makes pollution prevention and control very difficult.

Based on the above, options for energy efficiency improvement and pollution abatement in the three industries through technological, economical, managerial and institutional means were examined.

Book Reviews

Rural Energy Planning A Government-Enabled Market-Based Approach

Edited by K.V. Ramani, A.K.N. Reddy and M.N. Islam
Published by the Asian and Pacific Development Center (APDC), Pesiaran Duta, P.O. Box 12224, 50770 Kuala Lumpur, Malaysia
ISBN 967-9928-40-3, 1995, xxv + 590 pp.

The central focus of this volume is on rural energy development in liberalized rural energy markets enabled by appropriate governmental policies and indicative planning. This volume is one of the outcomes of a project funded by the Bundesministerium für Winthschaftliche Zusammenarbeit and Entwicklung (MBZ) (German Federal Ministry for Economic Cooperation and Development). The various chapters of the volume have been authored by members and affiliates of the Asian and Pacific Energy - Environment Planning Network (APENPLAN) of the APDC Energy - Environment Program. The topics and authors of the eighteen chapters of this volume are as follows.

Issues and Approaches

1. Introduction by K.V. Ramani and Amulya K.N. Reddy
2. Rural Development, Energy and Environment by K.V. Ramani, Peter Hills and M. Nurul Islam
3. Prevailing Paradigms for Rural Energy Planning by K.V. Ramani and M. Nurul Islam
4. GEMBASED Approach to Rural Energy Planning by K.V. Ramani, M. Nural Islam and Amulya K.N. Reddy
5. Approach to Rural Electrification by K.V. Ramani
6. Rural Energy Policy Analysis by Ramesh K. Bhatia and Nikhil Desai
7. Analysis of Technology Trends and Managing Technology Change by Thomas J. Wilbank.

Planning Methods and Techniques

8. Rural Energy Data Base Development and Management by K.V. Ramani, Qiu Da-Xiang and Charit Tingsabadh
9. Rural Energy Demand Analysis and Forecasting by Ramesh K. Bahtia
10. Rural Energy Technology Choice by Ucok Siagian and Saswinadi Sasmojo
11. Evaluation of Decentralized Energy Technologies by Jan Brägelmann
12. Rural Energy Demand-Supply Balancing by Arshad M. Khan
13. Economic Impact Analysis of Rural Energy Policies and Programs by Binayak Bhadra and K.V. Ramani
14. Environmental Impact Analysis of Rural Energy Policies and Programs by Peter Hills
15. Rural Energy Project Formulation by M. Nurul Islam and K.V. Ramani

Implementation Strategies

16. Rural Energy Market Potential Assessment and Market Penetration Strategies by Lalith Gunaratne, Viren Perera and K. V. Ramani
17. Financing Rural Energy Services by Mathew S. Mendis and Marcia M. Gowen
18. Research and Development of Rural Energy Centers and Strategies for their Replication by Amulya K.N. Reddy

The Role of the Private Sector in the Small-Scale Hydropower Field MHPG Series Harnessing Water Power on a Small Scale—Volume 12

by K. Goldsmith
Published by SKAT, Swiss Center for Development Cooperation in Technology and Management
Vadianstrasse 42
CH - 9000 St. Gallen, Switzerland
ISBN 3-908001-50-1, 1995, 165p.

Electricity production from renewable sources such as wind, solar and hydropower is expected to rise as they are clean and largely neutral with respect to CO_2 emission, and also because they are inexhaustible. Among these sources, hydropower remains the most extensively developed and widely applied form of renewable energy. There is also a vast and much under exploited potential for small schemes which are environmentally unobtrusive and are ideally suited for providing electricity for rural and outlying areas where electrification has hitherto seriously lagged behind. One might think therefore that decentralized power supplies meeting local demands for electricity in outlying areas from hydro resources would be widely available but this is not the case. Small hydro sources have not been tapped to any significant extent, at least not in the developing countries where the bulk of these sources can be found and where the rural population is still starved of energy and suffers considerable socio-economic deprivation by being restricted to an often only primitive subsistence economy.

Bearing in mind that the technology of small scale hydropower, say in the range of up to 15 MW, is well developed and there are essentially no engineering obstacles to its extensive use, one must look to other reasons why progress in its application has been so retarded. There has also now been a shift in governmental preference in many countries from public ownership of essential utilities to their transfer to the private sector, or at least to the opening-up of these industries to private participation. Although much has been said and written about the privatization of the electricity sector in the developing world, only a few projects with private participation have however been realized to date.

This book by K. Goldsmith therefore addresses the wide range of issues that arise when private participation in hydropower development comes into question. The author has made a special study of this subject, based on many years' experience in international consultancy both for and with public and private organisations. As there is very little to review concerning past achievements and failures in the developing world, and hence to draw conclusions from, the book offers guidelines based on current policies and practices in the industrialized world.

The topics covered in the book's eight chapters are — Overview, Development Trends, Assessment of Private - Sector Inputs, Criteria for Economic and Financial Viability, Project Formulation, Regulation, Financing Scenarios, and Corporate Issues, respectively.

Although the discussion concentrates on small hydropower, the processes described are essentially the same for thermal power schemes and can, within reasonable limits, be equally well applied in thermal or mixed hydrothermal power systems.

Publications Received

* Workshop Proceedings: Energy Efficiency in Buildings, 11-13 January 1995, New Delhi, Editor: B. Mohanty, 121 p.

* Energy Environmental Planning in Developing Countries-- EFOM-ENV, Programme for Asian Cooperation on Energy and Environment (PACE-E), Editor: T. Lefevre
  - Methodological Guide (ISBN 974-8202-28-3)
  - Programmer's Guide (ISBN 974-8202-29-1)
  - User's and Technical Guide (ISBN 974-8202-27-5)

* Guide Book on Energy Environment Planning in Developing Countries, Programme for Asian Cooperation on Energy and Environment (PACE-E), Editor: T. Lefevre
  - Synthesis Report on Energy-Environment Studies in Asia (Part 1, ISBN 974-8202-39-1)
  - Training Material on Energy-Environment Studies in Asia (Part 11, ISBN 974-8202-40-2)

* Guide Book on Energy Survey, Programme for Asian Cooperation on Energy and Environment (PACE-E), Editor: T. Lefevre (ISBN 974-8202-31-3)

* Sectoral Energy Demand Analysis and Long-Term Forecast, Methodological Manual, MEDEE-S, Programme for Asian Cooperation on Energy and Environment (PACE-E), Editor: T. Lefevre (ISBN 974-8202-37-2)

Training Courses/Conferences

Biomass Energy Technologies and Renewable Energy Oppurtunities in New Zealand
11-14 th March, 1996
Rotorua, New Zealand

● **Seminar: New Renewable Energy Oppurtunities for New Zealand**
Sheraton, Rotorua
11 March 1996

The latest information and potential applications of new and emerging renewable energy technologies including:

- wind energy
- solar thermal
- photovoltaics
- small/micro hydro
- biofuels
- landfill sites
- wave and tidal

● **Conference on Applications of Bioenergy Technologies in New Zealand**
Sheraton, Totorua
12-13 March 1996

This conference will bring together interested parties and international experts to describe the current scene and examine the critical factors for successful adoption of bioenergy technologies.

Key topic areas include:

- bioenergy use in New Zealand
- bioenergy used internally
- bioenergy and the environment
- biomass availability in New Zealand
- biomass conversion technologies
- economics of bioenergy
- factors critical to deployment
- research needs and oppurtunities

● **Field Tour**
14 March 1996

A visit to current or potential bioenergy sites is anticipated.

Options include:

- collecting harvesting residues
- bioenergy in a sawmill
- bioenergy in a pulp and paper mill
- ethanol production from dairy wastes
- biogas from sewage
- landfill design
- short rotation forestry

For further information contact:

Graham Diedrichs
Conference Organiser
Energy Efficiency and Conservation Authority
FREEPOST 4245
PO Box 37 444
Parnell
Auckland
New Zealand

Energex'96
The 6th International Energy Conference and Exhibition
3 - 7 June 1996, Beijing, China

Energex'96 conference will provide a vehicle for the exchange of professional expertise and transfer of technology by one to one interaction between energy researchers and industrial representatives from all nations. The exposition will provide opportunities for industry, research institutes and others to promote their capacity and capability and establish key contacts with their counterparts from within China and elsewhere.

The conference theme is "Energy Strategies in Developing Countries in the 21st Century: Challenges and Opportunities". The topics of interest include:

* Rational Use of Conventional and New and Renewable Forms of Energy
* Economic Development and Strategies
* International Cooperation and Communication
* Energy and the Global Environment Issues
* Rural and Urban Energy Challenges
* Energy Systems Analysis and Prospects
* Scientific and Industrial Transfer of Technology
* Energy Sustainability and Energy Options

Energex'96 Exhibition

The ENERGEX'96 exhibition, China International Energy and Power Supplies, Equipment and Facilities Exhibition, will be held in the same conference facility and on the same dates as the ENERGEX'96 conference.The scope of the exhibits include.

* Clean Coal Technology
* Oil and Gas
* Energy Efficient Products
* New and Renewable Energy Equipment and Products

For further information contact:

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Energy & Environment Information System (EEIS) in Thailand

Regional Energy Resources Information Center (RERIC) of the Center for Library and Information Resources (CLAIR), Asian Institute of Technology (AIT) serves as the Primary Contact Point (PCP) of the EEIS in Thailand. EEIS is a United Nation Industrial Development Organization (UNIDO) supported industrial information system with particular focus on energy and environment information for small and medium scale industry sector. EEIS is an extension of the UNIDO Industrial and Technological Information Bank (INTIB) network.

For details contact:
Regional Energy Resources Information Center (RERIC)

Diary of Events

* **12-14 February 1996**
New Delhi, India
2nd Annual Renewable Energy South Asia '96
and
August/September 1996
Jakarta, Indonesia
3rd Annual Renewable Energy Asia/Pacific
For details contact:
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Alternative Developmnet Asia, Ltd,
5/F, # 3 Wood Road, Wanchai
Hong Kong
Tel: +852-2574-9133
Fax: +852-2574-1997

* **25-29 March 1996,**
Berlin, Germany
4 th European Conference on Solar Architecture and Urban Planning
For details contact:
DG XII, 200 rue de la Loi,
B-1049
Brussels, Belgium
Tel: + 32 2 299 11 11
Telex: 24877 COMEU B

* **14-18 April 1996**
Cairo, Egypt
Renewable Energy Conference and Workshop—A combined conference with the 4th Conference on Applications of Solar
and
Renewable Energy, and the 2nd Conference on Solar Electricity: Photovoltaics and Wind
For details contact:
Dr H El Agaamwy
P.O Box 487 Doki,
Egypt
Tel: 202-3610-806
Fax: 202-781-236

* **20-24 May 1996,**
Goteborg, Sweden
1996 European Union Wind Energy Conference and Exhibition
For details contract;
Ms. Anne Baubin
European Commission
Rue de la Loi, 200
SDME 3/20
Tel; + 32-2-295 9985
Fax; + 32-2-296 0621
Beijjing, China
Tel: + (81-6) 257 5681
Fax: + (86-1) 257 5691

* **20 May - 22 June 1996**
University of Twente
International Training Program on Energy and Environment for Sustainable Development
and
* **7 Oct. - 9 Nov. 1996**
University of Twente
Training Program on Energy Management and Cleaner Production in Small amd Medium Scale Industries
For details contract:
The Course Administration
Technology and Development
Group, VOK/CT 1807
University of Twente
P.O. Box 217, 7500 AE Enschede ,
The Netherlands
Tel: +31 53 4894377/ 4893545
Fax: +31 53 4893087
J.R.M.Borghuis@TDG.UTWNTE.NL

* **15-21 June 1996,**
Denver, Colorado, USA
World Renewable Energy Congress IV
For details contact
Mr Steve Hauser
Chairman of Tech. Committee
Division Director, NERL
1617 Cole Boulevard
Golden, CO 80401, USA
Tel: (303) 384 7416
Fax: (303) 275 4320

* **29-31 July**
Trabzon, Turkey
First Trabzon International Energy and Environment Symposium - TIEES
For details contact:
Prof Dr Teoman Ayhan
TIEES-96
Department of Mechanical Engineering, Karadeniz Technical University, Trabzon 61080, Turkey
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Fax: (462) 325-7405
energy96@risc01.bim.ktu.edu.tr

* **22-25 October 1996**
Darwin, Northern Territory, Australia
SOLAR '96 "Energy For Life"
For details contact:
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GPO Box 1392
Darwin NT 0801
Australia
Tel: +61 89 99 5440
Fax: +61 89 99 5289
email chandra@dme.nt.gov.au

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Center for Library and Information Resources (CLAIR), Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

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Power from Waste: A First of its Kind in Thailand

A refuse incineration power plant is being built at Chiang Mai, Thailand's second largest city. The plant ordered from Kvaerner Enviropower of Gothenberg, Sweden is to be completed in record time to coincide with the 50th Jubilee of the HM King of Thailand. With a circulating fluidized bed incinerator designed to burn 160,000 te/a of domestic refuse and generate some 20 MW of electricity, the plant will be the first of its kind in the country, and it is estimated that some thirty similar installations will be needed in the longer term.

Project leader Per Zachau says that "the need for such facilities in Thailand, and in the region as a whole, makes the contract a highly significant breakthrough creating major opportunities for Swedish leading edge technology in the environmental sector."

The deal includes a reciprocal purchase clause between the Thai Government and Kvaerner Enviropower of a novel kind - covering the establishment of a technology transfer scheme between the University of Umeå in Sweden and the University of Chiang Mai. Under the terms of the agreement, an emission technology research center will be built in Chiang Mai, with the aim of making the Thai institution a leading regional authority in the field.

To facilitate field measurements for the new plant as well as for existing coal fired power plants, Kvaerner will contribute to the purchase of mobile test stations for measuring NO_x,SO,CO,CO_2 and dioxins.

The Chiang Mai Plant

The $69 million project in Chiang Mai will be co-firing municipal refuse with lignite in a circulating fluidized bed combustion system. Raw refuse from the city of Chiang Mai in the north of Thailand will be delivered to the plant, where bulky, non-combustible material as well as ferrous materials will be separated prior to combustion.

The maximum refuse handling capacity of the plant will be 20 te/h or 160,000 te/a, but it is estimated that it will take 15 to 20 years before quantities of this order are processed. The plant will operate 24 hours per day, 7 days per week. Planned boiler operation is 8000 hours per year, net of scheduled maintenance.

The incoming waste and lignite is passed through two separate preparation systems which include equipment for size reduction and magnetic separation. The refuse will be fired in Kvaerner's own design of fluidized bed boiler along with lignite fuel. In energy terms the fuel split corresponds to 30% MSW (municipal solid waste) and 70% lignite

One ton of prepared domestic refuse has roughly the same energy content as half a ton of coal, and it is now feasible to convert about a third of the thermal energy content in the waste to electricity. A typical family of three could be supplied with 10%of its electricity needs by burning its own domestic refuse.

Emmision Control

The plant will be equipped with dry flue gas cleaning with hydrated lime, and activated carbon injection together with furnace limestone injection to reduce sulphur emissions and a fabric filter baghouse to limit particulate emissions.

(contd. on p. 2)

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Solar Energy in the Next 5 Years

As a result of the Rio and Berlin conferences on the Earth's climate, there is now a growing interest in finding ways to limit greenhouse gases worldwide. The use of solar energy will thus become increasingly important in the next few years as new developments in technologies and markets unfold.

According to Dr. David Mills, Vice President, International Solar Energy Society, the main technologies and markets to watch in the next five years are:

* Continued very rapid expansion of cost-effective wind generation in suitable areas; wind will become a large industry by the turn of the century

* Larger scale production of liquid fuels from biomass, particularly from biomass waste products

* Low cost seasonal load matching domestic hot water and space heating systems should begin to reach market by 1997, achieving cost parity in areas with low cost gas and electricity and greenhouse emissions 5 times below direct heating systems using similar fossil fuel

* PV concentration systems for co-generation aimed at small applications in high fuel cost areas, starting by the year 1999

* Industrial steam systems introduced just before 2000, able to compete against natural gas

* Introduction of inexpensive 24 hour village cooking systems by the turn of the century

* Solar thermal electric/gas hybrid systems achieve cost parity with natural gas generation by about the year 2001, forming a new reliable base technology for grid power

* Large desalination projects are introduced based upon wind or solar thermal electricity

* Low cost thin film photovoltaic systems begin supplying power below the cost of most diesel and small village generation systems by the year 2001

* Sale of lower cost thin film PV/accumulator charging units for home charging of electric vehicles by the year 2001 (yielding strong pollution benefit)

* Large projects which mix renewable generation (solar thermal electric and biomass, PV and wind, PV and Hydro) to begin in 2001

* Long term mega-projects to replace coal fired generation in India and China are begun in 2003.

(Source: *International Solar News*, Issue No. 1, October 1995, p. 3)

Power from Waste: .....
(contd. from p. 1)

The plant is designed to comply with the EU emissions standards for refuse burning plants, and will therefore be well within the corresponding limits for coal fired installations.

At present Chiang Mai does not have an efficient refuse handling system. Most waste is dumped on refuse tips or burned in residents' back yards. The new power-from-waste plant is to be installed mainly for environmental reasons. An extensive information program has been launched to present the public with an objective picture of the environmental performance and social consequences of the plant.

This was considered to be important in the light of complaints about the performance of old lignite fired power station units in the area.

(Source: *Modern Power System*, September 1995, pp. 51-54)

Photovoltaics Provide Electricity to Rural Communities in the Philippines and Thailand

Many rural communities in the developing countries do not have access to electrical power. Photovoltaic power generation is especially suitable for such communities because solar energy is clean and inexhaustible, and photovoltaic systems are simple and relatively easy to maintain.

Two such systems are now in place in the Philippines and in Thailand. In the Visayas region of the Philippines, Solar Resources Inc of Wilmington, Massachusetts has entered into a joint venture with three Philippine companies to install and monitor 18 residential photovoltaic demonstration systems to provide electricity to rural families for lighting and radio or television. In Thailand, the New Energy and Industrial Technology Development Organization (NEDO), a Japanese quasi governmental organization engaged in the research, development and demonstration of new energy and alternative energy technologies is conducting a project to demonstrate photovoltaic power generation systems for battery charging stations, in cooperation with the Thai Government's Department of Energy Development and Promotion (DEDP) and the Ministry of Science, Technology and Environment (MOSTE).

The Philippine Project

Solar Resources Inc, in a joint venture with three Philippine companies, is attempting to overcome the institutional barriers that block acceptance of renewable energy systems in remote or rural areas. The goals of Solar Resources include the establishment of local distribution, installation and servicing for the village photovoltaic systems. The response to an initial maintenance training course offered

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to Philippine electric co-operative technicians was very positive. The company plans to work in tandem with the co-operatives throughout the project to allay any perception of the joint venture as a competitor.

The demonstration consists of 18 installations of 48 Wp for rural homeowners, small businesses, and community centers. Each installation comprises ASE America modules, 10 A Solar Resources charge regulators, 110 A deep-cycle batteries, and two to three 15 W fluorescent lights. The charge controller has a plug for a 9 V radio and a 12 V television.

Future installations may include dedicated photovoltaic-powered battery charging stations for selected communities. Some hotels and businesses that promote ecotourism but lack grid access are targeted under the project expansion. These larger systems will probably use solar-wind hybrid systems to provide lighting and water pumping. Hybrid systems may also be suitable for Philippine barangay halls or community centers.

Performance and Costs

Solar irradiation at the project site is in the range 4.64-5.92 kWh/m²/day. In order to obtain the highest level of sun exposure, some trees were cut back and the photovoltaic panels elevated on steel poles.

During the sunny season between November and May, each 48 Wp system produces about 290 Wh per day. During the rainy season, each system produces about 240 Wh per day. The systems can power three fluorescent lights for three to four hours per day, a radio for 3 hours daily, and a black-and-white television for 2 hours.

The monthly rental fee for a photovoltaic module, mount, charge regulator and wiring is US $5.75. This is higher than the typical charge of $2.50 per month to a Philippine family for kerosene lamp fuel and $1 monthly for dry cell batteries. However, Solar Resources forecasts that the monthly photovoltaic system payment will drop after about 8 years, reducing the average rental cost over a 20 - year system life to about $4.03. The monthly fee includes maintenance services.The monthly rental provides a revenue to the joint venture. This is used for finance charges (60%), operating expenses (26%) and maintenance (8%), leaving a net profit margin of 6%. Simple payback is 8 to 10 years.

The Thai Project

The NEDO initiated project in Thailand has two photovoltaic systems in operation: a 4 kW prototype system and a 40 kW demonstration system. The aims of these systems are to develop measures for local electrification in remote areas, and to improve the efficiency and reliability of photovoltaic systems, by collecting and analyzing the various operational data obtained from the two photovoltaic systems.

The 4 kW prototype system was installed in Bon Khan Kang Rieng, about 200 km west-northwest of Bangkok, to provide 147 households with power for battery charging. Operational since May 1993, the system is equipped with 56 units of 71.27 W photovoltaic modules and 8 units of charging controllers, plus equipment for meteorological observation and data logging. Charging 16 sets of 12 V batteries (110 Ah, 20 hour rate) takes about 1 day. Thus, the 147 households served by this charging station are divided into 10 groups and each group charges its batteries every 10 days in rotation.

The 40 kW demonstration system in Yao Yai Island, about 15 km east of Phuket Island, was built to serve 500 households and to generate enough power to charge the batteries, even on low solar radiation days in the rainy season. On the basis of the prototype's system performance, the Yao Yai system is designed to lower the line loss. Thus, the voltage at the photovoltaic alleys is set at about DC 250 V, and the system converts DC to AC (square waves: 184 V, 200 - 300 Hz) and is connected to a large number of batteries through chargers. In this way, the loss of efficiency of the whole system can be reduced.

The charging station has 75 charging points and stores 100 sets of fully-charged batteries (enough for 2 days) as standby for low solar radiation days. Therefore, the station can always provide users with fully-charged batteries and there can be some flexibility in the recharging schedule.

The photovoltaic system, which is located centrally to four adjacent villages, began operation in February 1995. DEDP staff are stationed there to manage and maintain the system, and can supply information to the users.

(Source: *CADET Technical Brochure No. 26*, and *CADDET - Renewable Energy Newsletter*, Issue 3, 1995)

Worldwide Database on Small Hydro

An effort is underway to establish a comprehensive worldwide database that could be used to identify both existing small hydro facilities and potential for additional development.

The structure of the database is currently being determined, as is the computer software that will be used. Designers of the new database will study existing small hydro databases around the world to learn what data already is available and to identify what new fields of information might be useful. The new database is expected to be available for use in 1997.

The Canada Centre for Mines and Energy Technology (CAN-MET), Department of Natural Resources Canada, is fulfilling Canada's role as operating agent for the agreement's five-year small hydro effort. France and Italy are assisting in the small hydro program, and a number of other IEA countries are in the process of

(contd. on p. 4)

Local Capability Development in the Hydro Industry of Nepal

The 12 MW Jhimruk hydro plant in western Nepal, which exploits a 200m head between the Jhimruk and Madi rivers at a point where they flow within 1.5 km of each other, recently began operation. This scheme, which is part of the Jhimruk Hydro Electric and Rural Electrification Project, has an interesting organizational structure, and is the product of many years work on smaller schemes.

The ownership and management structure of Jhimruk has its roots in the structure created, by His Majesty's Government of Nepal (HMGN) and the United Mission to Nepal (UMN), to build and operate a 1 MW scheme, Tinau, near to the small industrial town of Butwal, where much of Nepal's hydro manufacturing activity has grown up. The companies formed at that time have subsequently grown and developed, and undertaken a range of projects.

The Jhimruk project has three principal objectives:

* to generate electricity for the national grid, with emphasis on dry season peaking capacity;
* to provide electric power to four hill districts; and,
* to develop Nepal's capability to plan and construct hydropower projects, and to manufacture and repair equipment for these, by strengthening the three Nepali organizations involved: Butwal Power Company Ltd as owner, and its subsidiary BPC Hydroconsult handling the design; Himal hydro and General Construction Ltd as civil contractor; and, Nepal Hydro & Electric Ltd as equipment manufacturer.

Himal Hydro is known for its tunnelling work, where it has used labor-intensive methods to produce very low cost constructions with a good safety record. BPC Hydroconsult designed the scheme, using the River Research Laboratory at Pulchowk, Lalitpur, to perform the model studies. Nepal Hydro & Electric (NHE) collaborated with Kvaener Energy, who built the turbine runners. The horizontal Francis turbines are 4 MW units, the housings for which were built in Nepal. NHE collaborated with ABB Energi for the Transformers, generators and switchgear.

Construction began in November 1989 and the scheme began generating on 17 August 1994. The total cost was approximately US$20 million, that is, about US$1700 per kW installed, a figure well below the cost of larger schemes implemented by foreign contractors in Nepal.

This very deliberate program of steadily developing local capacity may be a useful model for other developing countries which see a significant future for hydropower.

(Source: "Mini Hydro: Policy and Practice", *Hydronet, Micro Hydropower Network*, 1/95)

Worldwide Database .....
(contd. from p. 3)

joining the effort. Additionally, China's Hangzhou Regional Center for Small Hydro Power has joined the program as an associate member.

The small hydro program identifies several other tasks in addition to development of an international small hydro database. These tasks include development of an international information database devoted to activities and programs related to small-scale hydropower development. The other tasks include reviewing current methodologies for small hydro resource assessment and recommending improvements; and assessing successful low-cost small hydro technologies and their further development and application.

(Source: *SHP News*, No. 3, 1995, p. 3)

Wind Power Boom in India

India now has just under 557 MW of installed wind power capacity up and running. Reporting on installations upto September 1995, the Ministry of Non-Conventional Energy Sources (MNES) also reveals that nearly 509 MW of the total has been completed by the private sector. In the 1990-1992 fiscal year private sector installations amounted to no more than 9 MW.

During the first half of the current financial year, private firms have installed 206.350 MW, compared with 235.535 MW for the whole of the 1994-1995 financial year. Another 200 MW is expected in the ground by March, bringing the total amount of wind installed in one year in India to some 435 MW. This rate of development far exceeds that in any single European country at the moment and is reminiscent of the hey days of the California wind rush in the early 1980s.

India's fiscal policy has however created a roller coaster ordering process of wind turbines from manufacturers in the West. India's financial year starts in April. If machines are installed before September, the company is entitled to a 100 percent tax depreciation for that year - it can write off the total cost of the machine against tax. If installed before the end of March next year, 50 percent depreciation is allowed for the current financial year, and 50 per cent depreciation again for the next year.

Widespread fears that these lucra-

tive tax breaks could suddenly be withdrawn tends to lead to bouts of "panic order syndrome" on the Indian market. Large industrial companies install wind plants to secure their own power supply in a country where power cuts are all too frequent. But they make their investment in wind energy according to their tax planning for the relevant fiscal year.

The six month cycle of ordering, which obviously the suppliers are not very happy with, is however welcomed by the Indian administrative authorities. The breaks give them time to catch up with the paperwork and allow the State Electricity Boards to plan for uptake of the power being produced.

(Source: *Windpower Monthly News Magazine*, Vol. 11, No. 11, November 1995, p. 22)

Harnessing Renewable Energy Resources in India

Introduction

India's electricity demand has exceeded supply for many years. Installed capacity is around 76 GW, with a peak shortage of 19% and a suppressed demand growth of 10%. This deficit is expected to continue for the next 15 years or more. Consequently, the role that renewable energy sources can play in increasing the generating capacity is quite evident.

The Government's Role

A number of ministries, agencies and autonomous bodies of the Government of India (GoI) are concerned with renewable energy. The main remit is with the Ministry of Non-Conventional Energy Sources (MNES), covering both grid-connected and decentralized applications. The objectives of MNES include promoting research, development, demonstration and dissemination of renewables, framing policies for achieving objectives and implementation targets, and providing subsidies, soft loans and other fiscal incentives.

Some GoI fiscal incentives are aimed specifically at mobilizing private sector investment in wind power, and have resulted in over 1000 MW of private sector proposals being submitted. The incentives also favor the establishment of indigenous production, with tax levied on certain imports (either on selected components or full assemblies). Although incentives vary from State to State and between technologies, the following generally apply:

* 10% -15% Government subsidy on capital costs of energy equipment
* 100% depreciation of equipment permitted during its first year of operation
* 100% foreign equity participation permitted
* a five-year tax holiday for any new industry generating or distributing electricity
* soft loan facilities, normally available through the Indian Renewable Energy Development Agency (IREDA)
* premium prices payable for power from renewable sources
* advantageous power-wheeling and power-banking arrangements.

Funding Sources

The public sector is still the main source of funding in the power sector in India. The important agencies involved are :

* IREDA.

This is GoI's principal implementing agency for the deployment of renewables in a commercial context. In effect IREDA operates as a specialized development bank, encouraging private sector participation via concessionary finance for renewables development. Broadly, IREDA's criteria are that projects must be technically feasible, economically viable, commercially possible and politically acceptable. IREDA has received credits and grants from the World Bank, the Global Environment Facility and other development organizations.

* State Electricity Boards (SEBs).

Since the power industry was nationalized in 1947, each State has had its own electricity board responsible for power generation, transmission and distribution. Although the public monopoly on grid-connected generation ended in June 1991 (when private sector participation was invited), many SEBs retain control of transmission and distribution. However, they are almost all technically bankrupt.

* State Energy Development Agencies (EDAs).

Each state has an EDA which acts as the focal point of contact for renewables there. The exact form and function of the EDA varies: some are companies or departments of a State Ministry, others are autonomous organizations. EDAs can give up-to-date information on State activities and provide contacts with potential partners.

* Banks

Two of the major State banking groups, the Industrial Credit & Investment Corporation of India (ICICI) and the Industrial Development Bank of India (IDBI), are active in the renewables market. Other, commercial, banks will also lend against projects but probably at the prevailing rate of interest; many developers have preferred to pay this higher rate to avoid bureaucracy. Wholly-owned foreign enterprises may find it difficult to borrow money from some Indian banks.

(Source: *The Magazine of New and Renewable Energy*, Issue 16, August 1995, pp.20-21)

Independent Power Projects in Asia

Demand for electricity in developing Asian countries is rising at over 8 % a year. Asia will require about $400 billion worth of new power investment over the next 10 years, according to the World Bank. Indeed, on current trends, power generation capacity in the developing world will expand over the next 25 years by the equivalent of the entire capacity of Europe, North America and Japan combined - with most of that growth happening in Asia.

Although hundreds of Independent Power Projects (IPPs, where private firms, rather than governments, own power stations) are currently being negotiated in Asia, a mere six are up and running, according to the World Bank. The Bank is predicting that the power failures suffered by millions of Asians will get worse over the next few years.

The Role of Western Energy Suppliers

In the past, electricity demand in rich countries was growing fast enough to satisfy the appetites of the big western suppliers - General Electric and Westinghouse could concentrate on America, for example, and Asea Brown Boveri (ABB) and Siemens could focus on Europe.

But now the World Energy Council predicts that growth in electricity consumption in Western Europe and North America will slow to a mere 1% a year between 1990 and 2020 - compared with over 4% in many Asian countries. The result has been a scramble for contracts in Asia.

Now, with so many of their utilities inefficiently run and deeply in debt, short-on-cash Asian governments are increasingly putting contracts out to competitive tender. As one power-equipment manufacturer complains, "our product is turning into a commodity".

Many Asian governments are asking foreign firms not just to sell them power equipment, but to procure finance too. That means foreign firms becoming involved in IPPs, in which they both build and own plants, selling electricity to local utilities.

In theory, the big private power programs now under way in countries such as the Philippines, Indonesia, and Thailand, should offer a bonanza for foreign firms. IPPs have attracted interest from all sorts of companies, from electricity utilities such as Britain's PowerGen to oil majors such as America's Exxon. But they are proving immensely complicated deals to put together.

Before signing an IPP deal, firms need to secure a series of promises - from manufacturers to provide the equipment, from energy firms to provide the fuel, from lenders to stump up the money, and from utilities to buy the electricity at a certain price for the life of the plant.The last two are often the trickiest. In spite of guarantees provided by development banks, private lenders still fear that utilities might reduce their tariffs or that governments might, as Enron found in India, back out of deals.

In some cases the problem is jealousy. Local politicians and utility bosses do not like ceding power to foreign firms.In others, it is economics. Private firms will invest only if they can charge market rates for their electricity. Yet electricity charges in developing countries are often heavily subsidized - in 1991 they averaged 4 cent per kWh, less than half the marginal costs of supply, according to the World Bank.

Having to pay proper (that is, higher) rates to IPPs would force governments to grasp the political nettle of higher electricity charges for consumers. It would also raise the suspicions of local voters and politicians that foreign firms are ripping them off. Although the first IPPs in many Asian countries were offered to a single company or consortium that happened to have political connections, the trend has certainly shifted now towards competitive bidding in many Asian countries. The newest IPPs will be paid less for their electricity now than predecessors were under deals hammered out several years ago.

One unsurprising result of all this competition is widespread cost-cutting by the western firms. Siemens, which has cut the costs of building gas turbines by a third over the past two or three years, says that unless it reduces its manufacturing costs, it will lose money on many of its orders in Asia. GEC Alsthom has been buying more components from low-cost countries such as Brazil and China, and improving the design of its power plants, reducing their price by 30% in the past two years.

The foreign firms are also having to become more "Asian". Sourcing components locally help firms reduce costs, gives them a better understanding of local markets and regulations and can improve their chances of winning contracts.

ABB is aiming to increase the share of local content in its power-generation equipment from 25% to 50%. Siemens recently struck a series of deals with a Chinese state-owned firm to manufacture large coal—fired power stations. In recent bids for IPPs in Thailand, Japan's Marubeni, Belgium's Tractebel and America's Bechtel all became involved in joint ventures with Thai companies.

The most important lesson, however, for foreign companies is to give up trying to strike private, politically lubricated, deals with governments. The politics of many Asian countries are becoming too democratic, or at least too changeable, to allow such contracts to endure.

(Source: "Western energy suppliers find Asia not as lucrative as expected", *Bangkok Post*, November 6, 1995)

Gender Considerations in Energy Planning

The events of the past 20 years have transformed energy from a specialist technical issue into a matter of public concern. Dramatic increases in oil prices in 1973 and 1974 and subsequent changes in the international oil market resulted in many publications on the subject of energy resource management. However, in the rush to solve energy problems, gender issues were not fully taken into account.

Conventional energy planning, which is heavily reliant on developments in science and technology, assumes incorrectly that the effects of energy technologies are gender neutral. This situation has been exacerbated by a lack of information about socio-economic and gender issues in energy matters.

Prominent positions in both science and technology in general and in the energy sector in particular are held almost exclusively by men. Science and technology is not inherently masculine, but particular sets of values influence both decisions about the direction of scientific inquiry and practical priorities, such as which problems to tackle, which experiments to perform, and which research to support. Energy experts have defined their own models and classification systems, and have focused on high-tech solutions such as oil-fired and nuclear power stations. There has been less work on metabolic energy, and decentralized biomass technologies, for example, are considered peripheral to the conventional energy model. This status quo is biased towards those who have access to high-tech energy resources, and excludes those who supply household energy needs for the majority of the world's population.

A significant proportion of the global economy is dedicated to providing energy services in the form of cooking, heating, lighting, motors, appliances, and industrial processes. Countries in the South depend largely on non-commercial energy and their per capita energy consumption is much lower than that of the North, which uses two-thirds of the world's energy.

Women's Role

Interest in gender and energy can be traced back to the 1970s. Most work focused on fuelwood and stoves programs, and portrayed women as victims of energy scarcity marginalized by development programs, but also as managers of natural resources, innovating to survive. During the 1980s, the realization that cooking in particular consumes the largest portion of total energy (especially of biomass energy) in the South meant that women became the key target group for achieving major fuel savings

Urban women also use and produce energy, but their roles have received much less attention than those of their rural sisters. Urban women can contribute to energy conservation and end-use efficiency programs: they do most of the cooking, have preferences for fuels and appliances, and purchase or influence the purchase of stoves and other appliances. Women influence energy consumption when they use heating, air conditioning, hot water, and electrical appliances; they choose when to use energy, and they use household transport. Women are also the primary educators and formers of their children's future energy conservation (and consumption) habits.

Policies that determine energy pricing, the availability of new energy technologies, electrification, credit, and fuel subsidies, determine women's access to fuels and appliances. Women could advise energy pricing policy makers about preferences, real costs (including labor in searching for fuels, scarcities, and appliances), benefits to fuel users, and acceptable trade-offs.

The Need for Innovations

Gender aspects of issues affecting innovation and diffusion within the energy sector could be classified under four themes: education and training in energy resources management; global energy policy; small and medium-scale enterprises; and poverty and basic needs.

Training materials suitable for women and men at all levels need to be developed to establish or strengthen mechanisms that will involve people in energy policy and planning decisions, and help them make better use of science and technology to further this process. In global energy policies, gender-desegregated research is suggested for the following areas: the impact of different energy policies on women and men; the impact of women on energy policies; and the different perspectives and priorities that women energy planners and policy makers bring to policy making. Women's less-known roles in the energy sector as energy producers, workers, managers, and activists need to be better documented. Women's roles in the wider context of changing rural and urban energy and food systems, and the relationships between local, national, and global institutions and actors, are also important subjects for research.

Many of the small and medium-scale enterprises (SMEs) in which women are involved are labor and energy intensive; typically, many women either produce and sell biomass, or depend on biomass supplies for production. Efforts to improve traditional technologies to reduce energy use have proved complicated, and have on occasions resulted in the marginalization of women producers. More information is needed about the energy choices that women make in small enterprises.

In relation to poverty alleviation, women's interests have been best served as subsistence users of biomass energy in rural and urban improved stoves programs. Improving the efficiency of existing technologies (ranging from appropriate technologies such as grain mills, to more efficient kero-

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Gender Considerations .....
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sene stoves, to the use of renewable energy) can reduce the drudgery of much of women's arduous work, and can release time for other tasks. Men may take over tasks such as distant fuelwood collection with animals or carts, or running grinding mills. These are not necessarily negative developments if the women are able to obtain the cash needed to pay for the services. More research is needed on a number of issues, including total transport demand and human load carrying, the impact on women of reducing the need to use human or biomass energy, and the kind of tradeoffs that women make between fuel collection and use and other survival tasks.

A new model for energy use is needed, built on the understanding that although energy is an integral component of development, increasing energy supplies may not guarantee improved social welfare. It is energy services, not energy per se, that satisfy people's needs, and including gender considerations in a more people-focused energy model will facilitate the accessibility and relevance of these services to more of the world's neediest people.

(Source: "A Crisis in Power" by Elizabeth Cecelski and Judi Wangalwa Wakhungu, *Appropriate Technology*, Vol. 22, No. 1, June 1995, pp. 24-25)

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Small Scale Wind Energy Systems

RERIC is happy to announce that the special section on Small Scale Wind Energy System published with financial support from the Netherlands Ministry for Development Coperation will be resumed in RERIC News from the March issue of 1996.

We take this opportunity to express our grattitude to the Netherlands Ministry for Development Cooperation for the continued support.

RERIC News Editor

Meeting Thailand's Spiralling Energy Needs

Thailand's economic growth is forecast to grow at such a rate over the next 15 years that its balance of energy trade will fall into deep deficit, making the country increasingly reliant on imports to feed the demands of consumers, says a new report by Wood Mackenzie, the UK based energy consultants.

This growth is taking place against one of Asia's most ambitious electricity sector restructuring programs; indeed, the privatization scheme has been necessitated because of the economic growth and the expectation that central power authorities could not continue to handle the burden of financing such growth.

According to Wood Mackenzie, GDP growth averaged 8.4% per year in the 1990-94 period. It will be 8.5% this year and will climb at 6.6% to 2000 and 6.2% and 6% in the 2001-05 and 2006-10 periods.

Primary energy demand will rise by 7.8% to 2000, slowing to 4.4% to 2010. The energy demand forecasts are such that Thailand will need to import nearly 75% of its energy requirement by 2010, against 46% at present.

Wood Mackenzie's report makes it clear that power and transport will be the greediest sectors. By 2010, 36% of total energy demand will be for electricity production while 27% will be for transport. Residential use will account for 22% and industry 15%.

Electrification in Thailand continues to get more popular; it rose at a steady rate of 15.2% per year between 1990 and 1995. This is expected to slow to 13.3% until 2000 and only 5% until 2010. The most important sectors for electricity demand in Thailand are the industrial and residential sectors, with each accounting for about half of all electricity demand in 1993.

The largest industrial electricity consumer is currently the textiles industry where use of electricity is expected to continue to rise. In 1993, the two sectors together consumed 5128 mtoe (million tons of oil equivalent) of electricity (industrial, 2428 mtoe; residential, 2700 mtoe), up from the 1980 figure of 1120 mtoe. Electricity consumption for the two sectors is projected at about 21 000 mtoe for 2010 (industrial, 10 000 mtoe; residential, 11 000 mtoe).

Energy Capacity and Supply Options

Energy planners are well aware that the indigenous production in Thailand is not sufficient to cope with future demand for electricity.

Thailand is primarily a gas province - of the remaining hydrocarbon reserves, 84% is accounted for by gas on an oil-equivalent basis. The reserves of coal that exist are mainly of low quality lignite only.

Furthermore, production of gas and liquids is expected to decline around 2000 or soon after, although decline from the Unocal fields, where most gas is currently derived, is likely to be offset by new production from Bongkot, says the report.

Although production of lignite will continue to increase to 2010, its potential as an electricity generator is becoming increasingly limited due to environmental objections to its use and to its rather low thermal efficiency.

At present gas accounts for half of all electricity generated from power stations; the main ones being Bang Pakong (1375 MW), Rayong (1232 MW), South Bangkok (33 MW) and Khanom (674 MW).

Further planned gas-fired stations include plants at Wang Noi (1200 MW) and Ratchaburi (1800MW CCGT, 2800MW dual fired fuel oil/gas thermal capacity, with gas sources from Myanmar).

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By 2010, gas will account for 41% of power output, reducing coal's share to 49% rather than the 50%-60% level formerly planned by EGAT. The balance will be made up of oil-firing and hydro. Electricity output by 2010 will have soared to an estimated 269 TWh from 90 TWh in 1995 (the figure for 1980 was just 14 TWh).

The use of hydroelectricity generation is set also to decrease due to environmental objections. In fact Thailand has been able to exploit only one-fifth of its hydro potential. Although the country has several major dams, expansion in this area is in doubt due to environmental pressure.

On the upside, hydropower is being imported from Laos and such imports will rise with extensive plans for more hydropower capacity in Laos for which Thailand is virtually the only customer.

In 1993, Thailand imported 65 mtoe of hydropower from Laos and this figure is projected to rise to some 1 100 mtoe by 2010, giving Laos, which already has large hydro resources, an increasing potential as one of Thailand's main sources of energy.

Indeed, besides the Nam Ngum hydro project in Laos, there are a further three hydro powered schemes planned for Laos, as well as a lignite project.

Privatization of the Power Sector

Privatization comes as a major part of the government's strategy for Thailand's power sector. The Thai electricity industry has revealed itself to be particularly attractive to private investors due to its low risk and rates of growth currently forecast at above 10% per year.

There are effectively two streams of privatization policy in Thailand at present. Under the first, independent power producers (IPPs) may bid for the right to build plants in Thailand on a build-own-operate (BOO) basis.

The IPP programme is aimed at installing some 3 800 MW of capacity in the country between 1996 and 2002 and is the largest program of its kind in the world.

So far 65 consortia have expressed interest in joining the IPP scheme and by the year 2002, it is expected that EGAT and its subsidiaries will hold approximately 50% of the power generation market, the rest being in the hands of IPPs and Laos imports. The bids are now under evaluation.

The second scheme for privatization of the energy sector in Thailand is the selling off of existing power station assets. The Electricity Generating Company (EGCO) has been set up by EGAT as a private sector vehicle for power generation--51% of its shares have been sold on the Thai stock exchange, with EGAT retaining 49%.

So far EGCO has acquired the 1232 MW gasfired CCGT plant at Rayong and has the option to purchase the new 674 MW CCGT plant at Khanom.

(Source: *Financial Times, Power in Asia, The Asian Electricity Market*, Issue No. 186, October 2 1995, pp.6-8)

Energy Demand Continues to Outstrip Supply in the Asia Pacific Region

According to the latest assessment of energy trends in the Asia-Pacific region to 2010, brown outs will remain a problem in many areas as demand continues to outstrip supply. This is despite increments in electricity output of over 5% per annum across the region. The following are the main findings of a study by Wood Mackenzie, a UK based energy consultant considered among the most authoritative in the energy industry.

*Energy demand in the Asia-Pacific region is forecast to rise by 74% over the next 15 years. By 2010 demand will have reached 4100 mtoe, twice the level of demand in Europe by then, having increased at 1.2 times the level of GDP/capita growth during the period;

* The region's energy self-sufficiency will deteriorate over the period to 2010. Although a greater number of countries will be energy self-sufficient by 2010 (nine compared to six now), the overall position will fall from 79% to 70%. As a result, net energy imports for the region will rise by 150% to 1200 mtoe;

*Coal will remain the most important primary energy source as it is the most readily available indigenous fuel in the region. Demand will double over the next 15 years, its share of total primary energy demand rising to 46%. China and India will remain the main coal consumer although growth in the iron and steel industry will contribute significantly to future increases in demand;

* While the majority of Asia-Pacific countries are attempting to reduce oil dependency, transport sector growth will hinder this. Oil output will remain flat at best across the region, so demand growth of 3%/yr will create an increasing reliance on imported oil. By 2010 the region will be only 29% self-sufficient in oil, at which time the transport sector will account for 45% of total demand. Oil will then account for 70% of the area's energy imports, with just under 17m b/d being required from outside;

*Availability of supply will be the main constraint on gas demand, which is nevertheless expected to rise by over 5% per annum to 2010. Although production will rise by nearly 70% to reach 360 bn cubic meters (bcm) by the end of 2010, it is forecasted that demand will have more than doubled to over 460 bcm. The

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Energy Demand .....
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growth will be driven by power generation, which will account for over half of gas demand by 2010, with gas contributing 15% of all electricity generated by then. Despite this growth, however, gas will only account for 11% of total primary energy demand as lack of supply and infrastructure slows the development of potential markets;

*High cost and long construction lead-times are the main constraints on hydro development. Although a number of large projects are planned over the next two decades, especially in China, hydro's contribution will remain stable at around 14% throughout the period;

*While electricity consumption remains low by international standards, the rate of new plant development is dramatic. Average per capita consumption of electricity in Asia-Pacific stands at less than one-fifth of the level in Europe due in part to a chronic shortage of supply. Although electricity output is expected to rise by 5.5% per annum over the next two decades reaching 7.4m GWh per annum by 2010, power cuts will remain a problem in many areas as demand continues to outstrip supply. Nevertheless per capita consumption will have almost doubled to 1 700 kWh/yr by 2010.

The difference between countries will remain huge, with nearly 12 000 kWh per person consumed in Singapore as against 81 kWh in Cambodia (UK per capita consumption is 5200 kWh/yr).

(Source: "Asian power races to match demand, says WoodMac Report", *Power In Asia, The Asian Electricity Market*, 18 September 1995, Issue No 185, pp. 1-4)

Per annum growth in electricity output

	Countries	95-00		#	00-05 %		#	05-10 %
1	Laos	37.9	1	2 Cambodia	17.4	1	10 Vietnam	8.6
2	Cambodia	18.6	2	1 Laos	15.5	2	11 Myanmar	8.0
3	Indonesia	13.7	3	10 Vietnam	10.3	3	7 China	7.3
4	Thailand	13.3	4	11 Myanmar	7.8	4	1 Laos	6.8
5	Bangladesh	11.9	5	3 Indonesia	7.7	5	9 Pakistan	6.3
6	Philippines	10.2	6	5 Bangladesh	7.7	6	5 Bangladesh	6.0
7	China	8.9	7	7 China	7.7	7	3 Indonesia	5.9
8	Malaysia	8.9	8	8 Malaysia	7.1	8	12 India	5.8
9	Pakistan	8.1	9	9 Pakistan	6.4	9	2 Cambodia	5.2
10	Vietnam	8.1	10	12 India	5.6	10	8 Malaysia	5.0
11	Myanmar	7.0	11	4 Thailand	5.5	11	16 PNG	5.0
12	India	5.6	12	16 PNG	4.9	12	4 Thailand	4.2
13	Taiwan	4.9	13	14 Singapore	4.8	13	13 Taiwan	4.1
14	Singapore	4.7	14	13 Taiwan	4.2	14	14 Singapore	3.9
15	South Korea	4.4	15	15 South Korea	4.1	15	15 South Korea	3.5
16	PNG	4.0	16	6 Philippines	3.9	16	18 Hong Kong	2.5
17	Australia	3.4	17	18 Hong Kong	3.6	17	6 Philippines	2.0
18	Hong Kong	3.3	18	17 Australia	2.2	18	17 Australia	1.7
19	Japan	2.2	19	19 Japan	2.1	19	20 New Zealand	1.3
20	New Zealand	1.3	20	21 Brunei	1.0	20	21 Brunei	1.2
21	Brunei	0.7	21	20 New Zealand	0.9	21	19 Japan	1.1
				# 1995 ranking			# 1995 ranking	
	Regions	95-00			00-05			05-10
1	South East Asia	11.6	1	1 South East Asia	6.4	1	2 Indian Suncont.	5.9
2	Indian SubCont	6.2	2	2 Indian SubCont.	5.8	2	3 North East Asia	5.2
3	North East Asia	5.7	3	3 North East Asia	5.4	3	1 South East Asia	4.8
4	Australasia	3.0	4	4 Australasia	2.0	4	4 Australasia	1.6
	Asia Pacific	6.2		Asia Pacifi	5.4		Asia Pacific	5.1

Source: Wood Mackenzie

New Energy Policy to Improve Fuel Balance in Bangladesh

A new national energy policy has been announced with the objective to provide energy for sustainable economic growth. The policy is essential to undertake a systematic survey, exploration and exploitation of energy resources throughout the country.

The main thrust of the new policy is to ensure new generation and exploration of energy resources with private participation in different subsectors of the energy sector. Up to 2000, projected demand of commercial energy would be equivalent to 12 mt of oil for which an investment of $2.72bn will be needed.

The new policy recommended that power generation gets 45%-50% of the total available gas, fertilizer production gets 25%-27%, industry gets 13%-18%, and the commercial and domestic sectors get 8%-10%.

Given the present energy imbalance between the East and West zones, optimum development of all the indigenous energy sources, sustainable operation of the energy utilities, rational use of total energy sources, and environmentally sound sustainable energy development programs are among other measures included in the new policy.

It was also recommended that the tariffs on different types of final energy should be fixed on the basis of economic cost. When a decision is made to give any subsidy, it will be made at end users level. Private sector participation in the marketing process of the petroleum products and corporatization of different utilities were also recommended in the new policy.

The new policy also recommended setting up a regulatory authority to be called the National Energy Authority, attached to the Ministry of Energy and Mineral Resources to carry out the regulatory functions like issuing licenses to different agencies both public and private.

(Source: *Power in Asia - The Electricity Market*, 16 October 1995, Issue No. 187, p.14)

RESEARCH ACTIVITIES

The Energy Program, School of Environment, Resources and Development, Asian Institute of Technology

Assessment of Rural Energy Use and Potential in Myanmar

Researcher: Thi Thi Aye

Research Committee Members: Mr. J.B. Heredia (Chairperson)
Prof. S.C. Bhattacharya
Dr. G.V. Dang
Dr. S. Kumar

The pattern of rural energy use in Myanmar was studied. In order to determine the energy consumption pattern of the rural areas, a survey was conducted in three villages: representing the hilly region, the coastal region and the dry zone according to Myanmar's three main regions. The potential energy sources of each region were assessed, and the marginal costs for the potential energy sources were calculated at the current production level. The following results were obtained:

Fuelwood consumption is predominant in rural areas and it accounts for 69.8% of the total energy use. The consumption pattern in rural areas has been changing since the change to a market oriented economy in 1989.

Hydropower, biomass, natural gas and coal are of high potential in Myanmar. The data for some places show that solar and wind energy have a high potential. However, the overcutting of fuelwood is causing deforestation in certain places.

The results from the marginal costs studies show that ricehusk, fuelwood, coal and hydroelectricity are attractive to develop. Solar and wind energy are attractive to install in small scale power systems.

Purchase Price of Independently Produced Power: The Case of Nepal

Researcher: Raj Kumar Thapa

Research Committee Members: Dr. R.M. Shrestha (Chairperson)
Dr. G.G. Dang
Dr. X. Chen
Prof. K. Saeed

Independent Power Producers (IPPs) are a major source of new power generation capacity both in the industrialized and developing countries. They have a potential to meet the large and immediate financing gap by mobilizing direct foreign investment in the power sector. In develop-

ing countries IPPs have tapped new forms of financing in international capital markets. Private sector involvement in the power sector has also led to impressive construction and operational efficiency gains. Properly structured IPPs can also stimulate the development of local capital markets.

The study undertakes several detailed system expansion plans for the hydro dominated electricity supply sector of Nepal for the period 1996-2015. Wein Automatic System Expansion Planning Model developed by the International Atomic Energy Agency has been used to carry out the system expansion plan with and without the contribution of the IPP.

Significant costs of upto 20% of the total cost in the planning horizon were found to be avoided by the utility as a consequence of IPP supply to the grid. Avoided costs have been calculated from the long-run marginal cost perspective and adjusted for financial requirements. The avoided costs of 5.05 cents/kWh were found to be 6.48% lower than that required, 5.40 cents/kWh, to provide the required rate of return on equity of 16%, for the IPP under consideration.

Estimating the Thermal Energy Saving Potential in Industry: The Case of Hochiminh City

Researcher: Le Hoang Viet

Research Committee Members: Dr. B. Mohanty (Chairperson)
Prof. S.C. Bhattacharya
Dr. X. Chen

After a long period of embargo and a longer period of centralized administration of the economy with its subsidized price mechanism, the economy of Viet Nam has started to develop strongly. Hochiminh city is a key economic area of the country. Industry, which plays the most important role in the economy of the city, is the biggest energy consumer with a continuously increasing growth rate.

Outdated and second hand production equipment have lead to high increases in the energy cost of industrial products. It seems timely to estimate the energy saving potential of industry. This is one of the key steps in the consideration of re-investment and renovation and may lead to a reduction of investment or operation costs.

In this study, three industrial sub-sectors including textile, food and non-metal industries have been considered due to their large contribution in terms of gross industrial products, and share in total industrial energy consumption and energy intensity. Three factories for each sub-sector were selected for energy audits.

The energy saving opportunities could be classified as short, medium and long term based on investment requirement and pay back period.

From the energy audit results, and through extrapolation, the study estimates the saving opportunities of the textile industry to be 1.8% using short term measures (mostly housekeeping, combustion tuning, blowdown control, insulation improvement) and 38% using medium term measures (such as combustion efficiency controller, flue gas recovery, heat recovery from hot effluent, heat recovery from condensate, insulation of bare pipe). In addition to these measures, another 6.9% saving can be expected by opting for long term options such as replacement of boilers and furnaces. In the food industry, the saving opportunities could be 3% using short term measures, 45.5% using medium and 8.5% using long term measures. Finally, the saving opportunities of non metal industry could be 0.1% using short term measures, 0.7% using medium term measures and 11.4% using long term measures.

These energy savings would lead to overall sub-sectoral reduction of 2% using short term measures for the textile and food industries and 1% for the non metal industry. With medium term measures, the sub-sectoral energy consumption of the textile industry would be reduced by 31%, that of the food industry by 22% and that of the non metal industry by 15%. The long term measures would reduce 10% of sub-sectoral energy consumption of textile, 2% of food and 1% of non metal industries.

Daylighting and Artificial Lighting Integration: An Experimental Case

Researcher: Prachak Phradmali

Research Committee Members: Dr. Surapong C. (Chairperson)
Prof. E. Karmazsin
Prof. S. C. Bhattacharya

Daylighting possesses a good potential for application in the tropical climate. It can offer the benefit of reduction in electricity for lighting.

This study investigated daylighting in an experimental room in the AIT energy park. Experiments were conducted for four scenarios of daylighting and artificial lighting integration. The four scenarios cover the case of overall uniform lighting and non-uniform lighting arrangement, and two lighting control methods, continuous and step dimming. The resultant savings in energy for lighting ranges from 68% to 86% in comparison to the base case.

The investigation also included an estimation of the net heat gain into the building from daylighting and from electric lighting, which forms part of the cooling for the air-conditioning system. During the course of the daylighting

experiments, a number of fellow students were requested to assist in the evaluation of daylight comfort under all four scenarios of daylighting-artificial lighting integration. Continuous dimming received favourable responses from the subjects. Step-dimming on task areas tended to produce unfavorable responses.

Energy and the Environment in China: Options for Energy Efficiency Improvement and Environmental Pollution Abatement in Energy Intensive and Polluting Industries

Researcher: Wang Yu

Research Committee Members: Dr. X. Chen (Chairperson)
Dr. B. Mohanty
Dr. U. Stoll
Prof. Cunyi Yu

China is among the fastest growing economies in the world. The high economic growth is causing both high growth in energy consumption and environmental degradation.

Iron and steel, cement, and pulp and paper are three of the most energy intensive and polluting industries in China.

The study presents a sector by sector evaluation of technology, energy consumption pattern, energy efficiency and the situation of environmental pollution in the three selected industries. For each industry, an analysis of the determining factors of energy efficiency was carried out. Energy efficiency of each industry was analyzed in relation to technological level, production structure, ownership of enterprises, as well as fuel and raw material mixes. Potentials for improving energy efficiencies of the three industries were assessed by comparing the major energy efficiency indicators with those of industrialized countries. Then a cross-industry comparison on the common and different determinants of energy efficiency among the three industries was conducted.

It is found that the energy efficiency level and the pollution situation of these industries are mainly related to the production scale and ownership status of enterprises, technological level, as well as raw material and energy mixes. A large number of small size township enterprises involved in cement and paper production lowers the energy efficiency and makes pollution prevention and control very difficult.

Based on the above, options for energy efficiency improvement and pollution abatement in the three industries through technological, economical, managerial and institutional means were examined.

Book Reviews

Rural Energy Planning A Government-Enabled Market-Based Approach

Edited by K.V. Ramani, A.K.N. Reddy and M.N. Islam
Published by the Asian and Pacific Development Center (APDC), Pesiaran Duta, P.O. Box 12224, 50770 Kuala Lumpur, Malaysia
ISBN 967-9928-40-3, 1995, xxv + 590 pp.

The central focus of this volume is on rural energy development in liberalized rural energy markets enabled by appropriate governmental policies and indicative planning. This volume is one of the outcomes of a project funded by the Bundesministerium für Winthschaftliche Zusammenarbeit and Entwicklung (MBZ) (German Federal Ministry for Economic Cooperation and Development). The various chapters of the volume have been authored by members and affiliates of the Asian and Pacific Energy - Environment Planning Network (APENPLAN) of the APDC Energy - Environment Program. The topics and authors of the eighteen chapters of this volume are as follows.

Issues and Approaches

1. Introduction by K.V. Ramani and Amulya K.N. Reddy
2. Rural Development, Energy and Environment by K.V. Ramani, Peter Hills and M. Nurul Islam
3. Prevailing Paradigms for Rural Energy Planning by K.V. Ramani and M. Nurul Islam
4. GEMBASED Approach to Rural Energy Planning by K.V. Ramani, M. Nural Islam and Amulya K.N. Reddy
5. Approach to Rural Electrification by K.V. Ramani
6. Rural Energy Policy Analysis by Ramesh K. Bhatia and Nikhil Desai
7. Analysis of Technology Trends and Managing Technology Change by Thomas J. Wilbank.

Planning Methods and Techniques

8. Rural Energy Data Base Development and Management by K.V. Ramani, Qiu Da-Xiang and Charit Tingsabadh
9. Rural Energy Demand Analysis and Forecasting by Ramesh K. Bahtia
10. Rural Energy Technology Choice by Ucok Siagian and Saswinadi Sasmojo
11. Evaluation of Decentralized Energy Technologies by Jan Brägelmann
12. Rural Energy Demand-Supply Balancing by Arshad M. Khan
13. Economic Impact Analysis of Rural Energy Policies and Programs by Binayak Bhadra and K.V. Ramani
14. Environmental Impact Analysis of Rural Energy Policies and Programs by Peter Hills
15. Rural Energy Project Formulation by M. Nurul Islam and K.V. Ramani

Implementation Strategies

16. Rural Energy Market Potential Assessment and Market Penetration Strategies by Lalith Gunaratne, Viren Perera and K. V. Ramani
17. Financing Rural Energy Services by Mathew S. Mendis and Marcia M. Gowen
18. Research and Development of Rural Energy Centers and Strategies for their Replication by Amulya K.N. Reddy

The Role of the Private Sector in the Small-Scale Hydropower Field MHPG Series Harnessing Water Power on a Small Scale—Volume 12

by K. Goldsmith
Published by SKAT, Swiss Center for Development Cooperation in Technology and Management
Vadianstrasse 42
CH - 9000 St. Gallen, Switzerland
ISBN 3-908001-50-1, 1995, 165p.

Electricity production from renewable sources such as wind, solar and hydropower is expected to rise as they are clean and largely neutral with respect to CO_2 emission, and also because they are inexhaustible. Among these sources, hydropower remains the most extensively developed and widely applied form of renewable energy. There is also a vast and much under exploited potential for small schemes which are environmentally unobtrusive and are ideally suited for providing electricity for rural and outlying areas where electrification has hitherto seriously lagged behind. One might think therefore that decentralized power supplies meeting local demands for electricity in outlying areas from hydro resources would be widely available but this is not the case. Small hydro sources have not been tapped to any significant extent, at least not in the developing countries where the bulk of these sources can be found and where the rural population is still starved of energy and suffers considerable socio-economic deprivation by being restricted to an often only primitive subsistence economy.

Bearing in mind that the technology of small scale hydropower, say in the range of up to 15 MW, is well developed and there are essentially no engineering obstacles to its extensive use, one must look to other reasons why progress in its application has been so retarded. There has also now been a shift in governmental preference in many countries from public ownership of essential utilities to their transfer to the private sector, or at least to the opening-up of these industries to private participation. Although much has been said and written about the privatization of the electricity sector in the developing world, only a few projects with private participation have however been realized to date.

This book by K. Goldsmith therefore addresses the wide range of issues that arise when private participation in hydropower development comes into question. The author has made a special study of this subject, based on many years' experience in international consultancy both for and with public and private organisations. As there is very little to review concerning past achievements and failures in the developing world, and hence to draw conclusions from, the book offers guidelines based on current policies and practices in the industrialized world.

The topics covered in the book's eight chapters are — Overview, Development Trends, Assessment of Private - Sector Inputs, Criteria for Economic and Financial Viability, Project Formulation, Regulation, Financing Scenarios, and Corporate Issues, respectively.

Although the discussion concentrates on small hydropower, the processes described are essentially the same for thermal power schemes and can, within reasonable limits, be equally well applied in thermal or mixed hydrothermal power systems.

Publications Received

* Workshop Proceedings: Energy Efficiency in Buildings, 11-13 January 1995, New Delhi, Editor: B. Mohanty, 121 p.

* Energy Environmental Planning in Developing Countries-- EFOM-ENV, Programme for Asian Cooperation on Energy and Environment (PACE-E), Editor: T. Lefevre
  - Methodological Guide (ISBN 974-8202-28-3)
  - Programmer's Guide (ISBN 974-8202-29-1)
  - User's and Technical Guide (ISBN 974-8202-27-5)

* Guide Book on Energy Environment Planning in Developing Countries, Programme for Asian Cooperation on Energy and Environment (PACE-E), Editor: T. Lefevre
  - Synthesis Report on Energy-Environment Studies in Asia (Part 1, ISBN 974-8202-39-1)
  - Training Material on Energy-Environment Studies in Asia (Part 11, ISBN 974-8202-40-2)

* Guide Book on Energy Survey, Programme for Asian Cooperation on Energy and Environment (PACE-E), Editor: T. Lefevre (ISBN 974-8202-31-3)

* Sectoral Energy Demand Analysis and Long-Term Forecast, Methodological Manual, MEDEE-S, Programme for Asian Cooperation on Energy and Environment (PACE-E), Editor: T. Lefevre (ISBN 974-8202-37-2)

Training Courses/Conferences

Biomass Energy Technologies and Renewable Energy Oppurtunities in New Zealand
11-14 th March, 1996
Rotorua, New Zealand

● Seminar: New Renewable Energy Oppurtunities for New Zealand
Sheraton, Rotorua
11 March 1996

The latest information and potential applications of new and emerging renewable energy technologies including:

- wind energy
- solar thermal
- photovoltaics
- small/micro hydro
- biofuels
- landfill sites
- wave and tidal

● Conference on Applications of Bioenergy Technologies in New Zealand
Sheraton, Totorua
12-13 March 1996

This conference will bring together interested parties and international experts to describe the current scene and examine the critical factors for successful adoption of bioenergy technologies.

Key topic areas include:

- bioenergy use in New Zealand
- bioenergy used internally
- bioenergy and the environment
- biomass availability in New Zealand
- biomass conversion technologies
- economics of bioenergy
- factors critical to deployment
- research needs and oppurtunities

● Field Tour
14 March 1996

A visit to current or potential bioenergy sites is anticipated.

Options include:

- collecting harvesting residues
- bioenergy in a sawmill
- bioenergy in a pulp and paper mill
- ethanol production from dairy wastes
- biogas from sewage
- landfill design
- short rotation forestry

For further information contact:

Graham Diedrichs
Conference Organiser
Energy Efficiency and Conservation Authority
FREEPOST 4245
PO Box 37 444
Parnell
Auckland
New Zealand

Energex'96
The 6th International Energy Conference and Exhibition
3 - 7 June 1996, Beijing, China

Energex'96 conference will provide a vehicle for the exchange of professional expertise and transfer of technology by one to one interaction between energy researchers and industrial representatives from all nations. The exposition will provide opportunities for industry, research institutes and others to promote their capacity and capability and establish key contacts with their counterparts from within China and elsewhere.

The conference theme is "Energy Strategies in Developing Countries in the 21st Century: Challenges and Opportunities". The topics of interest include:

* Rational Use of Conventional and New and Renewable Forms of Energy
* Economic Development and Strategies
* International Cooperation and Communication
* Energy and the Global Environment Issues
* Rural and Urban Energy Challenges
* Energy Systems Analysis and Prospects
* Scientific and Industrial Transfer of Technology
* Energy Sustainability and Energy Options

Energex'96 Exhibition

The ENERGEX'96 exhibition, China International Energy and Power Supplies, Equipment and Facilities Exhibition, will be held in the same conference facility and on the same dates as the ENERGEX'96 conference.The scope of the exhibits include.

* Clean Coal Technology
* Oil and Gas
* Energy Efficient Products
* New and Renewable Energy Equipment and Products

For further information contact:

Mr. Liu Feng/Mr. Zhen Yingjun
ENERGEX'96 Secretariat
CICCST
P.O. Box 9651
Beijing 100086, China
Tel: (86-10) 257-5681
257-5685
Fax: (86-10) 257-7591

Energy & Environment Information System (EEIS) in Thailand

Regional Energy Resources Information Center (RERIC) of the Center for Library and Information Resources (CLAIR), Asian Institute of Technology (AIT) serves as the Primary Contact Point (PCP) of the EEIS in Thailand. EEIS is a United Nation Industrial Development Organization (UNIDO) supported industrial information system with particular focus on energy and environment information for small and medium scale industry sector. EEIS is an extension of the UNIDO Industrial and Technological Information Bank (INTIB) network.

For details contact:
Regional Energy Resources Information Center (RERIC)

Diary of Events

* **12-14 February 1996**
New Delhi, India
2nd Annual Renewable Energy South Asia '96
and
August/September 1996
Jakarta, Indonesia
3rd Annual Renewable Energy Asia/Pacific
For details contact:
Ms Cassy Kurtzman
Alternative Developmnet Asia, Ltd,
5/F, # 3 Wood Road, Wanchai
Hong Kong
Tel: +852-2574-9133
Fax: +852-2574-1997

* **25-29 March 1996,**
Berlin, Germany
4 th European Conference on Solar Architecture and Urban Planning
For details contact:
DG XII, 200 rue de la Loi,
B-1049
Brussels, Belgium
Tel: + 32 2 299 11 11
Telex: 24877 COMEU B

* **14-18 April 1996**
Cairo, Egypt
Renewable Energy Conference and Workshop— A combined conference with the 4th Conference on Applications of Solar
and
Renewable Energy, and the 2nd Conference on Solar Electricity: Photovoltaics and Wind
For details contact:
Dr H El Agaamwy
P.O Box 487 Doki,
Egypt
Tel: 202-3610-806
Fax: 202-781-236

* **20-24 May 1996,**
Goteborg, Sweden
1996 European Union Wind Energy Conference and Exhibition
For details contract;
Ms. Anne Baubin
European Commission
Rue de la Loi, 200
SDME 3/20
Tel; + 32-2-295 9985
Fax; + 32-2-296 0621
Beijjing, China
Tel: + (81-6) 257 5681
Fax: + (86-1) 257 5691

* **20 May - 22 June 1996**
University of Twente
International Training Program on Energy and Environment for Sustainable Development
and
* **7 Oct. - 9 Nov. 1996**
University of Twente
Training Program on Energy Management and Cleaner Production in Small amd Medium Scale Industries
For details contract:
The Course Administration
Technology and Development
Group, VOK/CT 1807
University of Twente
P.O. Box 217, 7500 AE Enschede ,
The Netherlands
Tel: +31 53 4894377/ 4893545
Fax: +31 53 4893087
J.R.M.Borghuis@TDG.UTWNTE.NL

* **15-21 June 1996,**
Denver, Colorado, USA
World Renewable Energy Congress IV
For details contact
Mr Steve Hauser
Chairman of Tech. Committee
Division Director, NERL
1617 Cole Boulevard
Golden, CO 80401, USA
Tel: (303) 384 7416
Fax: (303) 275 4320

* **29-31 July**
Trabzon, Turkey
First Trabzon International Energy and Environment Symposium - TIEES
For details contact:
Prof Dr Teoman Ayhan
TIEES-96
Department of Mechanical Engineering, Karadeniz Technical University, Trabzon 61080, Turkey
Tel: (462) 325-3223
Fax: (462) 325-7405
energy96@risc01.bim.ktu.edu.tr

* **22-25 October 1996**
Darwin, Northern Territory, Australia
SOLAR '96 "Energy For Life"
For details contact:
Solar'96 Conferernce
GPO Box 1392
Darwin NT 0801
Australia
Tel: +61 89 99 5440
Fax: +61 89 99 5289
email chandra@dme.nt.gov.au

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Center for Library and Information Resources (CLAIR), Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The "RERIC News" is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership package along with the International Energy Journal (formerly: Renewable Energy Review Journal). For further details contact:

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RERIC news

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Energy and Environment Information System (EEIS) in Thailand

The pilot phase of the Energy and Environment Information System (EEIS) initiated to deliver industrial energy and environment information to small and medium scale industries (SMIs) in Thailand was successfully completed with a workshop held at the Asian Institute of Technology (AIT) on 16 January 1996.

The Industrial and Technological Information Bank (INTIB) of the United Nation Industrial Development Organization (UNIDO) supported the Center for Library and Information Resources (CLAIR), AIT to undertake this pilot project in Thailand. One of the objectives of the EEIS is the institution of high impact mechanisms of information which corresponds to Thailand's capabilities in disseminating information. The EEIS provides a number of services including the provision of relevant, and up-to-date information.

The Regional Energy Resources Information Center (RERIC) of CLAIR serves as the Primary Contact Point (PCP) of the EEIS Network in Thailand. While setting up the network, potential partners in the energy, industrial, trade and information sectors were approached to act as Secondary Contact Points (SCPs) for the network. And as initial partners of the network, the following four SCPs were selected for this pilot project.

Participants with (seated l - r) Dr. Francis Devadason, CLAIR Associate Director, Mr. Ari Huhtala, UNIDO Country Director, and Prof. Robert D. Stueart, CLAIR Executive Director.

Federation of Thai Industries (FTI)

FTI was selected to represent the trade and industry association. FTI is the largest and only officially recognized private sector industrial organization. FTI has over 3600 member companies from 26 industry Clubs and 19 provincial clubs. Member companies include small, medium and large companies throughout the country. The roles selected by FTI are to promote energy and environment conservation issues and to act as information intermediary. The Industrial Environmental Management Office (IEM) is the direct contact as SCP.

Industrial Estate Authority of Thailand (IEAT)

IEAT was selected as representative of local enterprise, technology transfer and industrial productivity enforcement agencies. IEAT is a state enterprise attached to the Ministry of Industry. IEAT operates 23 industrial estates with a total of 1000 factories mainly medium and large industries. IEAT provides a one-station service for Thai and Foreign industrial organizations. IEAT is charged with implementing policy with regards to the government's rules and regulations in order to stop damage to the environment as necessary development takes place. The Environmental Enhancement Center (EEC) of IEAT is the direct contact as SCP.

(contd. on p. 2)

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Supplement: Small Scale Wind Energy Systems

Deployment of Small-Scale PV Plants in Rural China

China's energy demand has grown very rapidly along with the rapid development of many areas over the last decade or so. Energy consumption in 1992 was 2.3 times as high as in 1980. Now due to high population density and poor energy resources, the scarcity of energy is beginning to inhibit the development pace of China. Today, environmental pollution and the scarcity of energy are of growing importance to China.

To solve these problems, the Chinese Government has sought to make use of regenerative energies and has already made great progress in the utilization of biomass, biogas and small-scale hydropower. China has also had some success in thermosolar utilization, eg. solar collectors, solar stoves and solar houses. In the thermal utilization of solar energy, China has gained greater experience and comparatively more highly developed technology than in the field of photovoltaics (PV). Although a great deal of research in photovoltaic technology is currently being conducted, the products so far developed cannot compare, qualitatively or quantitatively with thermal applications. The possibilities of deploying photovoltaic technology are as yet extremely limited.

At the end of 1993, a total of 100 million people were still living in the Chinese countryside without electricity supply. Most of them live in mountainous areas, in border regions or in poor country villages. Their life of physical labor is hard, their standard of living very low. There is hardly any chance of supplying them with electricity.

Photovoltaic plants could be an important way of providing electricity to the rural areas of China. A field survey carried out by Zhou Shugin to evaluate the technical and socio-economic aspects in Jiangsu province of deploying PV plants in rural districts of China reveals the following:

- The reaction of the rural population to demonstrations of the solar lamp was positive. Villagers thought that the solar lamp and solar home system could be acceptable in rural areas if they were made economical.

- The climatic conditions in Jiangsu province are favorable to the utilization of solar energy. Even in the least favorable month of the year (December) the total radiation with the solar plants at its optimal angle of inclination can result in an average of 4897 Wh/m^2.

- In comparison with traditional lamps, the lighting quality of solar lamps is much better. The light beam relation between the Solux II and the petroleum lamp is 130:30.

- The costs of the solar lamp per hour of lighting (0.153 Yuan/h) are much lower than battery-powered torches (0.67 Yuan/h) or candles (0.27 Yuan/h), although somewhat higher than the cost of petroleum lamps (0.08 Yuan/h). If a family had two solar lamps and used them in conjunction with petroleum lamps, the annual total costs for lighting would be a little cheaper than for traditional lighting.

- Taking inflation into account, total annual costs for the solar home system will rise slightly, but costs will rise steeply for those connected to the electricity grid. The greater the distance from the existing grid, the more economical the solar home system is in comparison with a grid connection.

The Market

At the end of 1993 in Jiangsu province, there were still one million families (about 4 million people) in rural districts without any form of electricity supply. If only 10% of these families were to buy one solar lamp

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Technical Information Access Center (TIAC)

TIAC was selected to represent information centers. TIAC is Thailand's first information service operating as a commercial division of a government agency, the National Science and Technology Development Agency (NTSDA).

The main function of TIAC is to provide information in science, technology, business and industry. To achieve this function they also promote energy and environment conservation issues.

Technical Information Services (TIS)

TIS is designed to keep modern business, industry, public sector and researchers up to date with international technical development with focus on non-conventional energy, environment, biotechnology and food technology. TIS specializes on information from and about ASEAN. Membership of TIS in the EEIS ensures that the network will be well informed of the ASEAN information needs on energy and environment. This will be useful for future EEIS expansion in the region.

The workshop was attended by representatives from the three SCPs, the UNIDO Country Director, and representatives from PCP. The objectives of the workshop were:

1. To formulate marketing strategy
2. To discuss problems encountered and to identify possible solutions
3. To recommend activities that could be undertaken to achieve sustainability
4. To identify organizations to be invited as EEIS members
5. To recommend monitoring process and criteria.

Accordingly, discussions and recommendations on the marketing strategy, network operational procedure and guidelines, monitoring and sustainability aspects of the network were made during the workshop. The present network members reaches more than four thousand small and medium scale industries in Thailand. The network will however be further expanded to reach more SMIs in Thailand. The need for external funding was also realized as income from the target groups would not be able to sustain the network at this stage.

The members agreed to use the existing communication channels of the members to market EEIS. They also agreed to a progress meeting every six months to review the progress of the activities.

each, 100 000 lamps would be sold. The whole of China at the end of 1993 had 25 million families (about 108 million people) in rural districts without electricity supply. Again, if only 10% of these families each bought a solar lamp, there would be 2,500,000 solar lamps in China.

The solar home system which can also supply electrical energy for household appliance can be used by many higher income families who have no opportunity to link up with the national grid. This includes many people who, for example, live on islands or peninsulas where fishing is economic (in Zhejiang and Fujian provinces), or who live in mountainous areas where crop cultivation for consumption and medicine is viable, eg. in Guangxi province, or who live well from cattle raising on grassland and pasture, eg. in Neimeng. Most inhabitants have little chance of a grid connection but possess the necessary cash for a solar home system which would lighten their tasks through electric household appliances.

Determining Factors

Apart from sound technical and economic attractiveness, the success of actual dissemination of PV plants throughout the rural areas would depend on the following aspects:

Traditional attitudes and behavior

- Many people think that the solar lamp and solar home system are just too expensive. They direct their attention only to high initial costs of investment, but do not take into account daily running costs in comparison with traditional forms of lighting.

- The normal citizen will only think of the immediate price of electricity (about 0.35 Yuan/kWh), because this is the price they have to pay. Much more attention should be focussed on the fact that Chinese coal reserves are not unlimited as well as on the fact that large amounts of CO_2 are released into the atmosphere in coal-fired generation.

- Many people believe that the educational level of the rural population is not sufficiently high for the introduction of photovoltaic technology. They have not, however, considered that educational level is correlated with standard of living. The lower the latter, the worse the conditions for education and training. The less knowledge people possess, the poorer they remain.

Positive aspects

- The price rises in fossil fuel energy have meant that the population have become more aware of the need to use regenerative energies. In addition, photovoltaic technology applications are becoming more competitive in pricing.

- The unit cost of solar lamps and solar home systems can be reduced with an increase in unit production. Because there is a good market in China, the production of components can be carried out in standardized form on a large-scale; this would certainly ensure better marketability. The quality of individual components will also be improved by better production technology.

- With economic development and improvement in living standards, the population will develop a growing environmental awareness. The solar lamp and the solar home system with their minimal burden on the natural environment will attract the interest of more and more people.

Despite the presence of many obstacles for effective dissemination of small scale PV plants in rural China, the benefits in terms of social, economic and environmental terms that can be derived calls for a more concerted effort for its use.

(Source: Shugin, Z. 1996. Small scale PV-plants in rural China. *Appropriate Technology Forum* 7:14-15)

Biomass Conversion Technologies

Biomass energy has been and still is an important source of energy for all types of applications. This situation is expected to remain for the foreseeable future. Important reasons for this phenomenon are that biomass energy is available almost everywhere on earth, it is relatively cheap, it is virtually inexhaustible, it is renewable and, when used properly, is environmentally friendly. Rough estimates of the amount of biomass grown annually showed that, in terms of energy content, the amount is equivalent to about 2890 Exajoules (10^{18}). Annual biomass production is therefore about 8 times the total annual world energy consumption estimated at about 359 EJ, from all sources combined.

Biomass used as a source of energy consists not only of woodfuels such as trees, twigs, etc, originating from forests, agricultural lands, homesteads, waste lands, etc. but also consists of agricultural, forestry and other wood residues, crops grown specifically as a source of energy purpose (grasses, trees, etc.), aquatic weeds (water hyacinth, etc.), and others.

The energy content of biomass, ranging from about 17 GJ/ton - 20 GJ/ton dry is low in comparison with fossil fuels such as coal (23 GJ/ton - 33 GJ/ton depending on quality) and 38 GJ/ton - 40 GJ/ton for liquid fossil fuels.

The traditional applications of biomass energy are the use of fuelwood for cooking and space heating and for small scale industrial use (brick burning, lime burning, food processing, etc.). These are often relatively small scale and frequently, if not always, traded on a non-monetized informal local economy. However, "modern" applications of biomass energy looks promising in substituting conventional sources of energy such as coal, oil and gaseous fuels. Some examples are heat and electric power generation from biomass, liquid fuels from biomass such as ethanol, methanol, biodiesel, etc., gaseous fuels from biomass like gasification, biogas, etc. Incidently, most of these modern applications are relatively large scale.

"Modern" Biomass Conversion Technologies

Biomass energy technologies can be roughly divided into three main groups e.g.

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(contd. from p. 3)

direct combustion processes, thermochemical processes and biochemical processes. The first process is in principle directly concerned with primary fuels e.g. the fuels are used as they are found or after some from of processing such as size reduction, drying, compaction through briquetting, carbonization, etc. The latter two are basically processes in which the primary fuel is converted into a secondary fuel. In thermochemical and biochemical conversion processes the biomass is converted from a solid form into either a gas or a liquid through pyrolysis, gasification or catalytic liquefaction or through fermentation and other related processes such as hydrolysis with acids or enzymes, etc.

Direct Combustion Process

Using biomass to generate electricity and heat has been widely practiced in the past. At present it is making a comeback in many industrial applications. This can range from simple systems such as stoves, furnaces and boilers to more advanced systems like fluidized bed combustion technology, etc. However, often an intermediate step is involved e.g. feedstock preparation such as drying, sizing, grading, compaction, etc. as this will improve the combustion process as well as its control. The heat generated during combustion can be used directly in production processes but it can also be used to generate steam. The steam is normally used to drive a turbine to generate electricity. These are in principle straightforward conversion processes and equipment is commercially available in various sizes and capacities.

However, straight-forwarded conversion of thermal energy into mechanical or electric power results in considerable losses and it is physically impossible to raise the ratio of thermal to mechanical power above 60% (the so-called Carnot Limit). In practice conversion ratios are considerably lower than the maximum. Modern thermal power stations (200 MW - 600 MW) operating at high pressures (as high as 240 bar) and high steam temperatures (>500°C) and using seawater as a coolant can have an efficiency of about 45%. However, if the low temperature waste heat can be used productively, for instance in distract heating systems which are common in the cooler European countries or for drying or heating purposes, much higher overall efficiencies can be obtained.

Combined Heat and Power (CHP) systems are not limited to thermal power stations but can be and are used in many different configurations such as for instance internal combustion engines with the heat of the exhaust gases or coolant systems used for productive purposes. Related to CHP are co-generation systems which basically make use of the principle of simultaneously generating heat and electricity. As a rule of thumb it can be assumed that CHP and co-generation systems save about 30% of the fuel when compared with two separate systems.

Thermochemical Processes

Pyrolysis is the basic thermochemical process to convert biomass into more valuable or more convenient products (to be used as fuels or for other uses). The products formed are normally a gas, an oil-like liquid, and a char. The distribution of these products is dependent on the feedstock, temperature and pressure of reaction, the time spent in the reaction zone and the heating rate. High-temperature pyrolysis (1000°C) maximizes the production of gas (gasification) while lower temperature pyrolysis processes (< 600°C) have been used for centuries for the production of charcoal. Another approach to produce liquid fuels and chemicals from biomass is direct catalytic liquefaction.

Because of the interest in relatively simple biomass conversion technologies to produce low or high heating value gases and liquid fuels, pyrolysis has recently received a great deal of attention. Extensive research into new processes of biomass pyrolysis with low residence time in the reaction zone and high heating rates (flash pyrolysis is being carried out world-wide. Some of these projects have reached the demonstration stage, but few if any have yet been fully commercialized.

Gasification

Gasification is an established technology, the first commercial application of which dates back to 1830. During World War II, biomass gasification systems appeared all over the world. Almost one million gasifier-powered vehicles using wood or charcoal helped keep basic transport systems running. After the war, most of the systems were abandoned.

However, the energy "crises" of the seventies rekindled interest in biomass gasification systems. The technology was perceived as a relatively cheap indigenous alternative, for small-scale industrial and utility power generation in developing countries, that were hard hit by high petroleum prices but had sufficient, sustainable biomass resources.

Other more complex gasification systems such as high-pressure oxygen gasification indirectly heated gasifier systems, etc. often in combination with high-efficiency power conversion systems such as for instance biomass integrated gasifier steam-injected gas turbines (BIG/STIG) or integrated biomass gasifier combined cycle plant (IGCC), are at present under development. They show considerable promise and are expected to be able to compete with conventional coal, nuclear and hydroelectric power in both industrialized and developing countries.

Biochemical Processes

These processes make use of the biochemistry of the raw materials, and the metabolic action of microbial organisms, to produce gaseous and liquid fuels. Examples are biogas, ethanol, methanol., etc.

Ethanol

Ethanol fermentation from carbohydrates is probably one of the oldest processes known to man. Today, it is widely regarded as an important potential alternative source of liquid fuels for the transport sector. Raw materials for the production of ethanol from fermentation can be divided into three main groups based on the type of carbohydrate prevalent, saccharine materials, starchy materials and cellulosic materials. The choice of raw material for ethanol fermentation is critical, as feedstock costs typically make up 55%-80% of the final alcohol selling price.

Saccharine materials, with sugar available in fermentable form, require the least extensive preparation, but are generally the most expensive to obtain. Starch-bearing materials are often cheaper, but require

→

CNG - A Cheap and Pollution Free Fuel

Compressed Natural Gas (CNG), is an attractive alternative to petrol but is a finite source of energy. It is a by-product of petroleum extraction, and will be available in abundance for another fifty years. Cheaper than petrol, it gives more mileage and is considered to be pollution free.

Till around 1960, natural gas was considered to be a waste product of oil recovery. Since then countries like Italy, Soviet Union and New Zealand started experimenting with the gas as a vehicular fuel. But it was in the USA that the project really took off. In effect, the Clean Air Act Amendments of 1990 introduced CNG as a commercial alternate fuel. Other alternatives to gasoline were vehicles fueled by alcohol and electric cars. However the Green House effect of alcohol was found to be 80% more than gasoline. Thus CNG became very popular as the only available fuel which did not cause pollution.

The World Watch Organization, USA, describes CNG as "extraordinarily cheap and better than other alternatives from the pollution point of view". The supply of CNG in the USA is not expected to decline until after 2000 and after which it plans to import from Canada.

The Indian Experience

In India, the Supreme Court set up a high powered committee headed by a retired judge to make an assessment of the feasibility, of the alternatives available to reduce motor vehicular pollution. One of the recommendations of the committee was to convert to CNG, or a dual fuel mode.

CNG was introduced in Bombay in December 1992. Commencing as a pilot project by the Gas Authority of India Limited (GAIL) Bombay, CNG appeared to be the best alternative for the taxis in Bombay. By the simple inclusion of CNG kit priced at Rs. 30 000 (US$ 1000) the taxi owner had drastically reduced the cost of fuel.

It is now three years since this 'wonder fuel' was made available to the taxis in Bombay. Today it could be expected that out of the 40 000 taxis that ply in Bombay, a majority of the taxis willingly switch over to the CNG mode. Statistics however show that there has been a decline through the years in the number of taxis registering to change over to the CNG mode due to a number of reasons. The Bombay Taximen's Union reported 1200 conversions of taxis into the CNG mode in the year 1994. The year 1995 (till Oct), in contrast, records only 200 conversions of taxis into the CNG mode (as reported by the Regional Transport Office at Bombay Central)

According to GAIL, Bombay, CNG is available in abundant supply over a medium term, ie. for another 30 to 40 years. Today a two and a half km pipeline supplies CNG to the mother station at the City Gas Station, Wadala, an eastern suburb, where two compressors, each with a storage capacity of 835 kg of suction pressure of 625 m^3/m, are installed. The incoming gas (at a pressure of 20 kg/m^3 to 24 kg/m^3) is compressed to 250 kg/m^3 in the compressors.

Due to the very high pressure of CNG, there cannot be a reservoir to store the gas at the filling station (as in the case of petrol). Moreover there is a danger of leakage from the storage tank which could prove fatal in nature. Thus the gas is filled directly into the taxis from the cascades on the LCV. The LCVs have to wait till the gas is supplied to the required number of cars. This in itself is a poor management of resources. The transportation of the gas is the problem area, where the technical feasibility of the project lapses. GAIL admits: "Transportation of the gas across a traffic congested city like Bombay is not a desirable proposition."

In a city like Bombay, where taxis consume about 30% of the city's total petroleum supply, it is time that alternatives to fossil fuels are perceived and implemented. CNG should be able to play a major role in reducing pollution at least in the medium terms.

What is CNG?

Natural gas is a mixture of hydrocarbon gases (methane and ethane primarily) found in the sub-surface rock reservoirs. It may be produced through the decay of anaerobic organisms during petroleum 'cracking' (separation of petroleum from smaller and lighter hydrocarbons), or as a part of the coalification process. The energy content of natural gas is normally 900 BTU to 1300 BTU (British Thermal Unit). It is usually odorless, colorless, non-toxic and highly inflammable.

Constituents	*% Volume*
Methane	84.5
Ethane	7.7
Propane	2.4
i-butane	0.26
n-butane	0.32
i-pentane	0.18
n-pentane	0.19
Hexane	0.17
Nitrogen	0.12
Carbon dioxide	4.23

Compressed Natural Gas (CNG) is natu-

(contd. on p. 6)

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processing to solubilize and convert the starch to fermentable sugars. Cellulosic materials such as wood are the most readily available raw material, but the process runs on a semi-continuous basis with recovery and recycling of the yeast.

During ethanol fermentation considerable quantities of carbon dioxide are produced, which can be easily recovered, compressed and used as an additive in the beverage and food industries. The yeast and other insoluble components of the fermented feedstock are removed from the fermentation stills as stillage (also known as slops or vinasse). When starch is used as a feedstock, the stillage has a high protein content, and can be sold as a livestock feed after evaporation and drying.

The stillage from sugar fermentation is of lower value, and also constitutes a major waste problem. This is basically caused by the large amount of water used in the system which results in an effluent load of about 10 liters - 15 liters of effluent per liter of ethanol produced. In fact a molasses based distillery producing 60 000 liters ethanol per day may have a pollution load equal to a city of one million inhabitants.

(Source: Koopmans, A. 1995. Modern wood energy technologies. *Wood Energy News* 10(3):3-8)

(contd. from p. 5)
ral gas, which has been compressed for use as a vehicular fuel.

Benefits of CNG Over Other Fuels

1. Conservation of petrol and other fossil fuels leading to lesser import of oil.

2. Lower fuel cost (US $1.00 = Rs 33.00)

CNG	Petrol
Rs. 11.90/kg	Rs. 19.26/liter
(Rs. 0.79/km)	(Rs. 1.93/km)

3. More mileage - One kg of CNG gives an average of 15 km while a liter of petrol gives a mileage of 10 km.

4. A cleaner environment with respect to vehicle exhaust and evaporative emissions. The carbon monoxide emission of petrol fuelled taxis is 0.60 tons per day in Bombay whereas CNG fuelled taxis are reported to emit almost 0% carbon monoxide.

5. Lesser exposure of vehicle occupants as well as general traffic to toxic fuels and noise pollution.

6. Reduction in Green House effect due to lesser carbon dioxide emission.
(Note: A report by World Organization for Economic Cooperation and Development, USA, reports that transport emits 25% of world's total carbon dioxide. In industrial countries this may grow to 40%. The Indian Institute of Petroleum, Dehradun reported 107,012 tons of carbon dioxide emitted by motor vehicles alone for the year 1991 in India. It is expected to rise to 185,000 tons by the end of the century.)

7. Less danger to the vehicle from fuel spilling and danger of fire during collisions.

8. Advantages of running of CNG:
   a. Less frequent lubeoil change.
   b. Increase in spark plug life.
   c. Lesser wear and tear of engine.
   d. No major alteration required in the petrol engine.
   e. A CNG taxi saves an average of Rs 100 (US$3) per day.

(Source: CNG--Wonder Fuel. *Natural Energy Review* (January 1996):1-2)

Small Hydropower Development in India

In recent years, small hydropower (SHP) has gradually emerged as the most environment friendly and cost effective source of power generation — particularly in the private sector. Escalating costs of the conventional sources make small hydro not only an acceptable but a preferred source of electricity generation, wherever such sources are available.

The government of India has laid great stress on, and extended large benefits for, the development of SHP in the country. One of the most important changes brought forward by the government was to allow the private sector to enter the field of power generation. To give a boost to the renewable and non-conventional sources, a separate Ministry of Non-conventional Energy Sources (MNES) headed by the Prime Minister himself was created. The Ministry is under an independent and progressive Minister of State.

The overall small hydro potential in the country is estimated to be between 8000 MW to 10 000 MW of installed capacity. However, these figures are, in reality much lower as there are substantial areas that need to be properly investigated and listed.

Around 175 stations that have a station capacity of upto 3 MW each, operate in the country with a total installed capacity of 120 MW. Under construction are 172 projects which will add another 215 MW to the capacity.

Costs and Economics of Small Hydro

Hydro-electric power generation is capital intensive and SHP schemes are assumed to be even more costly as they are unable to utilize the economies of scale. However, the trend of investment proposals accepted during the recent past throughout the country, indicates otherwise. Mega sized thermal schemes based on both coal and gas are being proposed at between forty to fifty million rupees (US$ 1.3 m to US$ 1.7 m) or more per MW of installed capacity. Comparatively, the MNES is accepting costs of only upto Rs. 50,000 per kW (US$ 1700), equivalent to fifty million Rupees per MW; (US$ 1.7 m per MW) for the most remote SHP sites in the country.

The cost of generation of any power project is however a factor of the amount of energy generated and sold, and the operating costs of the plant.

The Plant Load Factors or PLF (ratio of average to peak load) of stand alone type SHP stations, particularly in remote locations, are extremely low due to the absence of off-peak hour loads. The recorded figures are in the range of 20% to 30%. This indicates that only this much of the installed capacity is being utilized to earn revenues. The grid connected schemes achieve higher PLFs as the energy not utilized can be exported to the grid.

The current unit costs of electrical energy generated by the SHPs vary between Rs. 1.00 (US$ 0.03) to Rs. 2.50 (US$ 0.075) per kWh. These costs compare most favorably with the cost of alternate sources in use at present.

Diesel generation, in unapproachable hilly locations, by air transported fuel may cost any where above Rs. 10.00 (US$ 0.3) per unit. The projected per unit costs of large thermal and hydro schemes are higher than the current SHP figures.

Government Incentives

The Ministry of Non-conventional Energy Sources (MNES) of the government of India has announced several cash subsidies for small hydro schemes which are as follows:

1. ***Survey and investigation***: Up to 100% subsidy limited to between Rs. 40,000 (US$ 1200) for Canal Drop Schemes below 500 kW to Rs. 150,000 (US$ 4500) for projects in hilly areas.

2. ***Detailed project reports***: upto 50% subsidy ranging between Rs. 40,000 (US$ 1200) for Canal Drop Schemes to Rs. 100,000 (US$ 3000) for projects above 500 kW in hilly areas.

3. ***Subsidies on capital costs***: Subsidy on the cost of E & M equipment and civil works up to 25% for grid connected projects and 50% for non-grid connected projects and those located in North East and other

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SMALL SCALE WIND ENERGY SYSTEMS

Published with financial support from the Netherlands Ministry for Development Cooperation
Editors: Renewable Energy Development v. o. f.

EDITORIAL

As you see, "Small Scale Wind Energy Systems" is back again after a one year absence. The Dutch Minister of Development Cooperation has recently renewed financial support for two more years, which is very good news! We believe "Small Scale Wind Energy Systems" can provide a platform for people working in this field to communicate with each other and to show that small scale wind energy indeed may contribute to local development. We are particularly grateful to the Dutch Minister for giving his support since the 'big' wind energy associations have been fairly absent in the small scale world.

We would like to thank Frank Goezinne and Dick Veldkamp for their editing work until now. They recommended us (RED) to become their successors and we hope to please you as well as they did.

In this issue, emphasis is on network creation in Asia and Latin America and on market stimulation. We also have an article about the situation in rural areas in Peru.

For the following issues, we invite all of you to cooperate and write about your experiences, activities, innovations, etcetera. Small scale wind energy is simply too important to be kept silent!

Jan de Jongh and Remi Rijs, editors

Stimulating the Markets for Wind Pumps

Articles in the "RERIC News" Vol. 17, nos. 3 and 4 (1994) described work on the markets for windpumps in developing countries which was funded by The Netherlands and the UK. A Dutch study found potential for larger markets in many countries and identified the barriers to progress and a Dutch/British seminar discussed how to develop them. The challenge of stimulating some of these markets has now been taken up in a pilot project funded by the UK's Overseas Development Administration (ODA).

Market Difficulties

The four major strategic problems which are found in almost every developing country windpump market are the lack of affordable finance for manufacturers and potential purchasers; information on the technology and its applications; support to users for operation and maintenance; and improvement of design and manufacture of the windpumps. However, every market is different and it is important to develop individual solutions. Another key issue is how to best use the knowledge and resources available in the industrialized countries in order to stimulate self-sustaining markets for local wind pumps in the developing countries.

ODA Project

The ODA project is designed to create local networks which will encourage and assist the players in the market to co-operate in market development activities. The project is intended to develop in such a way as to maximize the benefit of contact with existing networks, technical co-operation programs and other agencies. The project, which started in April 1995, is executed by UK consultants HGa with help from Gamos Ltd and Renewable Energy Development of the Netherlands. From amongst the countries in Asia with experience in windpumping, India, China, Philippines and Vietnam were selected on account of the strength of interest and the prospects for success. They are all very different from one another which provides a test for the pilot project.

The consultants looked for potential collaborators in each country amongst manufacturers and distributors of windpumps as well as a variety of NGOs, rural extension workers, government agencies, researchers and representatives of the users. It is particularly important to gain the maximum involvement of the manufacturers and suppliers as well as organizations which represent the interests of the users. In each country a workshop has been funded at which the participants have been invited to set up a network organization. At the time of writing three countries have set up a network and the fourth is expected to do so soon. The network organization provides a forum for the members to work together on identifying opportunities and barriers to progress. The members can then develop suitable activities, either collectively or in smaller interest groups. The network organization also becomes a point of entry for the consultants to input information and other support to the network and its members in developing the market.

Future Organizations

During the rest of 1996, the network organizations will be assisted to develop their activities and design new projects for which national or foreign support can be sought if required. Towards the end of the year, a regional workshop will be held at which the members can exchange experi-

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International Seminar on New Developments in Wind Pumps

The 3-S Pump Project

From 23-26 November 1994, a seminar/workshop was held in Santa Fé de Bogotá, Colombia with the objective to disseminate gained know-how and technology with respect to the 3-S (Smoothing, Starting, Sealing) pump concept. The Universidad de los Andes, Colombia; the Technical University of Eindhoven, The Netherlands and the University of Reading, United Kingdom had been working on this concept in a joint European Community (EC) contract between September 1992 and August 1994 under the auspices of the Commission of the European Community DG XII. The title of the project was "International Scientific Cooperation Project between Colombia, United Kingdom and The Netherlands: the Development of an Innovative 3-S Pump". Participants, mainly reseachers, project managers and representatives of the scientific community from various countries in Latin America, were previously identified and invited personally. The workshop and its proceedings are expected to contribute to the effective application of the 3-S pump concept in small and medium size wind pumps worldwide.

The focus of the 3-S project has been on the riser, pump rods and piston pump components and includes:

- smoothing aims at reducing the dynamic loads in the wind pump either by introducing flexibility into the drive train or by incorporating soft elements below ground level in the pump chamber;
- sealing aims at eliminating the need for a leather cupseal by replacing it with a hydrodynamic (non-contact) seal, which in principle should reduce maintenance;
- starting aims at solving a classical problem in wind pumping, i.e. the need for a much higher wind speed to start the wind mill than that to keep it running.

The main starting device that has been investigated within the project is the "floating" or "matching" valve.

The proper understanding of the basis of the 3-S pump concept is of paramount importance if in the long term these improvements are to be successfully implemented in commercially available wind pump systems. Some foreseeable advantages of this development are an increased reliability and overall efficiency (which includes increased water output) of the wind pump system as a whole, and considerably lower maintenance and repair costs.

Technical details of the 3-S project are outlined in: Smulders, P.T., et al., 1994. "The 3S-Pump Project: Piston Pump Innovation for Wind Pumps". In *5th European Wind Energy Conference*, 1145-48, Thessaloniki, Greece.

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ences and ideas.

A wide variety of new projects is envisaged for the next phase. For example, they could include specific technical help to a manufacturer; training for designers, manufacturers, installers, operators and maintenance workers; an awareness campaign amongst funding agencies and banks; demonstration and dissemination projects; preparation of training packages for local training institutions; or setting up a maintenance or ganization in rural areas.

The ODA is providing funding for the workshops and for the start up costs of the new organizations as well as for the consultants. It is hoped that the ODA and other agencies will be sufficiently interested to fund the future projects and activities. If this approach to stimulating the markets is successful then perhaps other countries can be helped to start their own network and join the region organization.

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International Seminar on New Developments in Wind Pumps

Experiences on Wind Pumping: A Summary

During the 3-S workshop in Bogota (23-26 November 1994), participants presented their experiences on wind pumping as follows:

Chile, Bolivia

Javier Gho and Carlos Garrido (Chile) reported about the experience based upon variants of the Colombian design Gaviotas MV2E. Thirty commercial Gaviotas wind pumps were imported through a donation from the UNDP and merged with a local development of the Cretan type wind pump. Eight systems with 4 m to 6 m diameter are now working in the field. A similar experience of academic research being translated into commercial wind pump systems, was reported by Emilio Montaño from Bolivia.

Panama

At the Universidad Tecnológica de Panamá, a program has started to gather meteorological information. Financial resources are sought for to buy equipment for further evaluation at selected sites with known wind energy potential.

Peru

Rómulo Bisetti and David Chávez of Grupo (PUCP - Lima) gave an overview of the used wind pump types in Peru, e.g.: Argentinian multibladed type; locally developed multibladed back-geared wind pump; the ITINTEC design; the Matto and Miramar yawless wind pumps; Cretan wind pump; Dutch WOT 12PU500 wind pump. Also in Peru, a group at the Universidad Nacional de San Agustín in Arequipa has recently started to work in wind energy according to Rúsbell Zevallos.

Nicaragua

Here the "bomba de mecate" is being developed, which is a rope-washer pump

Wind Pumping Network in India

A workshop on "Development of Wind Pumping in India" held on December 1st and 2nd, 1995 at Madras and Auroville jointly by the Center for Scientific Research (CSR), Auroville, and the Tamil Nadu Energy Development Agency (TEDA) was attended by over 40 persons including manufacturers, users, non-government organizations, state energy development agencies and media. Deliberations were conducted at Madras on December 1st where it was decided to form the "Wind Pumping Network in India". On December 2nd the participants saw several types of working wind pumps in Auroville including the WP-2s made nearly 40 years ago by the National Aeronautical Laboratory (NAL) at Bangalore. The results of some of the latest research on wind pumps recently carried out by CSR under a Deutsche Gesellschaft Fuer Technische Zusammenarbeit (GTZ) GMBH sponsored project was also made available to them.

At the Madras workshop, the main objectives of the Network were defined as follows:

- to strengthen the existing windpump designs;
- to bring in and test proven models from abroad for various applications;
- to strengthen market research;
- to investigate new ways of funding for wind pumps by means of soft loans and credit schemes from financial institutions in India;
- to organize awareness programs for different categories of users, government officials, institutions and manufacturers;
- to formulate favorable government policies towards wind pumping in India;
- to stimulate manufacturers to impart proper training in the operation and maintenance of wind pumps to the users.

The Wind Pumping Network will be operated by CSR who has been involved in research and development of mechanical windpumps for more than a decade and has, in co-operation with the manufacturer AUREKA, developed the highly successful, direct-drive, 5.5 m diameter AV-55. This machine was found to be the most cost-effective wind pump being manufactured in India today, based on a market study on wind pumps recently carried out for the Dutch government. Auroville also happens to be one of the few concentrations of working wind pumps in a country where over 80% of the installed wind pumps do not work. However, in spite of the "12PU500" fiasco (over 2,000 installed with over 90% not working), Mr. Tency Baetens and Mr. K. Raghavan of CSR found in their "End-User Survey of Wind Pumps and other Pumping Systems in South India" that there are clusters of 12PU500s still maintained and operating successfully. The Network will attempt to study the ingredients of such success stories with a view towards replication.

Besides working towards the objectives defined at Madras, the Network will organize research in methods to improve performance of wind pumps and reduce cost of water pumped. As part of a GTZ sponsored project, Robert Trunz of CSR set up a wind pump test-bed during 1995 and studied the

(contd. on p. 4)

combined with a CWD wind turbine design. Important characteristics of the construction are its simplicity and the low loads imposed by the pump on the wind rotor resulting in an efficient low-cost system.

Colombia

Mauricio Arango from SENA (Colombian apprenticeship training body) presented a general overview of wind pumps installed there about 40 years ago. The main problem is the lack of maintenance and repair. The systems are used by the Wayu indigenous tribes (about 150,000 people). SENA has started a training program in conjunction with the Universidad de la Guajira. The region has a strong wind, making it difficult to use another wind pump type (for instance, the Jober wind pump). It has forced local manufacturers to develop a more robust wind pump system, with some success.

Jorge Castro (Jober) was the only manufacturer represented. He gave a brief summary of the interesting development of 100 wind pumps and four models in 1994. The systems were mainly sold in Colombia but some have been exported to Venezuela and Ecuador. The most recent development is a wind pump to suit the conditions of the Guajira region.

Mauricio Gnecco (Fundación para el Desarrollo de Tecnologías Apropiadas - FDTA) showed the interesting experience of the use of wind pumps in the Llanos Orientales. FDTA is a non-governmental organization with the purpose of increasing the use of appropriate solutions for rural needs. Strong emphasis is on energy supply from various sources, one of them being wind. At the time of the seminar, FDTA is working together with Jober to promote the use of wind pumps for water supply for humans and animals in the Llanos region.

Venezuela

Vicente Durán and Eliodoro Gómez described the work of Fundación Zumaque, which works in extension and health care in remote regions of Venezuela, and of the Universidad Francisco de Miranda. The latter has a wind energy test site on Paraguana peninsula, a region not unlike the Colombian Guajira, where a variety of vertical and horizontal axis wind turbines have been installed.

Prospects

Common points are the recurrent necessity to have more international technical cooperation projects as well as financial resources. Education is needed in the field of renewable energies, environmental problems and sustainable development in Latin America. The idea was launched for a Latin America based association for Wind Energy for Rural Areas (WERA). To carry on with this idea, Uniandes (Universidad de Los Andes) undertook the responsibility to manage the beginning of such an association for the next two years, perhaps in another country, to share the experience of implementing the 3-S pump concept in wind water pumping and to invite some more institutions from the region.

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Wind Energy for the Rural Sector in Peru

Rural Situation

Unlike the urban people, rural population in Peru has no access to electricity supply by the public grid. While cities and larger settlements have now been connected to the national grid fed by hydro and thermoelectric power plants, the rural areas still depend on small-scale energy supply. Micro hydro electricity can not meet the needs of these areas where 40% of the country's population live, dispersed or in villages of less than 10 000 people.

As many regions in Peru have a good wind potential, their needs might be satisfied by using small wind generators of sizes of less than 1 kW upto 10 kW. Locations that are most attractive for the implementation of wind energy, are the departments of Puno, Ica, Trujillo, Piura, Arequipa, among others. North of Trujillo, at Cape Malabrigo, average wind speeds clearly exceed 8 m/s, which is also the case in Marcona, Ica. (Actually, wind speeds at these locations are such that plans are being studied for two wind parks of respectively 30 MW and 75 MW.)

Wind Battery Chargers

Peru has a long tradition in design and manufacturing of wind generators, most of them using a 12 V car alternator to charge batteries. Until now, the most effective wind charger system is the three-bladed Waira (which means wind in the Inca language Quechua), developed by Eng. Franco Canziani. It has passed a period of tests, failures and modifications that were carried out together with Grupo, and is now available in two sizes of 700 W and 1200 W rated, depending on the local wind speed. At present, about 25 of them have been installed at various locations in the country (coast and mountains). Price of a 700 W model is US$ 1950, while a 1200 W model costs US$ 2250.

It is believed that the present technology may permit to design wind generators of sizes upto about 10 kW. For larger turbines it would become very difficult to construct the rotor blades.

Wind Pumping

The Peruvian coastline provides favorable conditions for wind water pumping. It is a desertic zone crossed by some rivers that come from the Andes and that are without water at least three months every year. The coast has a high wind potential with annual average wind speeds of 4 m/s to 6 m/s, and in the areas near the valleys underground water is found between 5 m and 40 m depth.

Wind pumping is not unknown to farmers in Peru, and a number of indigenous wind pumps have been designed and installed. Most of them had a limited capacity of, at best, comparable to a motor pump of about 1 kW. It practically means that the known wind pump models can only serve a very small area of some few hectares. Given a pumping head of 20 m, one may hardly think about irrigation of more than 2 ha to 3 ha using a wind pump (depending on the product and the irrigation methods).

At present, the following wind pump types are found in Peru: Miramar (Miramar, Piura), improved Miramar type (Chiclayo); Alborada; Zimic, Infantes, Segovia, Fiasa ("American" type); Matto; MCTB500 (PUCP, second generation wind pump). Large wind pumps for water flows of 4 l/s and suitable to deeper wells are not available in Peru, and an appropriate wind pump of this size would be very useful. Moreover, farmer interest in wind pumping has recently revived due to the increased fuel prices (from US$ 0.50 in 1985 to US $ 2.00 now). This makes wind pumping more competitive, but short and medium term credits for investments in renewable energy are still rather scarce.

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(contd. from p. 3)

effects of five different techniques to increase water output, especially during low winds. Two devices (floating valve and spring device) were found to be extremely promising and field trials are planned as the next step before a widespread dissemination to manufacturers and users. Water output is increased by nearly 50% mainly in low and medium winds, and the lower cut-in wind speed results in more pumping hours and therefore increased reliability of the water supply. Since nominal extra cost is very low, it is envisaged that after successful field trials, manufacturers will be provided all necessary assistance for incorporating these devices in their wind pumps. Retrofitting existing windpumps with these devices can also be easily done and possibilities will be explored.

The Network will also formulate relevant Indian standards and certification procedures for the manufacture and installation of wind pumps. Quality assurance has always been one of the major bottlenecks and the Network expects to make a substantial contribution towards the successful development of wind pumping in India.

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Publication does not imply agreement of the editors. Contributions should preferably not be longer than 300 words. For longer articles please contact the editors. The editors reserve the right to shorten reactions and articles.

Hotels in Thailand Help in Cutting Energy Consumption

Several major hotels in northern Thailand are expected to become participants in a national program designed to cut electricity use and save the environment. The Government's campaign to curb energy consumption and the role the tourism industry can play were the focus of the Thai Hotels Association's Green Hotel seminar held in Chiang Mai in January.

A new law that took effect in December 1995 requires any hotel that consumes more than 1000 kW of electricity to take conservation measures, according to Sithiporn Ratanopas, Director of the Office of Electricity Demand Side Management at the Electricity Generating Authority of Thailand (EGAT).

The hotels are eligible for help in implementing those measures, through EGAT's Green Building program, which is open to all businesses that are big power consumers. Hotels can receive subsidized loans repayable over five years by signing contracts with EGAT to participate in the program.

Japan's Overseas Economic Cooperation Fund has given US$200 million to support the conservation effort, according to Mr. Sithiporn said.

As well, the Environment Preservation Fund now has some eight billion baht (US$ 320 m) available for loans to EGAT customers who want to reduce waste. And the US government has provided an additional grant of $17.5 m for a five-year energy saving project.

Thailand currently consumes an average of 12 000 MW of electricity, a figure that could double within 10 years if no measures are taken, Mr. Sithiporn said. This would mean the equivalent of 40 more Mae Moh lignite plant being built, or seven big dams.

If EGAT and its customers can reduce energy consumption by 10%, the country can save 20 billion baht (US$ 800 m) a year. The hotels as heavy energy users are setting an example.

Of the 35 hotels belonging to the Thai Hotels Association's Northern Chapter, the Westin, Lotus Pang Suan Kaew, Chiang Mai Plaza and the Empress are expected to come under the new conservation law. According to Thai Hotel Association (THA) Environment Committee chairman Chatchawal Supachayanont, 48 owners of 60 hotels have joined the Green Building program so far.

The Dusit Resort Pattaya is paving the way with a pilot project that stresses conservation of energy, water and all other resources. Already it has reduced its electricity bill below one million baht.

The regional seminars, organized by THA and featuring government energy experts, have drawn wide-spread participation by hoteliers.

(Source: EGAT offers help to hotels in cutting energy consumption. *Bangkok Post*, Thursday, January 18, 1996)

(contd. from p. 6)

specified regions. The acceptable per kW installed costs have, however, been limited to between Rs. 27,000 (US$ 800) for Canal Drop Schemes above 500 kW to Rs. 50,000 US$ (1700) for remote locations.

The State Electricity Boards (SEB) are still the major authority to distribute power to the consumers. However, as a part of the package allowing the entry of the private sector to the power industry, the government has evolved some norms, the most important of which are:

1. ***Captive use of power***: any industry in the private sector is authorized to Build, Own and Operate (BOO) a power plant and to use the whole or a part of the power generated, for its captive use.

2. ***Wheeling of power***: the power so generated can be fed into the existing grid of the (District Electricty Board) DEB at the nearest convenient point along the grid system of the SEB. The SEB will be entitled to impose a "Wheeling Charge" for the transportation of the power at pre-arranged rates that vary from 3% to 15% for various categories.

3. ***Banking of power***: since the generation of hydropower is a seasonal activity, the generating utility will be entitled to feed the excess power as available, into the grid of the SEB, which will 'bank' it for future use. The power will then be released after a mutually acceptable time period that may extend upto 12 months.

4. ***Third party sale***: apart from the captive consumption of power generated by a private utility, it is allowed to sell power to bulk consumers of its own choice, at a rate settled between the purchaser and the seller, without the interference of the SEB. The power so sold will be wheeled through the grid of the SEB for which the SEB will be paid a pre-agreed "Wheeling Charge".

5. ***Buy back by the SEB***: if, however, no such consumer is available, the excess energy will be purchased by the SEB. The rate of purchase of such power will be mutually agreed in advance.

The other important concessions announced by the Central Government are:

1. ***Tax holiday***:full tax holiday for any utility engaged in the field of power generation for a period of 5 years from start of production

2. ***Depreciation***: permission to depreciate 100% of the capital cost in the first year of purchase.

3. ***Customs duties***:permission to import without license and generally with low rates of customs duties.

4. ***Central excise and sales tax***: exemption benefits from Central Excise by the Central Government and from Sales Tax by most State Governments.

5. ***Soft loans***: provision of loans at concessional terms and subsidized rates of interest by the Indian Renewable Energy Development Agency (IREDA) and other financial institutions.

(Source: Kedia, D. 1995. Government incentives for small hydropower generation in India. *Hydronet* 2: 5-7)

RESEARCH ACTIVITIES

The Energy Program, School of Environment, Resources and Development Asian Institute of Technology

Retail Price Regulation and Purchase Price of Independently Produced Electricity: The Case of Sri Lanka

Researcher: A.M. Anula Kumarihamy

Research Committee Members: Dr. Ram M. Shrestha (Chairperson)
Dr. X. Chen
Dr. Arif Saeed Malik
Dr. J.C.S. Tang

The Sri Lankan government seeks to encourage private sector participation in the power sector due to the shortage of available investment needed to meet the electricity demand. But lack of clear policies has delayed private participation considerably. Specially no policies has been set for the purchase of power from the private sector.

The first part of the study focuses on developing a methodology for computing a rational purchase price for Sri Lanka. Rates have been designed based on the concept of avoided cost. Long run differential revenue requirement (LRDRR) approach and Peaker approach were used to calculate the avoided cost. The avoided cost is intended to reflect the true value of electricity to the utility. But successful private power development will require that the utility pay private developers an agreed-upon rate on their investment, a rate based on the true cost of generating power. Therefore a financial analysis was carried out to calculate the purchase price that gives fair rate of return to Independent Power Producers (IPP) using discounted cash-flow approach. Due to difficulty of getting true cost of power generation by IPP, hypothetical data were used in the financial analysis.

It is found that the purchase price which was calculated using financial analysis for IPP is significantly higher than the avoided cost, and therefore the purchase price which is equal to the average avoided cost gives low ROE (return on equity) for IPP. However, if IPP sell electricity only in peak period, the avoided cost to Central Electricity Board (CEB) will give high ROE for IPP. It is impossible to justify the appropriate value for the purchase price at this level due to various limitations. The main objective is to develop a methodology for computing a rational purchase price. These two values (avoided cost and price given by the financial analysis) are the boundaries for the appropriate price.

The second part of the study focuses on regulating the retail price of electricity under a price-cap regulatory scheme. The main objective of this part of the study is to check the workability of an incentive based regulatory scheme for the Sri Lankan power sector. It is found that, indexing electricity prices with respect to broad-based index of Consumer Price Index (CPI) is not practicable to Sri Lanka due to large swing in CPI.

Feasibility of Thermal Energy Storage Applications in Thermal and Combine Power Cycle Generation

Researcher: Teerasak Prakaiboontawee

Research Committee Members: Dr. S. Chirarattananon (Chairperson)
Prof. E. Karmazsin
Dr. Giap Van Dang
Dr. Arif Saeed Malik

The application of energy storage in the field of electricity production is of growing interest. Shortage of electricity produced by electric utility during peak period of the day, partly can be reduced by using thermal energy storage system. It consists of charging a storage system during low demand periods, this energy is delivered or contributed to the grid at periods of peak demand. This load-leveling influences the electricity production in two ways. First with respect to costs, the installed capacity required is reduced, which results in lower investment costs for the electricity production system. Secondly with respect to fuel requirements, a higher efficiency and thus a lower fuel input is realized.

This study is on the potential evaluation of using mechanical and absorption chillers application in gas turbine inlet air cooling to boost up the output of generator during peak hours. A case of Bang Pakong Combine Cycle Plant and Nong Chok Open Cycle gas turbine are considered. The study includes ice storage and chilled water storage applied to different gas turbine performance. The evaluation included sensitivity of different alternatives to install thermal storage compared with new gas turbine power plant.

Economic evaluation of thermal storage system was shown by some economic indicators — the discount pay back period, the net present value and the internal rate of return. The result shows that investment in thermal storage is 30% to 60% of the investment cost of new gas turbine plant, with a discounted payback period of 3 years and internal rate of return of upto 40%.

Electricity Generation Potential in Wood and Agro Industries and Assessment of Environmental Benefits in Selected Countries

Researcher: Aung Naing Oo

Research Committee Members: Prof. Sribas C. Bhattacharya (Chairperson)
Dr. B. Mohanty
Prof. E. Karmazsin

The electricity generation potential in wood industry and selected agro-industries, rice mill, sugar mill, palm oil mill and coconut industry, by using biomass residues has been studied for five

selected countries: Indonesia, Malaysia, Myanmar, the Philippines and Thailand. The unit electricity costs ($/kWh) of the different biomass-fired power systems proposed are estimated. The potential reduction of CO_2 and SO_2 emission due to the electricity generation in wood and agro-industries is estimated considering the potential saving of fossil fuels.

The potential of electricity generation is estimated for each industry considering three generation options with different investment levels. The potential of electricity generation in wood and agro-industries is found to be as high as 58.9% of total power generation in 1992 by the electric utilities in Myanmar. Even for a highly electrified country like Thailand, the potential generation from wood and agro-industries could be about 11.5% of total generation by the electric utilities.

The unit electricity cost estimated for different biomass-fired power systems varies on capacity and type of the system. For small units in rice and wood industries, the unit cost of electricity generated from gasifier and steam engine systems varies from $0.095/kWh to $0.165/kWh. For steam turbine system, the unit electricity cost in all industries, except a low investment option in the sugar industry varies from $0.041/kWh to $0.127/kWh depending on capital requirement, opportunity costs of residues, plant utilization factor etc. In case of the sugar industry, the unit electricity from low investment option of generating electricity by maintaining the existing low pressure system is found to be about $0.235/kWh.

Considering the potential saving of fossil fuels due to electricity generation in wood and agro-industries, the estimated potential of CO_2 and SO_2 emissions reduction are also quite high. For Indonesia, estimated CO_2 and SO_2 emissions reductions are about 13,300 thousand tons and 330 thousand tons per year, respectively.

Thermal Energy Conservation Opportunities in a Sausage and Meat Packing Plant in Vietnam

Researcher: Nguyen Thi Bich Hang

Research Committee Members: Prof. E. Karmazsin (Chairperson)
Dr. S. Chirarattananon
Dr. J.C. Vincent

A study on the energy consumption and the energy conservation potential in a sausage and meat packing plant, named VISSAN-Import Export Corporation, in Vietnam was conducted.

An Energy Audit has been done for the steam department in the plant. Energy analysis of the existing boilers was used to identify the locations, types, and magnitudes for the losses. The major loss was the energy released with flue gas, representing about 16% of total energy input to the boiler. In addition, it was found that a significant amount of flash steam was vented without any heat recovery.

The energy conservation measures such as excess air control, increasing the boiler load, heat recovery from flue gas and flash steam insulation improvement were investigated and studied.

An air preheater and a flash vessel were designed for the plant and the results of economic analysis gave attractive annual benefits with a very short payback periods.

After all, if all aforementioned energy conservation measures are realized, a significant amount of money is saved for the plant by reducing the energy consumption, resulting in less production cost and more profit per product unit.

An Experimental Study of Spouted Bed Gasification

Researcher: Md. Raisul Islam

Research Committee Members: Prof. S.C. Bhattacharya (Chairperson)
Dr. S. Chirarattananon
Dr. S. Kumar

This study is on gasification of sawdust, sawdust pellet and lignite in spouted beds. Two distributor designs were used in the study: a conventional circular central jet distributor and a recently proposed design in which the air inlet was in the form of a circular slit.

Pellet showed the best gasification performance among these fuels. Maximum concentration of CO, H_2 and CH_4 in the gas for this fuel were found to be about 18%, 9.5% and 4%, respectively, for air flow rate of 120 l/min and air fuel ratio of 1.8. For sawdust with the same operating conditions, these values were about 12.7%, 2.8% and 2.16%, respectively. Lignite gave better gasification performance at higher bed depth. At bed depth of 223 mm., concentration of CO, H_2 and CH_4 were 17%, 10.2% and 1.15%, respectively, during gasification of lignite with the same operating conditions. Central jet distributor gave better gas quality than circular slit distributor. Of course, the air flow rate of circular slit distributor was higher.

This study also included the experimental investigation of catalytic effect of dolomite to crack tar in the produced gas. Dolomite was used as both primary and secondary catalyst and was affected by bed temperature. However, it showed spectacular performance as secondary catalyst at high temperature; at 900°C, tar conversion of about 97.19% and tar content in the exit gas of about only 0.049 gm/m^3 of gas was achieved. Gas quality also improved when dolomite was used as secondary catalyst.

A comparative study of spouting pressure drop, pressure drop across distributor and the minimum spouting velocity was carried out with circular slit distributor of three different opening areas (176.7 mm^2, 353.4 mm^2 and 706.80 mm^2). A significant change in minimum spouting velocity, spouting pressure drop and pressure drop across distributor was observed with the change of their opening areas, bed particle size and bed weight. Spouting pressure drop was almost independent of distributor opening area and pressure drop across distributor decreased with the increase of its opening area. The minimum spouting velocity increased with particle size as well as bed weight. Compared to a central jet distributor, circular slit distributors had both higher minimum spouting velocity and spouting pressure drop.

Human Resources Development Programs

7th AIT - WHO Training Course on Solar Refrigerator Repair and Maintenance
15 - 26 April, 1996, Energy Program, Asian Institute of Technology. Bangkok, Thailand.

The 7th AIT-WHO Training Course on solar Refrigerator Repair and Maintenance will be organized by Energy Program, Asian Institute of Technology (AIT), in collaboration with EPI of World Health Organization (WHO), Geneva, Switzerland.

The objectives of this course are:

- to introduce solar photovoltaic concepts for application to refrigeration, and

- to provide sufficient training to the participants in the repair and maintenance of photovoltaic refrigeration equipment in order that after successful completion, the participant will have capability and confidence in solving problems related to photovoltaic refrigerators.

The course emphasizes hands-on work supported by sufficient theoretical study to enable a full understanding of the practical components of the course.

The course includes introduction to solar energy and basic DC electricity, PV panels, batteries used in PV systems, charge and discharge controllers and introduction to refrigerators, the refrigerator as a part of the solar installation, system wiring, sizing of PV systems, installation of PV system, PV system and refrigerator troubleshooting and system maintenance and course review.

This two week course is designed to provide intermediate training in solar photovoltaic (PV) technology with emphasis on refrigeration for vaccine storage. It is specifically designed for persons with some prior PV experience or basic electrical training who has a current work requirement for planning, installing, maintaining or supervising programs relating to rural based solar photovoltaic systems for refrigerated vaccine storage.

This course will be of interest to participants from government departments and agencies, energy agencies, health care center personnel, NGO's and others involved in solar photovoltaic applications.

Persons successfully completing the course will have basic competence in small PV system and solar refrigerator installation and maintenance.

Training Course on Photovoltaics for Rural Electrification: Project Development and Administration
8 July - 19 July 1996
Asian Institute of Technology, Bangkok, Thailand

This two week course, organized by the Energy Program of the Asian Institute of Technology, Bangkok, Thailand, is designed specifically for government and utility company planners and project officers who are responsible for rural development or rural energy delivery and are interested in photovoltaics as a possible means for rural electrification.

The course emphasizes project design, implementation and administration and is generally non-technical though enough technical concepts will be introduced to allow participants to understand the operation of a photovoltaic system as used for rural electrification. Specific important topics to be covered are:

- Survey techniques to determine needs and the economic situation of prospective users;
- Institutional arrangements appropriate to the special needs of individual PV systems for rural electrification;
- Methods of Comparative Economic Analysis to determine whether PV is the least cost option for rural electrification at the project side;
- Obtaining funding for PV rural electrification projects;
- Site evaluation and selection;
- The use of consultants in PV project design and implementation;
- Specifying, tendering and purchasing for PV projects;
- PV project administration; and
- Basic PV system theory

The course will include some theory but will emphasize case studies and practical exercises.

For further details on both courses contact:

The Coordinator
Energy Program
Asian Institute of Technology (AIT)
G.P.O. Box 2754
Bangkok 10501
THAILAND
Tel: (66-2) 524 5440
Fax: (66-2) 524 5439, 516 2126
Telex: 84276TH

New President and Secretary/Treasurer for IASEE

Professor S. C. Bhattacharya and Dr. S. Kumar of the Asian Institute of Technology have been elected as President and Secretary/Treasurer, respectively, for a two year term starting January 1996 of the International Association of Solar Energy Education (IASEE).

The International Association for Solar Energy Education (IASEE), founded in 1989, is a non-profit organization with the purpose of promoting renewable energy education worldwide. IASEE, with more than 400 members from 75 countries, is a Working group on Education of the International Solar Energy Society (ISES).

Activities of IASEE are: (i) publication of a biannual newsletter, (ii) publication of a series "Progress in solar energy education", and (iii) organizing international symposia on renewable energy education.

For membership and other details, interested persons are requested to contact:

IASEE Secretariat
Energy Program, Asian Institute of Technology
GPO Box 2754, Bangkok, Thailand
Fax: (66) (2) 524 5439 or 516 2126

Book Reviews

Farmers, Forests and Fuel -Towards a New Biomass Energy Strategy in Sri Lanka

Mick Howes with Pandula Endagama
Published by the Intermediate Technology Publications 103/105 Southampton Row London WCIB 4HH UK.
ISBN 1 85339 089 5, 1995, viii + 173p.

The crisis of declining fuel availability and the perceived link between this and the environmental degradation has led to extensive investment in domestic stove programs and the promotion of new forms of forestry, initiatives which have drawn strength and impetus from a growing awareness of gender issues, accompanied by the recognition that women tend to be affected first and most strongly by fuel shortages.

This book by Mick Howes, surveys the current and likely future extent of biomass energy shortages, and seeks to identify the most appropriate responses to fuel supply problems on the basis of experience in Sri Lanka. The author discusses the outcomes of earlier interventions and how far criticisms of these schemes are justified, before presenting some broad principles to be followed and lessons to be learned about approaches to fuel shortages in a complicated and highly differentiated rural economy.

Chapter 1 of the book covers the 'Other Energy Crisis' and its critics. Chapter 2, which completes the introductory section, (Section I) traces the evolution of energy policy-making in Sri Lanka from its origins in 1974, and sets a context within which to explore the more specific biomass-related interventions which are covered later in the book.

Section II reviews the proposition that it is helpful to think in terms of national biomass energy deficit, and describes a methodology which enables the extent of shortages to be disaggregated both by geographical location and socio-economic group. This section includes secondary sources and reports findings derived from a series of field studies conducted in various parts of Sri Lanka in 1987.

Section III describes the major biomass-related interventions with which the government of Sri Lanka has been associated; assesses the overall effectiveness; and spells out their implications for different sets of people. Chapter 5 looks in detail at the Community Forestry Project (CFP), and Chapter 6 at the promotion of stoves under the National Fuelwood Conservation Program (NFCP).

The final section returns to the most general themes raised in the introduction, seeking to explain the outcomes of the interventions, to explore alternative solutions to Sri Lanka's biomass energy problems, and to sketch in some broader principles regarding the role which the state might usefully perform when confronted by a rather complicated and highly differentiated rural economy.

International Events

INSIDE ASIA

19 - 21 June, 1996, Asia - Pacific Conference on Sustainable Energy and Environment Technology, Singapore.
Contact:
APCSEET Secretariate
Nanyang Technological University
Nanyang Avenue
2263 Singapore
Tel/Fax: 65-79-95243/16178
email: apsce@ntuvax.ntu.ac.sg

7 - 9 October, 1996, 3rd International Renewable Energy Asia Pacific '96 Exhibition and Conference, Manila, Philippines.
Contact:
Ms Sylvia Gilkes
Alternative Developmnet Asia, Ltd,
5/F, # 3 Wood Road, Wanchai
Hong Kong
Tel: +852-2574-9133
Fax: +852-2574-1997
Email: altdev@hk.super.net

6 - 10 January, 1997, The 3rd International Conference on Solar Cookers Use and Technology, Avinashilingam Institute for Home Science(Deemed University), Coimbatore, Tamil Nadu, India.
Contact:
3rd Int'l Conference on Solar Cookers
c/o Chancellor of Rajammal Devadas
Avinashlingam Deemed University
Coimbatore 641 043 India
Tel: 91-422-440 140
Fax: 91-422-438 786

3-7 February 1997, First International Conference Renewable Energy - Small Hydro, Hyderabad, India.
Contact:
CVJ Varma, Secretary
Int'l Association for Small Hydro,
CBIP Building
Malcha Marg, Chanakyapuri
New Delhi - 110 0221, India
Tel: 91-011-3015 984, 3016 567
Fax: 91-011-3016 347
Email:cbip@cbipdel.uunet.in

OUTSIDE ASIA

Solar '96, National Solar Energy Conference, 25th ASES Anual Conference and 21st National Passive Solar Conference, Colorado, USA.
Contact:
American Solar Energy Society
Boulder, Colorado. USA
Tel: 303-443-3130
Fax: 303-443-3212

14-18 April 1996, Renewable Energy Conference and Workshop—A combined conference with the 4th Conference on Applications of Solar,
and
Renewable Energy, and the 2nd Conference on Solar Electricity: Photovoltaics and Wind, Cairo, Egypt.
Contact:
Dr H El Agaamwy
P.O Box 487 Doki,
Egypt
Tel: 202-3610-806
Fax: 202-781-236

20-24 May 1996, European Union Wind Energy Conference and Exhibition, Goteborg, Sweden.
Contact:
Ms. Anne Baubin
European Commission
Rue de la Loi, 200
SDME 3/20
Tel: + 32-2-295 9985
Fax: + 32-2-296 0621

20 May - 22 June 1996, International Training Program on Energy and Environment for Sustainable Development,
and
7 Oct. - 9 Nov. 1996, Training Program on Energy Management and Cleaner Production in Small amd Medium Scale Industries, University of Twente, The Netherlands.
Contact:
The Course Administration
Technology and Development Group,
VOK/CT 1807, University of Twente
P.O. Box 217, 7500 AE Enschede ,
The Netherlands
Tel: +31 53 4894377/ 4893545
Fax: +31 53 4893087
J.R.M.Borghuis@TDG.UTWNTE.NL

15-21 June 1996, World Renewable Energy Congress IV, Denver, Colorado, USA.
Contact:
Mr Steve Hauser
Chairman of Tech. Committee
Division Director, NERL
1617 Cole Boulevard
Golden, CO 80401, USA
Tel: (303) 384 7416
Fax: (303) 275 4320

24-27 June, 1996. 9th European Bioenergy Conference Conpenhagen, Denmark.
Contact:
DIS Congress Service Copenhagen AS
Herler Ringvej ZC, 2730 Herlev,
Denmark
Fax: +45-4492-5050

26-28 June, 1996. Power-Gen Europe'96 Budapest, Hungary.
Contact:
Ms. Nel Jonk
Kaap Hoorndreef 54
3563 AV Utrecht, The Netherlands
Tel/Fax: +31-30-6509-63/-28

16-18 July 1996. 13th International Conference on Passive & Low Energy Architecture, Building and Urban Renewal, Louvain la Neuve, Belgium.
Contact:
Professor A. de Herde
Architeccture et Climat, Place Levant
B-1348 Ottignes Oouvain la Neuve
Belgium
Tel: +32 10 47 21 42
Fax: +35 10 47 45 44
e-mail: deherde@arch.ucl.ac.be

29-31 July 1996, First Trabzon International Energy and Environment Symposium - TIEES, Trabzon, Turkey.
Contact:
Prof Dr Teoman Ayhan
TIEES-96
Dept. of Mechanical Engineering,
Karadeniz Technical University,
Trabzon 61080, Turkey
Tel: (462) 325-3223
Fax: (462) 325-7405
energy96@risc01.bim.ktu.edu.tr

25 - 31 August 1996, Energy efficiency in Buildings, Pacific Grove, CA, USA.
Contact:
ACEEE, 2140 Shattuck Avenue,
Suite 202, Berkley, CA 94704 USA
Tel/Fax: +1-510-54999-14/-84

16-19 September 1996, EUROSUN 96, Freiburg, Germany
Contact:
DGS, Augustenstraße 79
D-80333 München
Tel: +49 (0) 89-524071
Fax: +49 (0) 89-521668

22 - 25 October 1996, Energy Africa'96 Nairobi, Kenya.
Contact:
Tracey Nolan
37 Upper Duke Street
Liverpool L1 9DY, UK
Fax: +44-151-709 7801

16 - 19 September 1996, EuroSun'96, 10th International Solar Forum, Freiburg, Germany.
Contact:
ISES-Europe or
Deutche Gesellschaft für Sonneenergie
Augustenstrasse 79
80333 München, Germany
Tel/Fax: +49-8952-4071/-1668

22 - 25 October 1996, Solar'96 "Energy for Life". Darwin, Northern Territory, Australia.

Contact:
Solar'96 Conference Secretariate
G.P.O. Box 1392
Darwin
Niorthern Territiry NT 0801
AUSTRALIA

The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Center for Library and Information Resources (CLAIR) , Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

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Working Council on Sustainable Energy in the Mekong Region

The Canadian International Development Agency (CIDA) supported a constitutional meeting on "Sustainable Energy in the Mekong Region", held in Phitsanulok, Thailand, during March 20-22, 1996. The Meeting was hosted by the Solar Energy Research and Training Center (SERT) of Naresuan University, Phitsanulok, and co-organized with the Regional Information Service Center for Southeast Asia on Appropriate Technology (RISE-AT).

The delegates from the following institutions participated:

- Ministry of Mines, Energy and Industries, Dept. of Energy, Royal Kingdom of Cambodia
- Yunnan Semiconductor Factory, Kunnming, People's Republic of China
- Institute of Science and Technical Information of Yunnan, People's Republic of China
- Science, Technology and Environment Organisation, Lao People's Democratic Republic
- Ministry of Industries, Institute of Energy, Socialist Republic of Vietnam
- Vietnam National Center for Science and Technology, Socialist Republic of Vietnam
- Ministry of Science, Technology and Environment, Dept. of Energy, Kingdom of Thailand
- Solar Energy Research and Training Center, Naresuan University, Kingdom of Thailand
- Regional Information Service Center for South East Asia on Appropriate Technology (RISE-AT), Chiang Mai, Kingdom of Thailand

The participants of this meeting first met as a group at the seminar "State of the Art and Prospects for PV-systems in Thailand and Neighboring Countries" at Chiang Mai, Thailand, 1994, it was then proposed that the countries within the Mekong region maintain these valuable links between the respective institutions.

Participants of the Meeting

It has been evident during this period, that institutions within the Mekong region requires cooperation link to promote the use of sustainable energy technologies. The existing needs to date have been in the form of training, field visits, seminar preparations, initiating studies and/or projects, sharing literature, and identifying locally proven technologies.

Energy production and use is and will remain a major factor effecting the environment of the countries in the Mekong Basin. Already the energy developments in some countries are adversely effecting the environment, and as economic growth and change continues in the region, the demand for energy can be expected to grow even faster, with an ever increasing impact on the environment.

The adverse environment-effect impact of rapid development of energy supply in the Mekong region over the next decade can be reduced by building mechanisms and institutions to encourage the use of alternative energy technologies. In many

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Supplement: Small Scale Wind Energy Systems

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cases alternative energy sources are not only environmentally more sound than conventional approaches, they can also be cost effective.

This meeting initially focused on an independent overview of the countries within the Mekong River Region with respect to sustainable energy technologies, such as:

- An identification of what sustainable energy technologies are currently in use and planned for within each country.
- An identification of the sources of finance that did and will support these applications.
- An identification of the barriers encountered in the development and implementation of sustainable energy.

This overview was presented, documented and viewed on a national and regional perspective, highlighting common barriers across the region, and the potentiality of formalizing the existing institutional relations into a working structure to regionally address such barriers.

The participants actively discussed and determined the benefits that could be gained by each country from establishing an ongoing working relationship with other countries in the Mekong region on sustainable energy technology. The participants further identified an appropriate name, organizational structure, and functions of the working relationship.

There was a common consensus to formalize the relationship and to establish a "Working Council on Sustainable Energy in the Mekong Region". The respective organizational structure was agreed on, and Mr. Pho Muangnalad (Director of Cabinet) of the Science, Technology and Environment Organisation (STENO), from Lao People's Democratic Republic was voted to be the first Chairman of the Council, and the Solar Energy Research and Training Center (SERT), Naresuan University, Phitsanulok, Thailand was chosen as the Secretariat. It was also agreed that the representing institutions present at this meeting maintain the role as "National Focal Points", which will form the regional body within the Mekong River area.

The initial functions of the "Working Council on Sustainable Energy in the Mekong Region" are:

- To facilitate information exchange in the practical application of sustainable energy technology.
- Collect basic day-to-day data for daily reference and for future planning.
- Assist on project development (emphasizing on bi-lateral and multi-lateral co-operation).
- Be a "Clearing House" on typical barriers and relevant issues.
- Aim to establish indigenous standards of sustainable energy systems, that are appropriate to the Mekong River region and the respective conditions.
- Present the importance of sustainable energy technologies to interested parties, particular in the plans of policy makers.
- Promote and create more awareness of sustainable energy to the public at large.

The "Working Council on Sustainable Energy in the Mekong Region" is already actively engaged into its role, and now the "National Focal Points", the Institute of Science and Technical Information of Yunnan, and the Yunnan Semiconductor Factory of P.R. China will host a seminar on solar energy during August 26-30, 1996. The Seminar is titled "Financing and Commercialisation of Solar Energy Activities in South and East Asia", which will be supported by the Carl-Duisberg Society (CDG) from the Federal Republic of Germany. This opportunity recognizes the Working Council's role to perform seminar preparations as the organizing committee, and allowing continual formal contact between the "Focal Points", to strengthen the relationship-structure of the "Working Council on Sustainable Energy in the Mekong Region" which is now established.

(Contributed by Mr. John O'Donoghue, Solar Energy Research and Training Center, Naresuan University, Phitsanulok 65000, Thailand)

Privately Funded Hydro Project in Nepal

The Khimti Hydropower Project, located about 100 km east of Kathmandu, is one of the very first privately financed projects, and the very first under the new legislation in Nepal that allows private investors to participate in hydropower development. The 60 MW project will increase the country's electricity generation by 25%.

The Nepali Butwal Power Company (BPC) and three of Norway's leading hydropower developers and suppliers, Statkraft, ABB Kraft and Kvaerner Energy, plan to spend US$140 m building the 60MW Khimti Hydro power project under licence from His Majesty's Government of Nepal.

The investment, which is being provided by Norway's Eksportfinans, Norad and the Nordic Development Fund, as well as two multilateral lending institutions, International Finance Corporation and the ADB, was announced last month as Statkraft confirmed plans to increase its focus on project-financed hydropower projects in South East Asia.

The plant will be owned and operated by Himal Power Limited (HPL), which has signed a 20-year Power Purchase Agreement (PPA) with the Nepal Electricity Authority (NEA). After this period, 50% of the plant will be transferrred to NEA, whose obligations under PPA are guaranteed by His Majesty's Government of Nepal.

Nepal's theoretical hydropower potential is estimated to be 83 000 MW, of which approximately 50% is exploitable. But only 240 MW have been developed to date. In contrast, Norway has developed 27 000MW. Per capita consumption of electricity in Nepal is less than 1% of typical industrialized countries.

The project is considered a welcome break in moving away from the donor-driven, imported schemes to one that will build on local expertise and capablities.

(Source: 1996. Small is beautiful. *International Water Power & Dam Construction*: 26)

Energy and Climate Change in China

Climate has always greatly influenced the development of human society, and it is now recognized that the amount of carbon dioxide (CO_2) and other greenhouse gases emitted through human activities might be sufficient to cause global changes.

A study of the impact of global climate change on agriculture, forestry, water resources, permafrost and other areas - and of the impact of sea-level rise - has shown that global warming would increase the frequency of drought, floods, and extreme climate events and thus adversely affect harvests of wheat, rice and cotton.

The temperature in China rose from the end of the last century to the 1940s in a similar way to the average trend of continuous increase in the northern hemisphere. It now tends to get warmer in winter in most parts of China, especially in the north. But there is no clear indication of temperature rise in summer: instead, some areas are getting cooler. Generally, the lowest temperature in a year tends to rise, while the highest temperature tends to fall.

There are clear regional characteristics in changes in precipitation in China over the last 100 years. The cycle of change differs from region to region and there have been significant time fluctuations in precipitation patterns. But no correlation has been identified between precipitation patterns and levels of greenhouse gases in the atmosphere.

More than 80 % of the total greenhouse gas emissions in China come from energy consumption and China's economy has high energy intensity. It consumes 3 to 10 times as much energy per unit of GDP as the major developed countries. So there is great potential for saving energy through improving energy efficiency. Indeed, energy consumption per 10,000 yuan (US $1200) GDP has already fallen from 13.36 tons of coal equivalent (tce) in 1980 to 9.3 tce in 1990.

Energy Production

Coal is the major energy source of China. In 1990 the total energy consumption of China was 987 million tce, and the consumption of coal accounted for 76 % of primary energy consumption. In 1990, China's CO_2 emissions amounted to 650 million tons of carbon, one tenth of the entire world total. But per capita emissions, at 0.6 tons a year, were only about 10 % of those in the United States and half the world average.

Industrial production accounts for 50.4 % of total coal consumption. More than 400,000 sets of boilers were in operation in 1990, consuming about 300 million tons of coal a year. 82 % of the industrial boilers are small and have an average efficiency of only 55 % to 60 %. If their efficiency could be raised to 70 % to 80 %, 60 to120 million tons of coal could be saved every year. Thermal electricity generation - the second largest user of coal - accounts for 25.6 % of consumption. In 2000, electricity generation will reach 860 billion kilowatt hours (kWh) a year and the proportion of coal converted into electricity will increase to about 35 %. At present, on average, about 430 grams of coal equivalent is needed to generate each kWh of electricity: the target is to reduce this amount to 360 grams of coal equivalent. If 860 billion kWh of electricity are generated each year, this measure would save some 60 million tce.

Commerce and domestic uses account for 21.6 % of coal consumption, mainly for heating and cooking. The energy is mostly provided by small stoves and separate boilers for individual buildings. Efforts are being made to develop central heating, heat and power cogeneration and coal gasification in cities. The coverage of central heating in cities is planned to expand from 7 % to between 18 % and 24 % by the year 2000, while gasification is planned to increase from between 16 % and 17 % to 22 % and 28 %.

Emissions Control

China's hydropower resources are very abundant, with an exploitable potential of 378 million kW, providing electricity generation of 1.92 trillion kWh per year, three times the 1990 figure. The generation of hydroelectricity will reach 240 billion kWh per year in 2000. Although this accounts for only 12.5 % of the total exploitable amount, it will save 100 million tons of coal.

In 2000, the nuclear electricity capacity will reach 1000 MW, generating 65 billion kWh per year, and saving the equivalent of 23 million tons of coal.

Energy pricing policy has to be reformed to solve energy problems. Economic instruments will help to encourage clean coal production, including screening and washing raw coal at mines. This will reduce transportation loads, raise the efficiency of coal use and improve the environment.

Forests play an important role as a sink for CO_2 and in the improvement of the environment. Six big afforestation projects will be in progress by the year 2000, and by then forest cover should have increased by 30 million hectares.

Experimental research projects for reducing methane emissions from paddy fields have been carried out in different regions of China and useful conclusions have been drawn for irrigation regimes and fertilizer use. Improving the breeds of ruminant animals and using ammoniated forage can raise milk and meat productivity and reduce methane emissions.

Preventive and Adaptive Measures

Both preventive and adaptive measures to deal with climate change should be considered. Adaptive measures are important, but the reasons for adopting them are affected by the uncertainties of the impact of climate change. Preventive measures are given some priority because they are generally linked with improvement in economic performance.

The key to reducing the rate of greenhouse gas emissions is to deal properly with the relationship between environment and development. After the 1992 United Nations Conference on Environment and Development, China further reaffirmed its strategy for sustainable development, focusing on the major environmental problems of its social and economic development and the new situation of transition to a socialist market economy. Aiming at a more harmonious relationship between environment and development, it worked out a set of strategic measures. In March 1994, the Government approved China's Agenda 21. In general, measures of fundamental significance are

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(contd. from p.3)

those that change the traditional development strategy, characterized by reliance on high input and high consumption, which results in low efficiency and the waste of energy and resources

Coordination of Activities

Climate change concerns almost all aspects of economic and social development, and so the Coordinating Group on Climate Changes was established under the Environmental Protection Committee of the State Council in February 1990 to coordinate the activities of relevant Government ministries and agencies. It has four working groups, working on scientific assessment, impact assessment and response strategies, economic implication and international convention matters of climate change.

The Chinese Government is also serious in implementing international obligations to protect the ozone layer. China has actively participated in the international efforts since 1986 when it took part in the work of the Ad-hoc Working Group organized by United Nations Environment Program (UNEP). China ratified the Vienna Convention and the Montreal Protocol in September 1989 and June 1991, respectively.

The Government set up a Leading Group on Ozone Layer Protection with the National Environmental Protection Agency (NEPA) as the head unit responsible for organizing and coordinating the activities to implement international obligations. Twelve other ministries and governmental institution take part in the Leading Group, and are responsible for the implementation activities in their respective sectors.

In 1992 the Leading Group organized a group of experts from different sectors to work on the drafting of China's Country Program for the Stepwise Phaseout of Ozone Depleting Substances. The Country Program was approved by the Executive Committee of the Multilateral Fund of the Montreal Protocol at its ninth meeting in 1993. A Supplementary Program on the Stepwise Phaseout of Ozone Depleting Substances in the Tobacco Industry was worked out in 1994 and the Strategies for Reducing Ozone Depleting Substances in the Sectors of aerosol, foam plastics, household refrigeration, industrial and commercial refrigeration, car air conditioning, halon fire extinguishing, electronic solvent cleaning and controlled substances production were worked out in 1995.

(Source: Rugui, Y. 1996. China and the atmosphere. *Our Planet* 7(5): 14-16)

Photovoltaic Building Integration in Japan

Japan is acutely aware of its reliance on Middle-Eastern oil imports and is intent on finding alternative primary energy resources which can offer both improved security of supply and, in line with the UN Framework Convention on Climate Change, reduced emissions of greenhouse gases. The Japanese Long-term Energy Supply and Demand Outlook predicts a reduction in the contribution of oil to meeting primary energy demand from 58% today to below 48% by the year 2010. This will be achieved largely by expansion of the existing nuclear program, but also through the introduction and increased utilization of new energy sources from a little over 1.2% today to 3% in 2010.

In December 1994, the Japanese government released a directive which will enable these goals to be achieved. The basic Guidelines for New Energy Introduction specify in particular the introduction of photovoltaics (PV), targeting the installation of some 400 MWp by the year 2000 (more than ten times the current installed capacity), with rapid expansion thereafter to realise a target of 4600 MWp by 2010.

PV Research and Development

Major Japanese electronics companies like Kyocera, Sanyo and Sharp (to name but a few) are at the cutting edge of international PV R&D. Since 1993 the industry has been boosted by government funding under the New Sunshine Program. Key objectives are to reduce PV electricity costs to below the electricity charge rate by 2000 and achieve convergence with conventional power generation costs by 2010. Currently the cost of PV electricity is around eight times greater than the price one would pay for grid power. Basic research is focusing on improving cell efficiencies and developing new mass production technologies, but in a country with high population densities and little available land for PV-specific projects, application developments are largely concentrating on residential grid-connected systems, including roof and facade integrated components. Many manufacturers are introducing some innovative products - solar shingles and roof tiles, and see-through cells for window applications, for instance - to attract a share of expanding markets.

The design and grid-interconnection of distributed PV power systems, including those suitable for building integration, is being closely investigated at the Rooko Island Test Center for Advanced Energy Systems near Kobe. The facility which is operated by the Kansai Electric Power Company Inc. (KEPCO) and the Central Research Institute of the Electric Power Industry (CRIEPI) under funding from the New Energy and Industrial Technology Development Association (NEDO), features 500 kWp of fixed flat-plate PV systems. Fifteen 2 kWp arrays are mounted on prefabricated houses and connected via power conditioning units to a variety of AC appliances. A 100 service conductor connects each array to a 6.6 kV distribution line and simulated test installation. Data collected during the ongoing tests is being used to assess the grid to which they are connected and vice-versa.

Subsidies

The government is offering subsidies both to householders to implement residential PV installations, and to local authorities to support the cost of PV systems on public buildings.Under the residential buildings program (dubbed the "70,000 rooftop program" because there is potential for the involvement of 70,000 homes) which is administered by the New Energy Foundation (NEF), users are eligible to receive a rebate of 50% of PV installation costs. In return they are committed to monitoring the performance of their system which is assisting manufacturers to design systems which are in tune with customers wants and needs.

(Source: Cowley, P. 1996. Rising Sun: Photovoltaic Building Integration in Japan. *Sun World* 20 (1): 12-14)

Ocean Energy: Renewable Alternative to Conventional Energy Sources

Solar radiation which sustains life on earth is continuous and inexhaustible. It has been estimated that about 10^{16} watts of solar energy reaches the earth. The ocean which covers about 71% of the earth's surface acts as a natural collector of this energy. Thus, the ocean has an enormous potential to supply energy in many different ways. The major advantages of ocean energy are that it is renewable and continuous throughout the year, pollution free and has minimum health hazards. As an energy source for remote islands, ocean energy will be the most important form of alternative energy since it comes from the immediate activity. The forms in which the ocean energy could be tapped are:

- Ocean Thermal Energy Conversion (OTEC)
- Wave Energy
- Tidal Energy
- Salinity Gradient Energy
- Offshore Wind Energy
- Marine Currents
- Marine Bio-mass Conversion

While R & D activity in all the above energy aspects is going on around the world, the forms of energy that have already achieved or could achieve technical feasibility in the near future are the following:

- Ocean Thermal Energy Conversion (OTEC)
- Wave Energy
- Tidal Energy

Ocean Thermal Energy Conversion (OTEC)

OTEC utilizes the temperature difference existing between the warm surface waters and the cold deep waters. The surface waters are at a temperature of 28°C while the deep waters, at a depth of 800 m to 1000 m, are at a temperature of 5°C to 7°C.

There are two types of OTEC systems. First is the open cycle system which uses sea water as the working fluid. In this system, the warm surface water is flash-evaporated in a chamber maintained under high vacuum and the generated vapor is utilized to drive a low pressure turbine connected to the generator. The exhaust steam is condensed using cold sea water.

The closed cycle system utilizes a low boiling point liquid like freon or ammonia as the working fluid. The fluid is evaporated using the warm surface sea water. After the vapor drives the turbine, it is condensed by cold sea water. This condensate is pumped back to the evaporator.

The OTEC systems can be installed in three possible types of locations.

- Where the distance of deep sea from coast is large, the OTEC plant could be placed on a floating platform with a cold water pipe suspended from it. An underwater cable is needed for power transfer to shore. Alternately, the energy generated may be utilized to produce energy-intensive materials like ammonia or hydrogen from the sea water. The products have to be transported to the mainland by ships.

- If the distance is around 10 km, the OTEC plant could be floating in the near shore area and the power generated can be transmitted to the mainland by underwater cables.

- If the deep water conditions are available within two to three km of the coast, the entire plant could be situated on land with the cold water pipe line running along the ocean bed to a depth of 800 m to 1000 m.

The major advantages from OTEC systems are:

- Power from an OTEC system is continuous, renewable and pollution free.

- The cold deep sea water is rich in nutrients and can be utilized for aquaculture.

- An open cycle OTEC system provides fresh water as by-product. The closed cycle system can also be combined with a desalination plant to get fresh water.

- OTEC is an important alternative source of power for remote islands.

- A floating OTEC plant could generate power even at mid-sea, and can be used to provide power for operations like offshore mining and processing of manganese nodules.

Wave Energy

The incessant motion of the sea surface in the form of wind-wave constitutes a source of energy which is continually being replenished. About 1.5% of the incoming energy from the sun is converted to wind energy. Part of the energy from the wind is transferred to the sea surface resulting in the generation of waves. This energy is carried to coastlines throughout the world where it is dissipated as the waves break. If this energy can be tapped and used economically it can satisfy a sizable portion of world energy needs.

Extraction of energy from the waves is more efficient than direct collection of energy from the wind, since wave energy is concentrated through the interaction of the wind and the free ocean surface. In this respect, the sea behaves like an immense energy collector whereby the wind energy, transferred to large sea surface is stored as mechanical energy in waves. The inertia of the waves provides this short time storage and also tends to smooth out a part of the high variability in time and space that is characteristic of the wind.

The wave energy potential varies from place to place depending upon its geographic location. Even at a given place, the energy availability varies during the different times of the day, for different months and from season to season.

Estimation of Wave Energy Potential

The power in a regular sine wave of wave front (W/m) is:

$$P = \rho g^2 a^2 T / 8\pi$$

where,

ρ = density of sea water (kg/m³)
a = wave amplitude (m)
T = wave period (s)

(contd. on p. 6)

EGAT and Alternative Energy Resources Developments

The Electricity Generating Authority of Thailand (EGAT) has been generating electricity, albeit a very small percentage, from "alternative" energy resources mainly in the rural areas of the country. Some important installations around the country are as follows.

Electricity from the sun

Approximately 70 kW photovoltaic cells have been installed at 62 sites of EGAT. Experiments on grid connections of PV/Hydro at Klong Chong Klum Hydro Power Plant, Sa Kaeo Province, PV/Wind at Promthep Alternative Energy Station, Phuket Island, and PV at San Kampaeng, Chiang Mai Province, have been conducted.

Electricity from the wind

EGAT has installed six (6) wind turbine generators at Promthep Alternative Energy Station, Phuket Island. The experience on grid connections will be useful to operate the larger system

Electricity from Solar Hot Water

EGAT has installed medium temperature solar water heating system with evacuated heat pipes solar collector of 50 kWth, to demonatrate the potential of hot water production for power generation using binary cycle system at Bang Pakong Thermal Power Plant, Chachoengsao.

Electricity from AC Battery

EGAT has a demonstration project of Battery Energy Storage (BES) system of 200 kVA/800 kWh, to store the off peak energy for on peak use and to improve the quality of electric power at far end transmission line at Fang Geothermal Power Plant, Chiang Mai

Electricity from Geothermal

After exploration in northern Thailand, the first 300 kW geothermal demonstration plant was installed at Fang, Chiang Mai province, and has been transmitting electricity to the grid system since the end of 1989. This is the first geothermal power plant in Thailand and the first binary cycle geothermal plant in Southeast Asia.

Electricity from Fuel Cell

A demonstration project of 50 kW Fuel Cell Power Plant using natural gas was installed at Bang Pakong Thermal Power Plant and has transmitted electricity to the grid during 1992-1993. The trial operation showed a satisfactorily high performance and the system can directly use natural gas produced in Thailand as a fuel. The technology has been studied and it is expected that it can be developed for comercial utilization in the rear future.

(Source: Public Relations Department. 1996. *EGAT and Alternative Energy Resources Development*)

(contd. from p. 5)

But the waves are not regular sine waves and are really random in nature. The wave parameters of a random sea wave is normally represented in the form of significant wave height H_s and zero crossing period T_z of wave crest. The power available in random sea is expressed as

$$P = 0.55 H_s^2 T_z \text{ kW/m of wave crest}$$

where,

H_s is measured in m and T_z in seconds.

This indicates that a wave condition having a significant wave height of 2 m and a zero crossing period of 7 seconds possess a power of about 15 kW/m at the wave crest. It is estimated that the global wave energy potential is in the order of 45 x 10^{15} W.

Tidal Energy

Tidal energy is produced by utilizing the rise and fall of tides to drive hydraulic turbines and generate electricity. It has gone through long stages of development and two tidal power stations have been in operation for more than a decade. The first one to go into commercial production is the Rance Plant in France. It is operational since 1966 and the installed capacity is 240 MW. The second plant is an experimental plant at Kislaya Guba in Russia.

It is assumed that power could be developed both during the neap and ebb tides using one basin. However, the energy potential of a tidal plant can be estimated as:

$$E = 0.017 R^2 S \text{ kWh/year}$$

where,

R = Tidal range (m)

S = Basin area (m^2)

In spite of the fact that two tidal plants are in operation for more than 10 years, more plants have not been built because plant construction is highly capital intensive. However, the important points in favor of tidal power are:

- The life of a plant is in the order of 75 to 100 years and is high compared to 25 to 35 years for a nuclear or thermal power plant.
- The technology of power development in tidal power plants is simple as in hydroelectric power stations.
- Improved construction technologies like prefabricated plants being sunk at site and development of Straflow turbines (with generator rotor mounted on the rim of the wheel) have considerably reduced the construction cost.

A tidal range of 3 m to 4 m is considered viable for installing a tidal power plant, but there are hundreds of sites around the world having a tidal range of more than 10 m. Several estuary projects in UK and Bay of Fundy projects in Canada are under very serious consideration.

Summary

Even though ocean energy has tremendous potential, very little of it has been tapped so far. A lot of research and development have taken place in fields like OTEC, wave energy and tidal energy and have reached a stage where one can get a clean, renewable alternative for conventional power. Concepts like marine bio-mass conversion and salinity gradient are at an experimental stage and are yet to mature. Many countries with long coast lines would benefit a lot from the developments taking place in the utilization of tremendous ocean energy potential.

(Source: Ravindran, M. and Pathak, A. G. 1996. Ocean Energy: A Status Report. *Natural Energy Review* 1(1): 10-12)

SMALL SCALE WIND ENERGY SYSTEMS

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Editors: Renewable Energy Development v. o. f.

EDITORIAL

In this edition we have a lot of windpumping, especially from Gujarat and Auroville in India. Further there is news on the current status of small wind electric systems in Albania. We have had quite some response after the first issue, mostly from Asia and Latin America. It shows that there exists a need for communication and information in this field. As the editors, we feel encouraged to go on collecting news on small wind energy.

Jan de Jongh and Remi Rijs, editors

Increasing the Water Output of Windpumps

Fine field testing has been reported from the Center for Scientific Research (CSR), Auroville, India on loadmatching devices for water pumping windmills driving piston pumps. This work, supported by GTZ, Germany, is among the best on wind pumping performed in the nineties.

A piston pump has obvious merits compared to its competitor the centrifugal pump: it has a high efficiency (80 %) which is more or less independent of pumping head and pump speed and it can be used to great depths (over 100 m). Its main disadvantage is that its load is very badly matched to the characteristic of the wind rotor.

The torque loading on the rotor during a pumping cycle is unevenly distributed as shown in Fig. 1.

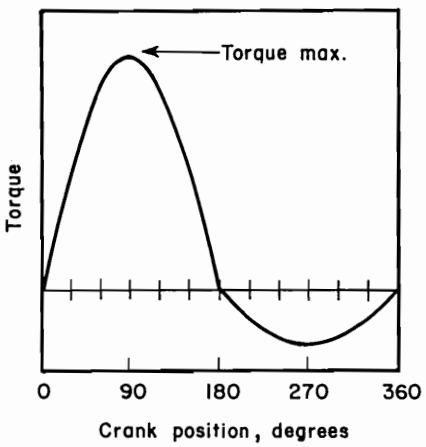

Fig. 1. Rotor torque during pump cycle

A running rotor has sufficient kinetic energy to take the bumps. Standing still however, a much higher wind speed is required to get the pump started than to keep it running. This represents a considerable loss of power output at low windspeeds.

Methods to improve this situation all boil down to smoothing the torque loads (and if possible reducing them) at low wind speeds.

The following five load matching devices were tested by CSR, all on the same windpump, the 5.6 m diameter 24-bladed AV55 developed by CSR. This makes a comparison of the results very reliable. The pump stroke in the experiments was 140, 180, or 227 mm, and the piston diameter 101 mm.

1. Counterweight balancing the weight of the pumprods and part of the hydraulic load. It is quite effective in increasing output but was rejected owing to the vibrations caused by the accelerations of the counterweight (Fig. 2).

2. Cam mechanism by which the upstroke is lenghtened and downstroke shortened in time, thus smoothing the torque. Rejected, due to technical problems of the cam mechanism.

3. Spring in tension between the tower and pumprod, more or less balancing the loads like the counterweight. Proved a reliable method to increase the output considerably (Fig. 3).

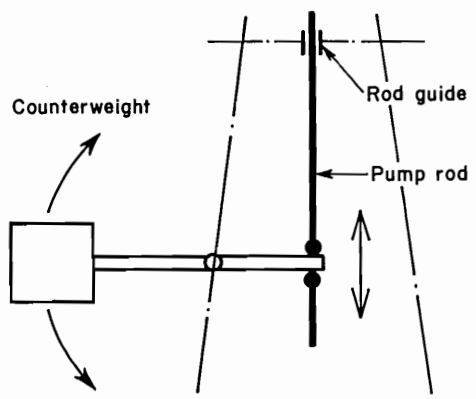

Fig. 2. Counterweight

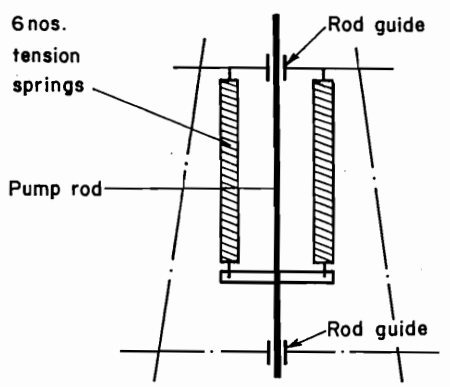

Fig. 3. Spring device

(contd. on p. 2)

Progress on Wind Pumping in Gujarat, India

The first attempt of wind energy utilization in the agriculture sector in the country began in 1952 under the Council of Scientific and Industrial Research (CSIR). The National Aeronautical Laboratory (NAL), which later came into existence, developed the WP-2 Water Pumping Windmill Model. R&D on various models indicated that for favorable places, wind pumps proved to be attractive as they are three times cheaper than the nearest renewable alternative, the wood-based gasifier. A comparison of cost-effectiveness with diesel and electric pumps indicated that given favorable wind conditions the cost of water pumped by windmills can be much lower. Most wind pumps can draw about 10 000 to 20 000 liters of water every day for a head upto 6 m. Applications include domestic water supply, water for livestock, irrigation drainage, fish farms, small ponds. The Gujarat Energy Development Agency (GEDA) therefore initiated the Water Pumping Windmills Program in 1980 with financial assistance from the State Government. In coordination with the Central Salt & Marine Chemicals Research Institute (CSMCRI - Bhavnagar), in 1980-91, ten experimental prototype windmill models of different designs were evaluated; of them, six were identified as suitable to local conditions in Gujarat. Unfortunately, sufficient data on their performance could not be collected as these windmills were severely damaged during the cyclone that hit the state that year.

The program received a major impetus with the introduction of the National Windmill Demonstration Program (NWDP) launched by the then Department of Non-Conventional Energy Sources (DNES). It mainly concentrated on the fabrication and installation of the 12-PU-500 Windmill model. During the Seventh Five Year Plan it received priority attention so as to generate extensive user response, create awareness about the technology and provide inputs for its subsequent extension to private farmers. As these windpumps were primarily installed for drinking water supply and small-scale irrigation, the development of other models was intensified.

Meanwhile GEDA had begun experiencing problems with most of the 95 12-PU-500 wind pumps installed in Gujarat since 1985. Major faults were detected in the pumping system, as well as in the transmission and the furling mechanism. Moreover, this wind pump was designed for shallow wells upto 10 m and low wind velocities, whereas several parts of Gujarat have deep water tables and high wind speeds. There-

(contd. from p. 1)

4. Matching valve. This valve, developed by the wind energy group of Eindhoven University of Technology in The Netherlands, is lighter than water and replaces the normal piston valve of a piston pump. At low wind speeds and so low pumping speeds, the valve by buoyancy remains open; the wind rotor can turn unloaded (except for the weight of the pumprods). It can be shown that at a critical piston speed the valve will close and pumping starts. It can further be shown that the valve - if properly designed- not only eliminates starting problems but also gives the pump a characteristic which at lower windspeeds is more or less perfectly matched to that of the rotor (Fig. 4). The hollow polypropylene valve was tested over more than 3 million cycles with very good results: reliable, no extra cost and greatly increased performance.

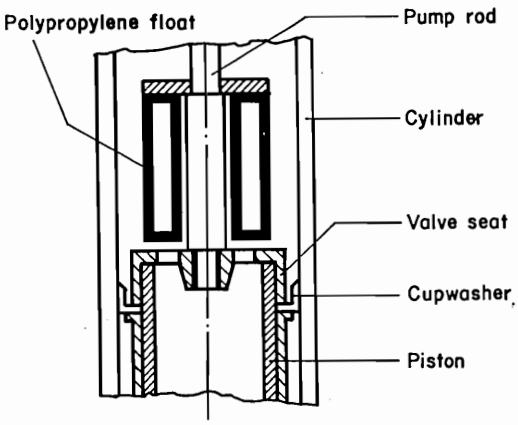

Fig. 4. Matching valve

5. Automatic variable stroke mechanism. This hydraulic system, designed by CSR, adapts the load at different wind speeds by automatically modifying the stroke length. The increase in water output is considerable. However, the mechanism besides adding 13 % to the price of the windpump is technically complicated and prone to a lot of maintenance.

Finally, the windpump was also tested in its conventional state, i.e. without any load matching device.

The conclusions from the tests are evident (Fig. 5). The output of a windpump can be increased by 30% - 50% by installing a spring or a matching valve as load matching device at low or no extra cost. The windpump starts pumping at a lower windspeed of 5 km/h instead of 7.5 km/h, meaning that water is pumped during more days than conventionally.

Load matching devices merit further development. They can be applied successfully on any windpump driving a piston pump. The use of springs and matching valve could be combined, in which case the spring should balance the weight of the pumprods; but it should also be explored to combine the matching valve with a modest

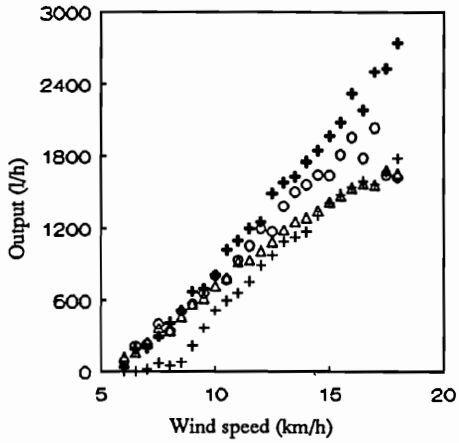

Fig. 5. Hourly ouput (l/h) vs. windspeed (km/h) for conventional pump (+) and counterweight (Δ), stroke 140 mm; spring device (o), stroke 180 mm; and matching valve (+), stroke 227 mm.

counterweight balancing the pumprod weight. Even the variable stroke mechanism merits further development, but should then be manufactured in large numbers. It would especially be useful if it could also reduce the stroke at high windspeeds.

Source: Robert Trunz. 1990. *Field Testing and Monitoring of Load Matching Devices for Waterpumping Windmills.* Auro shilpam, Auroville: Center for Scientific Research.

(Paul Smulders, Technical University Eindhoven, Fac. of Physics, PB 513, 5600 MB Eindhoven, The Netherlands. Fax: +31(40)246 41 51)

fore, GEDA decided to stop the program for the time being, and subject the 12-PU-500 to systematic testing before further trials in the field.

The Sardar Patel University (Vallabh Vidyanagar) was given the assignment to adapt the existing model to Gujarat conditions. The modified design used a chain transmission for better flexibility; a four-bar mechanism to guide the reciprocation motion; a leaking piston with a spring load to control the chain tension; a piston guided by brushes on both sides to avoid misalignment; and a drum-type brake connected to the furling mechanism. Two of these modified 12-PU-500s were field tested at Vallabh Vidyanagar and Porbandar but suffered technical problems which could not be sorted out because of short supply of spares.

Five other wind pump models have since been installed for evaluation. Four of them are indigenous designs, while one has been adopted from the Australian "Yellow-Tail". The four Indian models are: Nityanand developed by OM Engineering Works (Anjar - Kutch); EM-2 model developed by the Rural Engineering School (Rojmal - Bhavnagar); DW-300 developed by Autospares (P)Ltd (Pondicherry); and the 12-PU-500 model redesigned by the Rural Technology Group of the Sardar Patel University (Vallabh Vidyanagar).

These models are now being monitored. Users report they are satisfied with their performance but state that the costs are a major constraint, even at a 75 % to 80 % subsidy provided by Ministry of Non-Conventional Energy Sources (MNES) and GEDA. As an average a user is required to spend about Rs. 15,000.00 (US $ 430) per wind pump of a total cost of Rs. 50,000.00 (US $ 1430). If the windpumps are to be used by farmers on a commercial basis, the initial and maintenance costs need to be reduced substantially. The need for models with a larger capacity has also been voiced.

The Saurashtra and Kutch areas in Gujarat are ideal for wind pumping. A major application in coastal Gujarat is for draining in the large-scale salt panning industry. About 50 % of the Indian salt production is in Gujarat. Now draining is done by large diesel pumps, but wind pumps could be used as well because panning is generally done in summer when the wind conditions are fairly good. GEDA hopes to stimulate the use of windpumping and has set a target figure of 500 wind pumps for the next Five Year Plan.

(Pradib Rajeshirke, Gujarat Energy Development Agency (GEDA), IInd floor, Suraj Plaza -II, Sayajigunj, Vadodara - 390 005, India, Fax: +91 (265) 333 120)

Update on the Poldaw Windpumps

The Poldaw windpumps are a range of medium-sized very low-cost machines designed and developed by Neale Consulting Engineers Ltd (NCEL) in the UK. The designers have extensive experience of appropriate technology machinery design, and carried out the final engineering of the IT windpump in the 1980s.

The Poldaw machines have a rotor diameter of 3.5 m and 5 m. They are smaller than the IT windpump, and have a considerably simplified design, thereby achieving reduced cost without compromising robustness and reliability. They also incorporate various innovations, such as the use of automotive rubber bushes as bearings for oscillating components.

The 3.5 m diameter machine has been under development since 1990, and the pre-production trials started in early 1993. Production in the UK and Zimbabwe was started at the beginning of 1995, and further manufacturers in India and Pakistan have since signed manufacturing licences. Negotiations are underway with various other interested manufacturers, and there have been over 100 enquiries to date, from about 35 different countries.

Various surveys have established that there is a large potential demand for low-cost windpumps, providing that they are reliable, and that they are capable of pumping reasonable quantities from boreholes as well as shallow wells. The designers set out to produce a machine capable of pumping from as deep as 90 m (300 feet), and giving an average output from shallower wells of at least 3 to 4 times that of a handpump.

These requirements dictated a rotor size of at least 3 m, and therefore the challenge was to produce a machine of this size with the minimum cost consistent with adequate robustness and reliability.

Most successful small windpumps with a deep well capability use a speed reduction gearbox to avoid dynamic problems in the pump and pump rods. The Poldaw designs however use a direct drive (crank, connecting rod and rocker), but have a specially developed rotor which developes high torque at low speed. This has a tip speed ratio of approximately 0.7, and sacrifices some aerodynamic efficiency, which is compensated by a slightly increased rotor size. The elimination of the gearbox reduces the overall cost and improves reliability.

Testing was carried out in the UK to maximize the control and the accuracy of data collection. After 18 months continuous testing the machine was completely stripped to examine for wear, cracks and other defects. No severe problems were found, and with a few of minor design changes, it was deemed ready for production. The first test machine was re-installed after examination, and now has over 3 years of successful operation to its credit. There are about 30 other machines now installed and operating (mainly in Zimbabwe), and none have given any significant problems.

Enquiries are welcomed from potential manufacturers anywhere in the world. Licences generally confer exclusive rights for a particular country, except in the case of India where up to 4 regional licences are planned. The development of a 5 m design is underway and will be released to manufacturers when it has been adequately tested.

(Sandy Polak and Paul Dawson, Neale Consulting Engineers Ltd, 43 Downing St. Farnham GU9 7PH United Kingdom, Fax: +44(1252)73 71 06)

Problems on Small Scale Wind Energy in Albania

In Albania interest for the exploitation of wind energy began in 1992. During 1992-94 the Institute of Mechanical Studies and Design (ISPM) carried out a study on small scale wind energy systems and their applications in Albania, including the design and manufacture, and experiments with a windpump. The study was financed by the "Albanian Committee of Science and Technology" with a sum of approx. US$ 10,000. In 1995, ISPM performed a study on electricity generation using wind power, financed by the Ministry of Industry and Trade with US$ 20,000. Also, the Meteorological Institute in Tirana is performing a study on wind potential with funding from the European Community; the aim is to compile a wind map for Albania.

The introduction of wind energy in Albania involves three major difficulties. First, the region's energy demands need to be determined. The local administrations and energy specialists must be engaged in this work. In Albania the problem of heating of houses has not yet been resolved, especially in the remote zones. Until 1991 heating was done by burning wood, which caused great damages in forests. Since 1992, electric energy is being used (partly also kerosene), which causes power failure and overload of the electricity system.

Second, the regions with useful wind speeds must be identified. In the country, the meteorological wind data reveal that 50% of the Albanian territory has a wind speed of more than 5 m/s for half of the year. However, these data are based on conventional anemometry or even popular memory and need to be verified using more accurate, up-to-date devices. But such devices have not yet entered Albania. The idea is that by buying modern measuring devices and windmills from abroad, Albanian specialists can detect the promising zones, process data, and draw final conclusions.

Third, in Albania the cost of energy produced by wind power is often wrongly compared with that of conventional power generation. Nowadays this is perhaps the main issue for Albania. In fact, small stand-alone windmills are usually installed to furnish small consumers in zones far from the electric grid, where its extension would be a too big investment or be impossible. In any case the cost of wind energy in these zones is competitive with that of other small energy sources, like diesel, small coal or oil boilers, small hydro, or solar (of course, such an evaluation should be done separately for each case). The privatization of the electricity distribution in Albania may cause problems to supply the remote zones. This may give an incitement to find other manners of energy supply, one of them being wind energy.

(Eng. Eduard Papa, ISPM, Rruga "Ferit Xhajko", Tirana, Albania, Fax: +355(42)23 681)

Mariano Marcos State University ANEC Develops own Windmill

The Affiliated Non-Conventional Energy Center (ANEC) of the Mariano Marcos State University (MMSU) in the northwestern part of the Philippines, one of the 19 such centers all over the country, has built its own windpump as a direct result of a workshop on "Windpump Design and Manufacture" held in Iloilo City in the middle of 1995. The workshop was conducted by the Central Philippines University ANEC in cooperation with the University of Twente and Renewable Energy Development vof in The Netherlands. The workshop was attended by the author who proceeded to apply the gained knowledge to the design of a windpump. During a second workshop on windpumps "Project Implementation and Evaluation" held at the MMSU in October 1995, the author received valuable technical advice to improve the rotor which was then being made.

The windpump has 6 blades and a diameter of 3.5 m. The blade width is 0.45 m, and the twist angle is between 39.7 degrees at the base and 24.9 degrees at the tip. The tower has a height of 15 m, and is made from mild steel angle bars and round bars. The pump, which was made from parts of an existing commercial manually operated water pump, has a stroke of 10 cm. At an average wind speed of 2.5 m/s to 3.0 m/s at ground level, the capacity is from 7 liters/min - 15 liters/min.

Since this is a prototype, further improvements will be done to make it commercially acceptable. The most pressing improvement is in the area of the pumping unit. As of now, the pump is fitted with a rubber cup for suction which is prone to tearing.

The windpump is presently being used to irrigate crops planted by the university nearby. These include, corn, garlic and tobacco.

MMSU-ANEC's long-term plan is to install several windpumps as promotional units in highly visible, technically and economically feasible areas in the province of Ilocos Norte, Ilocos Sur, and Abra.

(Rudy P. Bareng, Technical Division Head, MMSU-ANEC, Mariano Marcos State University, Batac, Ilocos Norte 2906, Philippines)

"Small Scale Wind Energy Systems" is a quarterly publication of the Regional Energy Resources Information Center (RERIC), AIT, Bangkok, Thailand. It is distributed as a supplementary sheet with the "RERIC News" and by direct mailing. Citation is encouraged on the condition that the source is indicated. For subscription, articles or reactions please contact the editors: Renewable Energy Development v.o.f., PO Box 513, WS 1.49, 5600 MB Eindhoven, The Netherlands. Fax: +31(40)246 41 51. Tel.: +31(40)247 31 91. E-Mail: ydir@tnf.phys.tue.nl.

Publication does not imply agreement of the editors. Contributions should preferably not be longer than 300 words. For longer articles please contact the editors. The editors reserve the right to shorten reactions and articles.

RESEARCH ACTIVITIES

The Energy Program, School of Environment, Resources and Development Asian Institute of Technology

An Experimental Study of Pulsed Fluidized Bed Combustion and Gasification of Biomass

Researcher: Suthum Patumsawad

Research Committee Members: Prof. S.C. Bhattacharya (Chairman)
Dr. S. Chirarattananon
Dr. S. Kumar
Dr. B. Mohanty

This research presents the results of an experimental study of combustion, gasification and heat transfer in both conventional and pulsed fluidized bed.

Experimental studies on combustion, gasification and heat transfer in both conventional and pulsed fluidized bed were conducted using silica sand at size of 425-600 micron as the bed material. The pulsation was conducted by an air chopping machine. The experimental works on combustion and gasification were carried out with variations of equivalence ratio, bed temperature and pulsation frequency. The study on heat transfer in hot bed was conducted with variations of superficial air velocity and pulsation frequency.

With pulsation, the results show no effect on the performance of both fluidized bed combustor and fluidized bed gasifier when compared with the results of normal air supply. The study of heat transfer coefficient between fluidized bed and immersed surface increased when using pulsation and the maximum increase of heat transfer coefficient was at pulsation frequency of 2 kHz.

Heat Transfer Through Radiant Barrier: An Experimental Study

Researcher: Kosit Siwanansakul

Research Committee Members: Dr. S. Chirarattananon (Chairman)
Prof. E. Karmazsin
Dr. Arif Saeed Malik
Dr. G.V. Dang

Knowledge and understanding of heat transfer through a roof to an air-conditioned building have become a necessity in the important aspect of providing comfort to human being as well as for the rational use of energy that means benefiting both individual building owners and the national economy. The mechanism of heat transfer is a dynamic phenomenon influenced by many factors such as instantaneous solar radiation intensity, the thermal properties of materials, interior and ambient temperature.

For the most part of the world, heat transfer coefficient recommended by ASHRAE is adequate to use. But this figure will have more accuracy if the experimental study is set up for the case of a country with low wind speed.

Two types of roof, the tilted and flat roof made from CPAC Monia tiles and cellocrate sheet, respectively, are used for the tests with the variations of radiant barrier TYVEK, glass wool and gypsum board in the case of over purlin, under roof truss or as flat ceiling configurations under no ventilation or ventilation condition in the working hours. Heat flux and temperature results are given in graphical and tubular forms. The configuration of radiant barrier as flat ceiling is the best configuration among over purlin or under roof truss with not only no ventilation but also with ventilation. Radiant barrier as flat ceiling under ventilation is the best among other types of testing insulation material either under ventilation or no ventilation for the tilted roof. Radiant barrier as flat ceiling under no ventilation is the best among other types of testing for insulation material under no ventilation for the flat roof.

The simulation model using the finite difference method shows qualitatively good prediction for heat flux through roof compared with using the heat flux meter while temperature prediction using this model is fair compared with using thermocouples and the heat flux meter. This may come from time lag of measurement using the heat flux meter and the accuracy of the data logger and the multiplexer due to leakage of rain water in the experiment room.

A Study of Energy Conservation in an Industry Using Process Integration Approach

Researcher: Tang Ou

Research Committee Members: Dr. B. Mohanty (Chairman)
Prof. S.C. Bhattacharya
Prof. E. Karmazsin

This study aims to assess the energy conservation potential in a process factory. The scope of study includes not only the measures in the existing facilities and process, but also the promising options for future energy utility system after factory expansion.

Based on the facilities and processes analyzed, it is found that the energy utilization efficiency can be further improved by enhanced thermal and operation management. It is estimated that as much as 7.4 million Baht can be saved annually through energy efficiency improvements, representing 5.4% reduction in the energy bill, which includes 7.6% fuel saving and 1.1% electricity saving. Modest investment on the relatively simple modifications/additions in devices is required for these energy conservation options. In most cases, the payback period is only a few months, which is quite

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attractive from the factory's viewpoint.

Natural gas cogeneration, which is also encouraged by the government of Thailand, is a promising option to satisfy the energy utility requirement for the factory after its planned expansion. The suitable cogeneration system for this factory is gas turbine with post-combustion heat recovery system, which not only has the highest thermal efficiency, but also can provide the flexibility in operation. From the financial analysis of this option, NPV, PBP, IRR are found to be 310 million Baht, 5.3 years and 26.6%, respectively. Cogeneration with thermal-matching is not feasible in this factory because the selling price of electricity to the state electricity utility is not high enough to compensate for the high investment on the prime mover. Incorporating absorption chiller is not an attractive option either as the operation cost will increase in order to produce additional steam to makeup for the shortfall in the process heat demand. Moreover, installed capacity of compression chiller is adequate to meet all the future cooling needs of the factory.

Cool storage is an efficient measure to further improve the performance of cogeneration system. The supply shortage from cogeneration during certain period of the day can be provided by the cool storage. Therefore, the energy bill can be further reduced. From economic analysis, the most feasible option is to limit the demand from the grid. The corresporting NPV, PBP, IRR are 1.6 million Baht, 3.6 years and 35.5%, respectively.

Techno-Environmental Assessment of Biomass as a Source of Energy: The Case of Nepal

Researcher: Mahen Sharma

Research Committee Members: Prof. S.C. Bhattacharya (Chairman)
Dr. R.M. Shrestha
Dr. S. Chirarattananon

This report presents results of a study on techno-environmental assessment of biomass as a source of energy in Nepal. It is found that there exists a huge potential of biomass for energy in Nepal.

Annually about 10.3 million MT of agricultural residues could be potentially available for energy in Nepal. However, in 1992/93, only about 3.2 million MT of agricultural residues was actually utilized for energy.

Annually about 8.7 million MT of dry animal wastes is produced in Nepal. However, considering only cattle and buffalo dungs as viable for fuel use, about 3.0 million MT annually of dry cattle and buffalo dungs would be recoverable for energy. In 1992/93, about 2.02 million MT of animal wastes was utilized for energy.

In 1992/93, about 10.7 million MT of fuelwood was used in Nepal. About only 7.49 million MT of fuelwood could be harvested from the existing accessible forests in a sustainable way. However, it is found that from the energy potential in plantation in non-agricultural and degraded lands, about 26.6 million MT of fuelwood could be extracted annually.

Efficient biomass energy technologies can potentially conserve large amounts of biomass fuels in Nepal and reduce total emission of pollutants as well. It has been estimated that 33 % to 54 % reduction of the total emission of seven pollutants ie. CO, TSP, SO_x, NO_x, CO_2, CH_4 and N_2O from biomass combustion would be possible.

Assessment of Energy Management Options in Indian Sugar Industry

Researcher: K.S. Shriram

Research Committee Members: Dr. B. Mohanty (Chairman)
Prof. S.C. Bhattacharya (Co-Chairman)
Dr. R.M. Shrestha
Mr. J.B. Heredia

This study looks at the feasibility of using energy efficient systems in the Indian sugar industry. The study looks into the major energy consuming areas in a typical Indian sugar mill and examines opportunities to conserve energy or to optimize its use. The study has focused on the areas of the boiling house, condenser and cooling system, the turbo-alternator and steam generating systems. Energy models of these areas have been developed for a plant with a capacity of 2500 tons of cane crushing per day (TCD) using the sizes of equipment specified as standard by the Government of India. The optimization process looks at both the alternatives of bagasse maximization and power maximization.

Nine different scenarios have been examined for the boiling house, covering different bleeding schemes and sources of heating for the juice heaters and for pan boiling. The nine scenarios incorporate the schemes and features used in some of the Indian factories. Two optimized models for the boiling house based on the above scenarios have been developed, using the pressure evaporation and with a mechanical vapor recompression system. The steam consumption figures for the optimized models have been estimated at 38.2% (with MVR) and 40.2% (without MVR) per ton of cane crushed. Two schemes are also suggested for implementation in existing mills in India of either single effect pre-evaporator or double effect pre-evaporator system followed by a quadruple effect evaporator.

Different configurations of high pressure systems (turbo-alternator and boiler unit) have been examined keeping the process steam demand in view and the type of mill drive used (steam turbine system or electric / hydraulic motor drive system). The capacity of the mill to export electricity increases by approximately 20% as the system pressure is changed from 42 bar to 64 bar and by 32% as the system pressure is changed from 42 bar to 84 bar (with process steam demand at 50% on cane in a mill with electrified drives).

Financial analysis has been carried out for the systems proposed. The investments made in the boiling house to reduce the process

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steam demand are recovered in a short period especially for the power maximization alternative. The choice of 64 bar pressure for the turbo-alternator system seems very attractive from amongst the choices examined in the studies.

The barriers which hamper the use of high energy efficient systems in the Indian sugar industry have been studied. The measures already taken or necessary for the improvement of energy efficiency in the Indian sugar industry and to overcome some of these barriers have been elaborated.

Interfuel Substitution Analysis and its Application to the Transportation and Industrial Sections of Ho Chi Minh City, Viet Nam

Researcher: Nguyen Hoang Dung

Research Committee Members: Dr. X. Chen (Chairman)
Prof. T. Lefevre
Dr. B. Mohanty

In this study, a new approach used for interfuel substitution analysis has been developed in the framework of MEDEE-S model. It is known as End-use Based Engineering Approach which analyzes comprehensively the possibility of fuel substitution at the level of each end-use. Two sectors industry and transport, have been analyzed in detail.

The approach has been applied to the industrial and transportation sectors of Ho Chi Minh (HCM) City in Viet Nam to analyze the possibilities of interfuel substitution.

In the industrial sector, the possibility of substitution of fuel oil and natural gas for fuel wood during the 1992-2010 period has been studied. In transportation sector, the penetration of LPG as a substitute for gasoline and diesel was examined in urban areas in the same period.

The results show that fuel shares in total industrial energy requirement are sensitive to both energy management policy and relative cost of fuels. However, their responses are not the same for all fuels: most sensitive for fuelwood and less sensitive for natural gas.

The substitution of gasoline and diesel by LPG in urban transport is proved to be an important and necessary measure for improving air quality but this substitution depends on the strong energy management policy

Research Activities at University of Melbourne

The International Development Technologies Center within the Faculty of Engineering at the University of Melbourne has been offering a Masters Degree Program for the past 15 years. The combined coursework and research offers students the opportunity to study renewable energy and its associated technologies. Below are the titles of some of the research topics undertaken by past students.

- Computer simulation and economic analysis of box type solar cooker
- An investigation into the design and use of a simple forced convection solar assisted cocoa dryer for small holder growers in Papua New Guinea
- Performance prediction of small-scale photovoltaic refrigerators
- Solar refrigeration for the developing countries
- A preliminary feasibility study of using salt gradient solar ponds for desalination and other low temperature applications
- Simple solar technology for the drying of vine fruits
- Solar drying system for jute fiber
- Design and testing of a solar crop dryer
- Some aspects of the stability, maintenance and control of the salt gradient in solar ponds
- Small-scale solar refrigeration (SSSR) systems for vaccine storage in developing countries
- Design optimization and economic evaluation of a solar hot water system for rural wool dyeing in India
- A feasibility study for the design of a forced convective solar rice dryer
- Test performance and evaluation of used drum solar food dryer.
- Plastic film solar air heater
- Improvements in the sun drying of cassava for flour production
- Small-scale hydropower feasibility evaluation with a computer model
- Cross-flow turbine design for Indonesia
- Wet ethanol as petrol extender in SI engines in the Philippines
- The effects of methods of air supply on the operating behavior of a rice husk pyrolysis reactor
- Effect of wood variety on charcoal yield
- Thermal effects influencing the pyrolytic decomposition of rice husks
- The effects of intermittent air supply on the operating behavior of a rice husk pyrolysis reactor
- Energy losses and thermal efficiencies of traditional Burmese type cooking stoves
- Improvements of thermal efficiency of traditional Burmese cooking stoves
- Effect of carbon dioxide contamination on the performance of a biogas fuelled internal combustion engine
- The feasibility of introducing processes for energy recovery from MSW in developing countries
- Feasibility study on the use of upstream reboiler at Tongonan geothermal power station
- Feasibility study on the use of rotary separator turbines at Makiling-Banahaw geothermal field
- Simulation of four solar drying systems for crepe rubber drying in Sri Lanka
- Development and evaluation of a natural convection solar drier
- Evaluation of a solar water desalination plant in rural Pakistan

(Contributed by Dr. Bob Fuller, Co-ordinator, Energy Studies, the International Development Technologies Center, Faculty of Engineering, The University of Melbourne)

Book Reviews

Stove Images A documentation of Improved and Traditional Stoves in Africa, Asia and Latin America

Beatrix Westhoff and Dorsi Germann
Published by Brandes Apsel Verlag GmbH, Frankfurt am Main, Germany
ISBN 3-86099-136-1, 1995, 216p.

Stove Images contains a wealth of information on household energy and the use of stoves in Africa, Asia and Latin America. It covers three key aspects, namely Documentation, Visualization and Awareness-raising. It provides a systematic and typological survey on the basis of information and technical data on traditional and improved stoves, kitchens and other technologies which are currently in wide spread use in Africa, Asia and Latin America. The photographs and drawings make it above all a visual reading experience for all.

The target groups of the book are the national and international organizations, institutions, projects, groups and others who are active in the fields of energy, the environment and development.

The book is organized in three parts - Introductory Section, Information Section, and Technology Section. The introductory section contains 17 articles by authors in 10 countries. These are based on experiences gained and lessons learned in developing countries. The second section on information contains a bibliography with about 270 selected titles from 76 countries worldwide organized by fields with key words and index. A directory with about 500 addresses of organizations, projects and persons from 100 countries around the world is also included. The technology section contains 240 photos of traditional and improved stoves, of kitchens and other technologies and data sheets of different types of technologies.

Wealth From Waste

Edited by Sunil Khanna and Krishna Mohan, Tata Energy Research Institute (TERI), India
ISBN 81-85419-11-6, 1995, 280p.

The book edited by Khanna and Mohan contains articles that deal with options and technologies to treat and recycle wastes. The sheer quantity and diversity of wastes generated by industries and municipalities is posing serious risks to human health and environment. Inefficient technologies, ineffectual policies, and insensitivity on the part of industries have led to large-scale degradation of the ecosystem by domestic and industrial effluent.

The book contains much of what was presented in a work shop with the same title held by TERI as well as some specially commissioned articles by eminent personalities in the field.

The 15 chapters of the book authored by various experts and eminent personalities are as follows:

1. Environmental legislation and enforcement mechanism
2. Managing the environment-some issues
3. Cogeneration-a technology in waste reduction
4. Thermal gasification of biomass-potential, problems and research needs
5. Maximization of energy utilization by heat recovery
6. Methanogenesis
7. Improvements in microbial compost technology: a special reference to microbiology of composting
8. Vermiculturing
9. Lay wasted waste
10. Municipal waste treatment and energy recovery
11. The management of infectious wastes
12. Evaluation of fruit and vegetable processing wastes for bio conversion to methane by anaerobic digestion
13. Power generation based on distillery spentwash
14. Waste management options and technologies for the treatment and disposal of hazardous waste
15. Economic policies and analysis in effluent treatment and financial constraint.

Solar Heated Timber Drying Kilns A Manual on their Design and Operation

R.A. Plumptre and D.L. Jayanetti
Published by TRADA Technology Ltd. for the Overseas Development Administration (ODA)
ISBN 1 900510 00 6, 1996, ix+100p.

The manual is based on the knowledge and experience gained during the past thirty years in the field of timber drying using solar energy. It provides sufficient information for the reader to understand the principles of timber drying, how solar kilns work, how different designs are constructed and how they should be operated to obtain a high quality product.

The manual contains the following sections

1. Background
2. The Principle of Wood Drying
3. The Principle of Solar Energy Collection and Solar Kiln Design
4. Selected Kiln Types and Designs
5. Kiln Performance, Control and Operation
6. Timber Cane after Drying
7. Maintenance and repair of Solar Kilns
8. Which Kiln?

As can be seen from the titles of the chapters above, the manual covers different aspects of timber drying process from principles of wood drying to design, operation and maintenance. Details of various kiln types available and its selection criteria etc. makes the manual useful even for a person with very little prior knowledge to build a solar kiln for timber drying.

RERIC Human Resources Development Programs

1. Computer Assisted Designing of Energy Efficient Buildings (February 6 - 8, 1997)

This 3 day training course will be based on a pedagogical software for buildings called CASAMO developed by the French Environment Management Agency (ADEME) and the Energy Program, Asian Institute of Technology (AIT). The Participants will be introduced to the software which is a computer tool for designing buildings with pleasant thermal comfort conditions or low energy consuming air conditioning, or for calculating the dimensions of an air conditioning system.

With the help of the software, the participants will be exposed to various aspects of building design, namely

- evaluating the comfort conditions in a building
- calculating cooling loads when air conditioning is required
- calculating the dissipated heat gain in an enclosure, solar radiation input or casual gains, and
- determining the effect of the building's inertia

The course is designed more with a "training the trainers" objective but would be suitable for professionals working in the field of energy conservation in buildings.

2. Techno-economic Optimization of Cogeneration, District Cooling and Thermal Energy Storage (February 10 - 12, 1997)

This 3 day course will be based on a software for Combined Heating, Cooling and Power Generation called Total Energy Supply (TES) also developed by AIT with the support of ADEME.

The TES software was conceptualized with the integrated energy systems approach for buildings and industries where electrical and thermal requirements co-exist. It allows to conserve energy and reduce energy cost by combining energy services in a central supply facility. It determines the techno-economic viability of a particular Combined Heating, Cooling and Power Generation (CHCP) technology.

From the given demand patterns of electricity, heating and cooling utility, energy and equipment unit capacity costs and other financial parameters, the software predicts the optimum sizes and the scheduling of the CHCP plant, refrigeration system, auxiliary boiler, and marginal costs of the services provided. As an additional feature, the package estimates the reduction in pollutant emissions.

The software can provide the cash flow of the supply facility for a number of years. Lastly, the sensitivity of the internal rate of return (IRR) of the project with respect to factors such as escalations in energy price, equipment capacity costs, etc. can be investigated.

The training course is suitable for consultants, engineers, utilities and cogeneration developers.

Both the training courses will rely heavily on hands-on sessions and use of the above mentioned software packages. At the end of the training courses, the participants are expected to be able to independently use the software in the design and planning of their respective fields of applications. Each participant will be provided with a lincenced copy of the software package with the accompanying user manual and reference manual at the end of the courses.

The course director is Dr. B. Mohanty, Associate Professor, Energy Program, AIT, and team leader of the software development team.

Application forms and other details of the courses can be obtained by writing to:

Manager
RERIC/AIT
P.O. Box 4, Klongluang
Pathumthani 12120,Thailand
Tel: (66-2) 524 5866
Fax: (66-2) 524 5870
Email: enreric@ait.ac.th

International Events

INSIDE ASIA

21 - 24 August, 1996, Energy Summit, Madras, India
Contact:
Confederation of Indian Industry
23 26 Institutional Area, Lodi Road,
11003 New Delhi,
India
Tel: +91 11 4629994
Fax: +91 11 4633168

1 - 2 October, 1996, Energy and Power Expo, Beijing, China
Contact:
Adsale Exhibition Servicess Ltd,
4/F Stanhope House, 734 Kings Road
North Point, Hong Kong
Tel: +852 28118897
Fax: +852 25165024

7 - 9 October, 1996, 3rd International Renewable Energy Asia Pacific '96 Exhibition and Conference, Manila, Philippines
Contact:
Ms Sylvia Gilkes
Alternative Developmnet Asia, Ltd,
5/F, # 3 Wood Road, Wanchai
Hong Kong
Tel: +852-2574-9133
Fax: +852-2574-1997
Email: altdev@hk.super.net

6 - 10 January, 1997, The 3rd International Conference on Solar Cookers Use and Technology, Avinashilingam Institute for Home Science(Deemed University), Coimbatore, Tamil Nadu, India
Contact:
3rd Int'l Conference on Solar Cookers
(contd. on p. 12)

(contd. from p. 11)

c/o Chancellor of Rajammal Devadas
Avinashlingam Deemed University
Coimbatore 641 043 India
Tel: 91-422-440 140
Fax: 91-422-438 786

13 - 19 January, 1997, Technical Exchange Conference of Solar & Biomass Energies, Haikou City, Hainan Province, China
Contact:
Mr. Song Yuhua
Director of DCAST
No. 13, Block 4, People South Road
Chengdu 610041, China
Tel: 028- 5541487
Fax: 028-5212250

22-24 January 1997, The 20th Annual International Conference on Energy and Economic growth - is sustainable growth possible?, New Delhi, India
Contact:
Dr. Leena Srivastava
Dean, Policy Analysis Division
Tata Energy Research Institute
Habitat Place, Lodhi Road
New Delhi - 110 003
India
Tel: (91-11) 462 2246
Fax: (91-11) 462 1770

3-7 February 1997, First International Conference on Renewable Energy - Small Hydro, Hyderabad, India
Contact:
CVJ Varma, Secretary
Int'l Association for Small Hydro,
CBIP Building
Malcha Marg, Chanakyapuri
New Delhi - 110 0221, India
Tel: 91-011-3015 984, 3016 567
Fax: 91-011-3016 347
Email: cbip@cbipdel.uunet.in

OUTSIDE ASIA

16-18 July 1996, 13th International Conference on Passive & Low Energy Architecture, Building and Urban Renewal, Louvain la Neuve, Belgium
Contact:
Professor A. de Herde
Architecture et Climat, Place Levant
B-1348 Ottignes Oouvain la Neuve
Belgium
Tel: +32 10 47 21 42
Fax: +35 10 47 45 44
e-mail: deherde@arch.ucl.ac.be

29-31 July 1996, First Trabzon International Energy and Environment Symposium - TIEES, Trabzon,Turkey
Contact:
Prof Dr Teoman Ayhan
TIEES-96
Dept. of Mechanical Engineering,
Karadeniz Technical University,
Trabzon 61080, Turkey
Tel: (462) 325-3223
Fax: (462) 325-7405
energy96@risc01.bim.ktu.edu.tr

20-23 August 1996, Hydro Vision 96, Orlando, Florida, USA
Contact:
Hydro Vision '96
410 Archibald Street
Kansas City, MO 64111-3046
U.S.A.

25 - 31 August 1996, Energy Efficiency in Buildings, Pacific Grove, CA, USA
Contact:
ACEEE, 2140 Shattuck Avenue,
Suite 202, Berkley, CA 94704 USA
Tel/Fax: +1-510-54999-14/-84

16 - 19 September 1996, EuroSun'96, 10th International Solar Forum, Freiburg, Germany
Contact:
ISES-Europe or
Deutche Gesellschaft für Sonneenergie
Augustenstrasse 79
80333 München, Germany
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7 Oct. - 9 Nov. 1996, Training Program on Energy Management and Cleaner Production in Small amd Medium Scale Industries, University of Twente, The Netherlands
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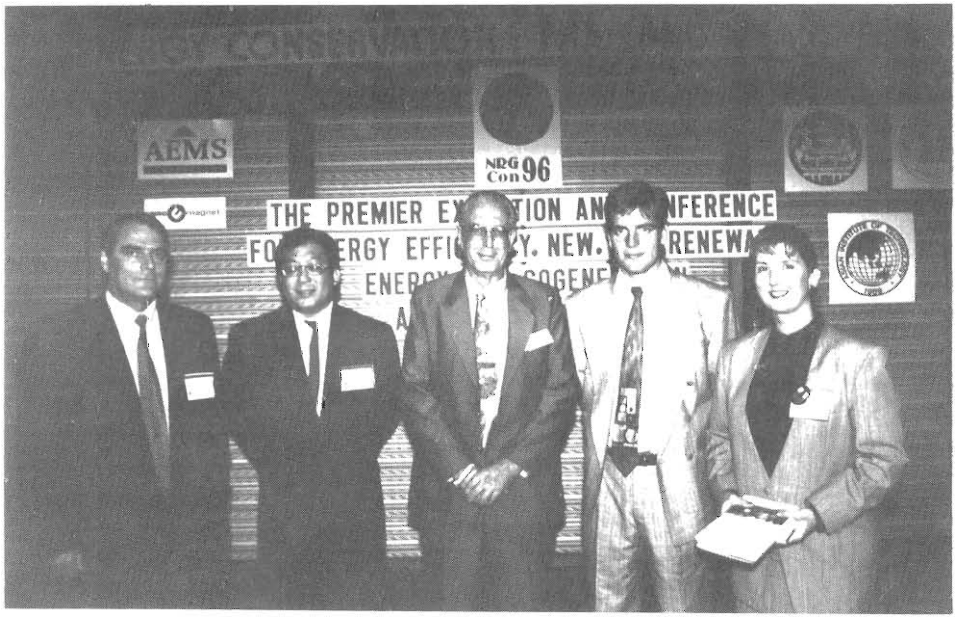
"Energy Conservation--Thailand Means Business" Conference Takes Place in Bangkok

"Energy Conservation--Thailand Means Business" began a dialogue that questions the application of non-regional building solutions for tropical buildings. And it refuted the often-heard claim that the Asian region lacks local expertise.

"Energy Conservation -- Thailand Means Business", the first conference to study the systems and design of energy efficient buildings in tropical climates, took place on 22 - 23 August in Queen Sirikit National Convention Center in Bangkok. Concurrent with the NRG Con96 exhibition that displayed new energy efficient technologies, this conference was attended by architects, engineers, building owners, and environmentalists who were looking for ways to integrate energy conservation into their buildings.



(From left to right) Mr.Willem Devries, Philips Semiconductors Thailand; Dr Ken Yeang, Yeang & Hamzah; Dr. John Halldane, Institute Iskander Urban Habitat and Highrise; Mr. Marc Devries, AEMS Exhibitions; Ms. Lisa Suprenant, NRG Magnet.

The conference began with a synopsis of the Energy Conservation Promotion Act and its implications for all buildings in Thailand. Government officials from the National Energy Policy Office (NEPO), the Department of Energy Development and Promotion (DEDP), and the Electricity Generating Authority of Thailand (EGAT) explained why reducing electricity demand is important, how to use government incentives to achieve this, and predicted the consequences of failure to conserve. With an estimated budget for the designated building programs of some 7,400 million Baht over the next three years, these energy conservation programs mean business, literally and figuratively!

With the policies, laws, and incentives to support the development of regionally-appropriate designs, architects in Thailand have renewed impetus to design better buildings. And with the technologies presented in the second day of this innovative conference, they have more information by which to make informed decisions as to what techniques best solve regional problems.

By bringing only those international experts that work in the tropics, this conference selectively sought answers to the problems which pervade tropical building design. This conference brought to Bangkok such renowned experts as Dr. Ken Yeang of Kuala Lumpur, world-famous architect whose pioneering works like Menara Mesiniaga, the first "bioclimatic skyscraper" illustrated environmentally-

(contd. on p. 2)

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friendly materials and climate-reactive technologies to save energy and reduce operating costs.

Many of the techniques Dr. Yeang uses in his bioclimatic skyscrapers have been researched and tested by another regional expert, Dr. John Halldane of the Institute Iskandar Urban Habitat and Highrise in Johor Bahru, who also spoke during the conference, presenting concepts for appropriate envelope design and raising serious concerns about the lack of regional design evaluation criterion for buildings.

Experts in technologies like spectrally-selective glass and the NASA-award winning technology of energy-efficient heat pipes gave participants even more examples of transferable technologies that make sense for this climate. In total, sixteen international energy conservation experts from around the world spoke on topics that ranged from hotel engineering for energy efficiency to holistic strategies for commercial building design.

As the first conference in Southeast Asia to seriously question standard practices and seek out international experts who focus on finding "just-right" solutions for tropical buildings, the conference showed that the comprehensive energy initiative in Thailand has both the intention and the expertise to make sweeping changes.

As seen in examples from other countries, the true cost of not taking a regional approach to solving regional problems can be staggering. Without a more specialized approach to engineering and architecture, Bangkok could suffer the fate of other cities that allowed construction of energy-inefficient buildings to overload their local economies. Dr. Yeang urged local architects to consider the consequences of such exponential energy use and such lack of concern for designing better, more energy-efficient buildings.

The need to conserve energy is clear when one considers that if per capita energy use in Asia was to rise to one fourth the current industrial country level, this alone would increase the total world energy use 60% by the year 2025. From an environmental standpoint, this global increase could make these countries electrified but unlivable, like the small Romanian town where the trees and grass are so blackened by soot that even horses can stay for only two years or else they will die, or the northern reaches of Czechoslovakia where the air is so badly polluted that the government actually pays a bonus to anyone who will live there more than ten years!

As Asian countries set about to sustain economic development and initiate environmental stewardship, learning from the experiences of others is critical to avoiding their mistakes. The process of evaluating all technologies, techniques, and designs began in earnest with this conference. And as this dialogue continues, the power of the ideas generated from this event may prove to be more sustainable than any source of man-made power could ever be.

(Contributed by Lisa Suprenant, Managing Director of NRG Magnet)

Electricity from Biomass

Biomass is a general term used to describe a wide range of materials from plants. In the field of renewable energy, biomass means resources that have been grown in a sustainable way and are of comparatively recent biological origin. The term does not encompass wastes from households or from industrial and commercial enterprises.

There are three main types of biomass feedstock:

- wood from conventional forestry or from short rotation coppice (SRC)
- other energy crops such as Miscanthus
- straw or other agricultural crop residues.

The most promising source of fuel wood is SRC grown specifically for the purpose, although sawmill residues, forestry residues from existing timber industries and thinnings can also be used and are available. Miscanthus as an energy crop is still in the development phase. Straw, on the other hand, is a by-product of cereal production. Some is already used for animal husbandry and other agricultural purposes, but much is still surplus and currently is disposed of by ploughing it back into the soil. In many cases it may be advantageous to use it as a fuel.

The Technologies

Energy is liberated from biomass by breaking down its structure. This is achieved either by thermal conversion using heat, or by biological conversion using digestion and similar processes.

There are three thermal conversion processes by which energy can be extracted from biomass:

- direct combustion - burning the biomass as a solid fuel in a boiler or stove
- gasification - where the biomass is converted to a gaseous fuel which can be used for power generation or for heating
- pyrolysis - where the biomass is converted to a liquid fuel product which can be used to generate electricity and for other purposes.

In direct combustion, the fuel is burned in air. It produces heat which can be used to produce hot water for heating or process uses, or steam to drive turbines for generating electricity.

In thermal gasification, the fuel reacts with air to produce a gaseous mixture of carbon monoxide, carbon dioxide, methane and hydrogen. Gasification offers high conversion efficiencies of 25 - 40%, depending on the size of plant. The technology is an economically attractive option for plant producing from 100 kWe - 30 MWe using biomass.

In pyrolysis, the fuel is heated in the absence of air to produce gas, oil and char.

→

Flash pyrolysis maximizes the yield of liquid product and can transform up to 85% of the energy of the biomass into this form. The high heating rates used in flash pyrolysis mean that the biomass must be dry and cut into small particles. This makes the process more suitable for straw and herbaceous crops than wood.

Environmental and Economic Aspects

In global terms, using biomass to produce energy results in no net contribution to greenhouse gases since the carbon dioxide produced in the process was absorbed previously by the plants as they grew. Thus, in simple terms, biomass conversion offers a way of producing energy for human needs which is also in harmony with the natural biological cycles of the earth and its atmosphere. Locally, the growing of fuel crops may contribute greatly to biodiversity and the local environment.

Whether this method of producing energy can be economically viable depends crucially upon the costs of feedstock and the efficiency with which it can be converted into a usable fuel. Higher conversion efficiencies mean that more electricity can be generated per ton of fuel burnt. Since the cost of the biomass fuel accounts for a large percentage of the operating costs of biomass-to-energy plant, increasing the amount of electricity produced from a given amount of biomass reduces the final cost of the electricity produced. Currently, effort is concentrated on developing new technologies to increase conversion efficiencies whilst keeping capital costs at or below those of equivalent conventional plant.

Applications

Power Generation

The most immediate application for biomass energy is electricity generation. There are many examples of biomass power generation in countries around the world. In California, USA, alone there is 8000 MWe of generating capacity.

Co-firing

Biomass can be used alone or together with conventional fuels such as coal in a process known as co-firing. Substituting biomass for a small percentage of fossil fuel at a conventional fossil-fueled power station can be attractive for a number of reasons. In particular, it allows the conversion of the biomass at high efficiency and means that fluctuations in biomass fuel supply are not critical for the successful operation of the plant. It also avoids the potential planning problems associated with new plant, allows biomass to take advantage of an already-established infrastructure, and provides a low-risk option for investors.

Co-firing wood is already feasible and the technology is ready for demonstration, although more technical and economic studies are still needed. Co-firing straw is likely to be more problematic because of its relatively high alkali content, which could cause expensive corrosion and fouling problems in a conventional power station. Biomass may also be used together with a conventional fuel in both gasification and pyrolysis systems. The technology for this is not yet developed but laboratory studies and pilot-scale trials are appropriate. The gasification option appears particularly promising.

Combined Heat and Power (CHP)

Another important application for biomass fuel is in CHP plant. In a conventional steam electricity-generating plant, up to two-thirds of the energy produced is rejected as low-grade heat. The temperature of this reject heat is usually too low to allow it to be used for industrial purposes. Better use can be made if the reject temperature of the steam from the turbine is raised to provide for a CHP system. However, this has some penalty in that there is less energy available for electricity generation by the plant. Using a gas turbine cycle instead of a steam turbine cycle has the advantage that higher-grade waste heat can be produced without any such penalty. Gasification and pyrolysis produce high temperature gas that can be fed into a gas turbine cycle in a CHP plant.

In addition, environmental concerns, development of new advanced conversion processes and the sheer surplus of agricultural and processing residues coupled with strong growth in electricity demand offer good opportunities for generating electricty from biomass.

(Source: Electricity from Solid Biomass, Technology Status Report 013, ETSU for Department of Trade and Industry, U.K.)

New Publication

FUNDAMENTALS OF COGENERATION
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Brahmanand Mohanty
Aung Naing Oo
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The Energy Conserving Building of Thailand

The rapid growth of Thailand's economy over the last decade has been matched by a proportionate rise in the country's energy demand. This has put an enormous pressure on the Kingdom's fragile environment. Realizing this, HM the King of Thailand signed into law the Energy Conservation Promotion Act (ECPA) in April 1993. The Royal Decree oultines the maximum amount of energy that Thailand's buildings will be allowed to consume and provides financial support for energy-efficiency strategies for the commercial and industrial sectors.

The Department of Energy Development and Promotion (DEDP) has the task of illustrating to Thai architects, engineers, building owners, and the public how to conserve energy. A demonstration project called "The Energy Conserving Building" that focuses on demonstrating the most advanced energy technologies appropriate for hot, humid climates has therefore been planned.

The Demonstration Project

Scheduled for completion in 1997 this building will showcase energy conservation technologies, act as a training center for energy managers, and be open to the public with exciting "hands-on" displays of new and innovative technologies.

Covering an area of some 14 000 m² enclosed in a series of unique and bioclimatically-placed forms, this building incorporates the best known technologies and techniques for energy-efficiency.

The architects and project team worked for months to combine all these elements into an "integrated approach" which uses Thailand's climate and natural resources to their best advantage.

By creating a suitable environment around the building and sensibly orienting the building on the site, these natural elements will enchance the overall energy efficiency of the building.

Some of the other technologies and techniques used within this extraordinary complex are:

- Cool micro climate and good building orientation to use site assets to best advantage
- Special air-flow windows which allow heat from the building to escape
- Spectrally-selective windows that let natural daylight in and reduce energy
- Insulative wall materials technologies that keep the cool in and the heat out
- Innovative window that allows skylights needing less artificial light
- Energy-efficient lighting which uses less electricity
- Ice storage to shift the peak air conditioning load and save electrical demand charges
- Automated building monitoring and control systems which track the energy for the building to improve the energy savings over the life of the building
- Research and computer simulation for energy-saving integrated building design in hot, humid climates
- Use of innovative daylighting techniques and design throughout the building leading to reduced need for artifical light during daytime to conserve energy

Energy Estimates of the Building

Using US Department of Energy (DOE) energy-use computer models, the team has been able to "model" the building prior to construction, to see how it will perform. These estimates are listed in the table below.

With half the lighting energy, less than half standard OTTV, and less than a third of air conditioning tonnage consumed by a typical Bangkok Building, the Energy Conserving Building will be a healthier, more comfortable building to live/work in and also a model for others to follow.

This demonstration building as well as the Act will go a long way in promoting energy conservation in Thailand. This will ultimately lead to protecting the local as well as global environment. The countries of the region and elsewhere would have a model to follow.

(Source: Bureau of Energy Regulation and Conservation (BBC). 1996. The Energy Conserving Building. Bangkok, Thailand)

Energy Estimates of the Demonstration Building

Energy Related Items	Energy Conserving Building Consumption	Energy Promotion Act Requirements	Typical Bangkok Building Consumption
Overall Thermal Transfer Value (OTTV)	18 Watts / m²	45 Watts / m²	65 Watts / m²
Lighting Wattage	8 Watts / m²	16 Watts / m²	25 Watts / m²
Air Cinditioning Load	63 m² / ton	Norecommendation on tonnage	20 m² / ton
Air Conditioning Tonnage	250 tons	Norecommendation on tonnage	700 tons

Green Energy Misssion/ Nepal Emphasizes on Above Ground Petrol Mining

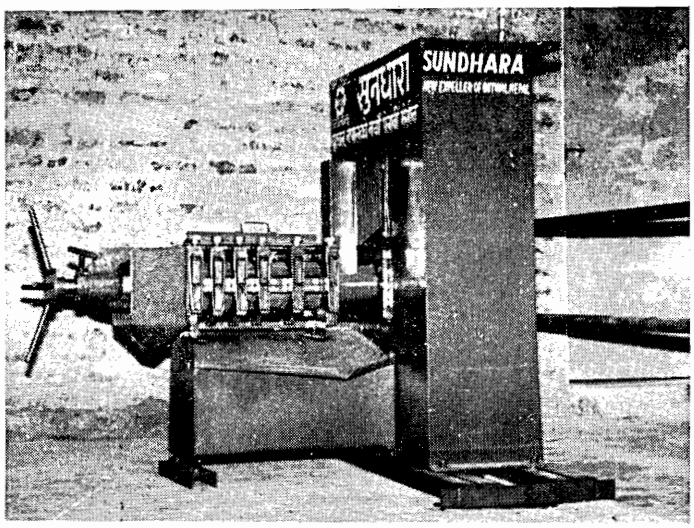
Green Energy Mission/ Nepal, a local nongovernmental organization (NGO) conducted a one day workshop on "Financial Investment Opportunity in Plant Oil Energy Development in Nepal" on 23 August 1996 in co-operation with the Water and Energy Commission / Secretariat (WECS), Ministry of Water Resources and The Nepal Rastra Bank with the participation of 28 different commercial banks and financial institutes of national and international nature, INGOs and NGOs. The main theme of the workshop was "Plant Oil Energy - Safe and Sustainable Rural Energy for Nepal".

During its inaugural ceremony, the Hon. Minister of State for Water Resources Sarbendra Nakh Sukla expressed that plant oil energy from the pine trees, seeds and nuts from various trees and plants could be the safe and sustainable rural energy for future development of Nepal not only to minimize deforestation, but also to improve agricultural productivity from the oil cakes after extraction of oil from the seeds and nuts. He strongly recommended that it should be systematically and commercially explored by Nepal. He requested the commercial banks and financial institutes to take keen interest in commercial production of plant oil energy in Nepal.

One year old Physic nut plant (Jatropha curcas L.) -- a source of oil energy

Nepalese Minister of State for Water Resources Sarbendra Nath Shukla giving an inaugural speech at the opening ceremony of the one day workshop on "Financial Investment Opportunity in Plant Oil Energy Development in Nepal

WECS' Executive Secretary Dr. Gobinda Dev Bhatta expressed that plant oil energy would be one of the potential components of sustainable rural energy for sustainable development of Nepal.



The Nepalese Oil Expelller

The Executive Director of the Green Energy Mission /Nepal Dr. Gyan L. Shrestha presented in detail the potential of plant oil energy, its research and development in Nepal. He also demonstrated that this plant oil energy should be developed by the least developed countries like Nepal as the cost effective, locally regenerative, environmentally friendly and sustainable alternative rural energy. He named this plant oil energy as "The Aboveground Petrol Mining of the Poor World". This workshop was concluded with the recommendation that Nepal should initiate commercial production of plant oil energy from the existing technology and natural plant resources under favorable national policies and planning. Commercial banks and financial institutes showed willingness in financial investment in exploring such aboveground petrol mining in Nepal.

(Contributed by Dr. Gyan L. Shrestha, Executive Director, Green Energy Mission/ Nepal)

International Seminar
"Financing and Commercialization of Solar Energy Activities in South and East Asia",
Kunming City, Yunnan Province, P.R. China
26-30 August, 1996

The first solar energy seminar for South and East Asia, held in Chiang Mai, Thailand in 1994, highlighted the "Prospects for Photovoltaic Systems in Thailand and Neighboring Countries". This event allowed an exchange of relevant information on solar energy applications that are in use and/or planned for by the respective countries within the region. This seminar recognized that solar energy technologies are significantly mature, pragmatic, environmentally sound, and highly appropriate for indigenous local conditions; however only marginally delivering the commercialization it promised within this favorable setting.

The rationale of the second seminar held in Yunnan was to focus on the potentials and constraints to achieve commercialization of selected solar energy technologies, particularly at a time when various activities are being proposed or nearing implementation within this region. This integral meeting proposed further strengthening the existing inter-regional linkages between the closely-related delegates, who have now formed a "Working Council on Sustainable Energy in the Mekong Region" by seriously viewing the requirements of elevating solar energy into a commercially favorable position across the region.

This second seminar was sponsored and organized by the Carl Duisberg Gesellschaft (CDG), on behalf of the Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung (BMZ), Federal Republic of Germany; the Yunnan Science and Technology Commission, the Institute of Scientific and Technical Information of Yunnan (ISTIY); and the "Working Council on Sustainable Energy for the Mekong Region"; in cooperation with the Regional Information Service Center for South East Asia on Appropriate Technology (RISE-AT); and the Solar Energy Research and Training Center (SERT), Thailand.

There were 70 delegates from ministries and institutes of energy, experts from research institutions, project planners, solar energy companies and distributors, representatives from financing and development planning institutions, who represented the following countries: Royal Kingdom of Cambodia, PR China, Laos PDR, the Philippines, the Kingdom of Thailand, SR Vietnam, Republic of Indonesia, India, Nepal, Sri Lanka, Finland, Australia, the United States of America, and the Federal Republic of Germany.

Delegates to the Kunming Conference

The content of the seminar strongly emphasized on financing strategies and proven mechanisms that are already in place within the South and East Asian Region, which have already encouraged the dissemination of solar energy technologies in some of the countries, who simultaneously have closely-related social, economic and environmental conditions with their neighboring partner countries. Presentations highlighted an identification of ways to pursue sustainable development goals, by identifying, evaluating and financing solar energy activities, through viewing project risks and feasible financing structures to direct funds from users to suppliers.

The delegates of the seminar arrived at the following conclusions after careful deliberations:

Global and South East Asian Perspective

- Solar energy is considered as the only known technology with global potential to ensure sustainable energy supply in the long term.
- There is an enormous renewable energy potential in South and East Asia due to the geographical conditions of the region, coupled by the large proportions of population who still do not have access to regular energy supply.
- Solar electricity has special advantages as a modular technology: it can be used as small stand-alone systems for individual households, as well as electricity generation units on larger power grids.
- The responsibility for the extra costs of solar energy devices (due to small production quantities) should be carried globally, as the scale-up of photovoltaic manufacturing serves the future sustainable energy supply globally. Simultaneously the provision of well-established joint programs among the South and

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SMALL SCALE WIND ENERGY SYSTEMS

Published with financial support from the Netherlands Ministry for Development Cooperation
Editors: Renewable Energy Development v. o. f.

EDITORIAL

As you can see, the September issue of "Small Scale Wind" is dedicated exclusively to windpumping. We have news from Egypt, India, and the Philippines. We have also an interesting article from Dan Davies, UK, who has recently concluded a Ph.D. work on the reduction of pump rod forces.

As the editors we feel that not everybody is acquainted with the backgrounds of windpumping and small wind electric business. We have therefore decided to start with a series of introductory notes, each of them dealing with a tiny bit of "small wind basics". Do not hesitate to give us your opinion about this and do not forget mailing us your news!

Jan de Jongh and Remi Rijs, editors

The Niche for Mechanical Windpumps (I)

Small-scale water supply in the rural areas usually involves very low power requirements. In many regions in the world, sufficient wind resources are available to attain these power levels by using a small, mechanical windpump. Even at moderate wind speeds, such a windpump can be more cost-effective than its competitors, the solar pump and the diesel engine.

Applications and Power Requirements

The water requirements for a number of typical applications are summarized in Table 1. These requirements determine the effective hydraulic power output $P_{av,hyd}$ given by:

$$P_{av,hyd} = \rho_w \, g \, Q' H \quad \text{[watts]} \qquad (1)$$

with ρ_w the density of water (1000 kg/m³), g the gravitational constant (9.8 m/s²), H the pumping head in meters and Q' the pumping rate in m³/s. If Q' is given in m³/day, the formula turns into:

$$P_{av,hyd} = 0.113 \, Q' H \quad \text{[watts]} \qquad (2)$$
(where Q' is in m³/day)

The volume-head product ($Q' H$) is a direct measure of the power requirement and is expressed in m⁴/day. A nett hydraulic power of 1 Watt continuous (during 24 hours) is equivalent to 8.8 m⁴/day, and 1 kWh_{hyd} is equivalent to 367 m⁴.

The requirements shown in Table 1 range from 10 m⁴/day to 1000 m⁴/day, equivalent to average hydraulic outputs of a few watts to about a hundred watts.

Windpump Output and Wind Resources

The average output of a wind energy system can be expressed by the following formula:

$$P_{av} = E / T = \beta V_{av}^3 A \quad \text{[watts]} \qquad (3)$$

In windpumping, P_{av} is taken to be the effective average hydraulic power $P_{av,hyd}$. It is related to the rotor swept area A and the average wind speed at the site V_{av} by introducing the (empirical) quality factor β. In field conditions, a value of β of 0.05 is acceptable, a value of 0.15 is excellent. An average value for a well-designed windpump is $\beta = 0.1$. It should be noted that a good quality factor, hence a high performance, is not obtained by choosing an efficient windpump design only. It also relies on how a windpump is matched to the site conditions (i.e. wind and water resources). And first of all it depends on the reliability of a windpump and the way it is maintained. This defines whether a windpump is actually available for pumping when it is required to do so.

(conts. on p. 2)

Table1. Indication of water depths, required daily volumes of water and typical rotor sizes for windpumps

Application	Head				Daily Volume [m³/day]	Typical rotor diameter [m]
	very low < 3 m	low 3 - 10 m	medium 10 - 30 m	deep > 30 m		
Community water supply			x	x	20 (500 people)	2.5 - 7.0
Domestic water supply			x	x	1 - 3 (small farm)	1.5 - 2.5
Cattle watering			x	x	20 (500 head)	1.5 - 4.5
Irrigation	x	x			40 - 100 (approx. 1 ha)	2.5 - 5.5
Drainage	x				100	2.5 - 3.5
Saltpans	x				1000	2.0 - 7.0

The GEF-ESES Windpump Project in Egypt

The Egyptian Solar Energy Society (ESES) has signed an agreement in September 1995 with the United Nations Development Program (UNDP) through its Global Environmental Facility (GEF) NGO Small-Grants Programme. ESES, which is a non-governmental organization, will design, manufacture, install and maintain four small-size wind turbines for water pumping in remote areas in Giza and other Governates in Egypt. The project duration as originally proposed is two years and the amount of donation received from the GEF program is US$ 28,000.

The members of the ESES team have developed a sophisticated new design of windpump which will hopefully be capable of pumping water at a rate of 3 m^3/h to 5 m^3/h depending on the depth of the wells and the available average wind speeds. The new machine has a 5 m rotor diameter, 6 blades each of 2 m length, and a 9.5 m tower. It is connected to the submersed piston pump by a crank-arm mechanism, and has a regulation system which prevents the wheel from exceeding 100 rpm.

Starting-up of the project is according a four-phase plan as follows:

- carrying out calculations, completing design and manufacturing drawings, and manufacturing of all components of the first windpump prototype;
- installing the machines on a strategic site where a lot of individual participants will see what they are and what their use is;
- selecting suitable villages interested in a windpump installation, based on technical conditions (adequate site and well flow) and on an economic basis too (financial involvement and establishment of a committee in charge of managing the maintenance fund);
- training of indigenous people.

The Society signed a constract with the Engine Factory (EF), which is considered as one of the biggest factories in Egypt. EF will manufacture under its reputed quality control the windpumps according to the specifications, designs and drawings offered and made by the Society. A variety of issues was put forward which are all related to manufacturing, and to some extent to maintenance and after-sales support. A market will only develop if the potential customers are confident that a suitable support structure such as the Engine Factory exists, for repairs and maintenance at affordable cost. This is vital to the project success.

From 14 to 16 April 1996, a wind energy workshop was held in Cairo with the objective of disseminating know-how and technology gained with respect to the new windpump design. The discussion was concentrated on the advantage of having both the transmission mechanism with a reduction speed ratio of 3:1 and the spring device mounted in the piston pump to keep the piston rod always in tension. Performance evaluation of the windpump will be the next phase before dissemination to the end-users. At the end of September 1996, a meeting will be held with local authorities, villages' representatives, financiers' representatives, and NGOs. The focus during this event will be on the conditions for providing and setting up a windpump for the villagers, and on their financial contributions.

(Hisham El Agamawy, Egyptian Solar Energy Society (ESES), P.O. Box 487, Dokki - Egypt, Fax: (202)781 236)

(contd. from p. 1)

The rotor area is a good indicator for the total cost of a windpump system. Eq. 3 shows that, for a given rotor size, the delivered output increases rapidly with the average wind speed at a site. At higher wind speeds, the same amount of water can be pumped by using a smaller and cheaper windpump. The price of unit water will then be lower and the windpump will be more cost-effective. It is now widely accepted that windpumping is economically feasible at sites where $V_{av} \geq 3$ m/s, in some cases even down to 2.5 m/s. Such average wind speeds are very moderate and are found at many sites in the world.

A Niche for Windpumping

Mechanical windpumps can fill the gap between the smaller handpumps and the larger electrical or engine-driven systems. This is depicted in Fig. 1.

At the lower end of the scale (below 100 m^4), there is no deal in competing with the simple and much cheaper handpump. At the higher end (above 1000 m^4), the increased technical complexity makes mechanical windpumps less cost-effective and less reliable. In fact, 2500 m^4/day is about the upper output limit feasible for mechanical windpumps.

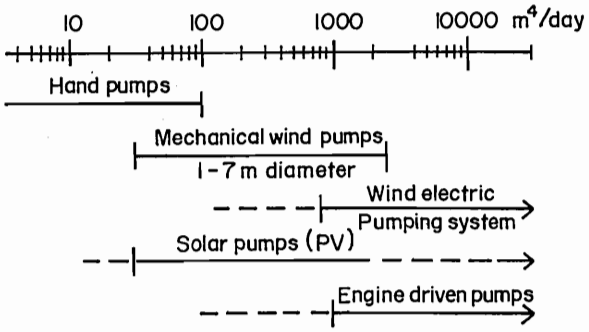

Fig. 1. The niche for mechanical windpumping versus other pumping techniques.

Engine driven pumps are uneconomical at very low requirements because they are not designed for these output levels. Diesel pumps do not exist below 2 kW rated power and are used at part-load and intermittently. Solar pumps can be applied for a wide range of power requirements, due to the modular character of the solar panels.

At larger demands, wind power may be used to generate electricity to drive a motor/pump combination. Such equipment is commonly refered to as a Wind Electric Pumping System (WEPS) and can be attractive at average wind speeds of 5 m/s and higher.

(Source: BWEA/RAL Workshop - "Technology and Implementation Issues Related to Renewable Energy Systems in Developing Countries", ISBN 1 870064 25 9, Abingdon, United Kingdom, June 1995)

The Reduction of Lift Rod Forces in Piston Pumps

One of the greatest barriers to the uptake of windpump technology is that of reliability. This is particularly true of the smaller, lighter "second generation" of machines which tend to run at much higher speeds than their larger, multi-bladed, counterparts. This high speed operation can make the loads in the lift rod excessive. For example, the French organization GRET (working in Mauritania) reports that 42% of failures on their 2.5 m diameter machines are due to overloading of the lift rod.

During the pump cycle, at a point after the bottom dead center the piston valve closes. Suddenly the upward moving lift rod has to accelerate a stationary mass of water up the rising pipe. The peak loads which occur as a consequence of this acceleration can be five or six times the load due to the static head of water.

Under a project funded by the U.K. Engineering and Physical Sciences Research Council the dynamic behavior of a reciprocating piston pump has been investigated. The inclusion of varying degrees of softness in several of the windpump components has been shown to greatly reduce the peak lift loads.

The inclusion of a small amount of flexibility into the lift rod, such that it stretches by around 10% of its length when supporting the static head, can be sufficient to almost half the peak lift rod load at high speeds. One major benefit of this technique for improving the longevity of a windpump is that it can be easily retrofitted to any machine.

A more complex alternative is to use an air chamber to smooth the flow fluctuations up the riser pipe and therefore prevent the accelerative loading of the system. An air chamber system, making use of the bladder from a very small hydraulic accumulator connected to a large volume of air held inside the lift rod has proven to be very successful (Fig. 1). The bladder provides storage for 55% of the swept volume. The back-up chamber holds a volume of air five to six times the swept volume. The material is impermeable to water and air and is easily sealed. The bladder is designed to survive 10 million cycles, enough to outlast the piston seal. This device has the additional benefit that it will perform better with a restricted riser pipe.

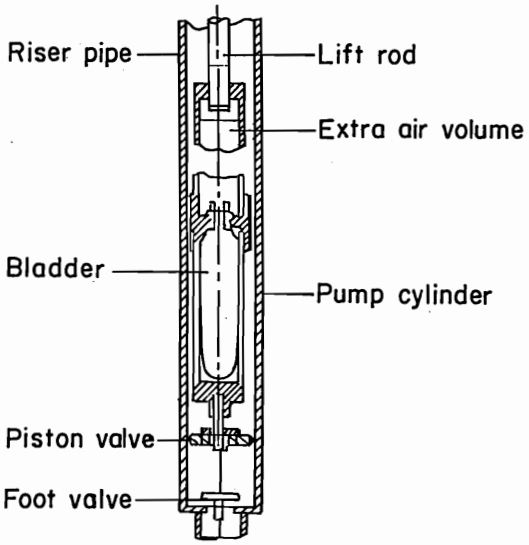

Fig. 1. Enclosed air chamber for flow smoothing. The bladder accumulator with back-up softness are both mounted on the lift rod immediately above the pump.

Another solution, which is often prohibitively expensive or too complex for the smaller machines, is to reduce the speed at which the pump operates. A novel realization of a drive mechanism originally used by the Canadian Brantford windpump at the turn of the century has been built and tested at Reading. This device translates the rotational speed of the rotor shaft into a long slow reciprocating motion using two duplex sprockets and a length of duplex chain with carrier plates.

These simple technologies can greatly reduce the peak load suffered by the lift rod and the above ground windmill structure and offer the possibility of reliable fast running wind powered water pumps.

(Dan Davies, University of Reading, Department of Mech. Engineering, Whiteknights, P.O. Box 225, Reading, RG6 6AY, United Kingdom, Fax +44(1734)313 327)

Windpumps and Drip Irrigation: Success Stories from Gujarat, India

In continuation on the article in the previous issue of "Small Scale Wind", Mr. Pradib Rajeshirke reports about the experiences of some windpump users in Gujarat. Users should not passively await another government program, but take intiatives and get familiar with windpumping. Only direct user involvement, he concludes, can make windpumping in India successful.

Mr. Kantibhai Kataria, a small garment merchant in Rasulabad (Vadodara) reports an average monthly income of Rs. 5,000 (US$ 150) on his plantation since he started using a windpump to irrigate his 1.5 ha farm in September 1995. He smiles: "I have no electricity and neither is a connection in the near future within my reach. But that's no longer a problem, and now that I have learnt to use it correctly and manage it on my own, it is a blessing in disguise".

Inspired to install the windpump on the advertizement released by GEDA in that year, Kataria decided to invest Rs. 15,000 (US$ 450) as a contribution to the total cost of Rs. 44,000 (US$ 1,300) given as a central and state subsidy. He replies that this is a one time investment. Before, he paid a daily amount of Rs. 250 (US$ 6) in winter and double the amount in summer to water mango, coconut, papaya, banana, lemon and other seasonal vegetables.

Kataria's perseverance and personal initiative have played a crucial role. In the first year of installation, the manufacturer (Marut Energy Equipment, Pune) came regularly every three months to service Kataria's windpump. He taught him how to take care of basic maintenance, greasing of moving parts, changing oil, changing washers, and so on. Kataria proudly states: "I can do all these things myself. I am alert to any abnormal sounds and carefully watch the water

(contd. on p. 4)

Wind Energy Developments in The Philippines

As a step in the direction of harnessing wind resources, the Philippines' Department of Energy through its Non-Conventional Energy Division (DOE-NCED) has formulated a comprehensive New and Renewable Energy Program to accelerate the development, promotion and commercialization of new and renewable sources of energy in the country. The philosophy "awareness creates demand" has triggered DOE to conduct a massive information campaign to stimulate alternative sources of energy. To this aim several activities have been undertaken by the Department.

Recently, series of training workshops on wind energy were conducted by DOE and RED Renewable Energy Development in The Netherlands, and financially supported by the Dutch University of Twente. These workshops aim to establish institutional and technical capacity at the national level to develop the exploitation of wind energy as an integral part of the Philippines' Power Development Program. Seeing the need to address the issues on the opportunities and barriers in the development of the wind energy market, the Wind Energy Association of the Philippines (WEAP) was organized. The WEAP in coordination with the Department will be the focal point for wind energy activities. Initially, the association will concentrate its actions on windpump development and later divert to electricity generating wind turbines.

There is some tradition for water pumping windmills in the country. The most known windpump is the Reymill Windmill in Santa Rosa, Nueva Ecija. Over 200 units of this brand have been installed, which has made the village to the country's "windmill town".

Until now, the application of wind turbines for power generation in the country was limited to pilot-scale attempts. Despite previous failures, DOE together with the government-owned utility National Power Corporation (NPC) continues to harness wind energy. NPC and the Department of Science - Philippine Council for Industry, Energy Research and Development (DOST-PCIERD) have set up a 10 kW pilot project in Pagudpud, Ilocos Norte to demonstrate the viability of wind energy for village power. Likewise, field monitoring equipment was installed on several locations to collect data for future activities.

Also, DOST and the US-Department of Energy have started the "Philippine Wind Mapping Project" which will be implemented by REPSO and aims at developing a wind resource atlas of the country. Finally, the UNIDO study entitled "Assessment of Technical, Financial and Economic Implications of Wind Energy Application for Electricity Generation", will definitely contribute to a widespread acceptance of wind energy in the daily life of the Filipino people.

(Rodela Romero, Department of Energy, Non-Conventional Energy Division, PNOC Complex, Merritt Rd., Fort Bonifacio, Makati, Metro Manila - Philippines, Fax: 632-818 8614)

(contd. from p. 3)

output so that I can spot problems before they magnify into major issues. But the real secret is the careful use of the water pumped by the windmill. I have coupled my wind pump with a drip irrigation system. An even moisture supply in the soil is critical for good crops to convert this barren orchard into a prosperous abode.

In Dediapada village, Bharuch district, another farmer coupled his windmill with a drip irrigation system to water his 'ber' orchard. He claims a profit of Rs. 40,000 (US$ 1,200) in just one season. His success has led to a boom in the demand for windpumps in this area. His neighbor who cultivates a rose garden, has recently invested in a similar system. As both plants require steady water supply for promising yields, the drip technology meets the needs perfectly.

Mr. Balubhai Bhadani, a farmer in Junvader village (Bhavnagar district), irrigates his 1 ha farm to produce three-seasonal crops (pomegranate, bajri and chillies) since he installed his windpump in August 1993. The micro-irrigation application today, fetched him an economic return of over Rs. 40,000 (US$ 1,200) in the last two years and reduces the drudgery of watering the crops. He is very pleased with his windpump as it demands low maintenance and his operating expenditure amounts to about Rs. 200 (US$ 6) for the expenses on oil. "I would advise every farmer to install such a device where you have to only rely on the wind god".

(Pradib Rajeshirke, Gujarat Energy Development Agency (GEDA), IInd floor, Suraj Plaza -II, Sayajigunj, Vadodara - 390 005, India, Fax: +91 (265) 333 120)

"Small Scale Wind Energy Systems" is a quarterly publication of the Regional Energy Resources Information Center (RERIC), AIT, Bangkok, Thailand. It is distributed as a supplementary sheet with the "RERIC News" and by direct mailing. Citation is encouraged on the condition that the source is indicated. For subscription, articles or reactions please contact the editors: Renewable Energy Development v.o.f., PO Box 513, WS 1.49, 5600 MB Eindhoven, The Netherlands. Fax: +31(40)246 41 51. Tel.: +31(40)247 31 91. E-Mail: ydir@tnf.phys.tue.nl.

Publication does not imply agreement of the editors. Contributions should preferably not be longer than 300 words. For longer articles please contact the editors. The editors reserve the right to shorten reactions and articles.

East Asian Countries will have a far stronger influence on an international forum than any individual project alone.

Financing

- With limited and diminishing fossil fuel sources, greater awareness to decision makers is extremely important for considering the use of renewable energy resources, not only as a technology for remote rural areas, but also as a mature technology to be applied on a wider scale.
- Basic financing structures of implementing solar energy should be developed as a part of implementing national energy plans.
- Greater awareness of such alternative energy solutions is unlikely to emerge from in-country institutions, thus private sector initiatives should be encouraged to activate project development into the existing institutional and policy framework.
- Delegates agreed on the future task to combine existing bilateral and multilateral financing instruments, in order to introduce and disseminate large numbers of decentralized solar energy systems in rural areas, as well as large installations for urban and industrial energy supply.
- Delegates will approach their respective governments as well as donor agencies, for the provision of equity and loans for setting up rural energy service companies.
- In case where financing institutions and banks are restricted from granting loans to users and manufacturers of solar energy systems, the respective countries and responsible agencies should review their legal instruments in harmony with financing instruments to promote solar energy activities in their countries.

Commercialization

- Solar energy system manufacturers and suppliers are asked to provide comprehensive energy services, adopted to well defined consumer needs, and not only to sell energy technology.
- This requires an exact matching between climatic conditions, system layout and expected energy services. However, this approach needs a supportive governmental regulation system, as well as services with tailored financing mechanisms.

Strengthening Cooperation

- It was also noticed that the responsible institutions for the application, promotion, planning, and financing for solar energy are unclear, overlapping and scattered. Thus it is advised that the responsible institutions for areas be clarified, to enable a better understanding of the relevant channels to streamline efforts for project initiation and development.
- Mutual cooperation, the exchange of know-how, as well as the promotion of program activities for supporting renewable energy technologies among the countries forming the "Working Council on Sustainable Energy for the Mekong Region" should be further strengthened. Appropriate communication technologies, such as electronic mail, discussion groups and document distribution should be established.
- The support of member countries in neighboring countries of the "Working Council on Sustainable Energy for the Mekong Region", expressed their sincere intention to continue cooperation and exchange information for on-going and future activities in the field of solar energy development and promotion in South and East Asia.
- Besides the regional cooperation amongst the countries in South and East Asia, delegates would also welcome the setting-up of National and local Energy forums to create public awareness among policy makers, promote the application of solar energy technology, elaborate positive framework conditions, and foster human resource capabilities.

The organizers of the seminar were most pleased with the seminar outputs. There was stimulating discussions for policy advocacy, as well as positive networking and a variety of means of information dissemination. Ultimately there was a closer bond between the delegates to collaborate for inter-regional solar energy activities for the betterment of people and the environment of south East Asia as a whole. A third seminar on the application of solar energy for South and East Asia is now proposed to take place in 1997 in Hanoi, SR Vietnam.

Finally, the delegates of the International Seminar expressed their sincere thanks to the donors for their support.

(Contributed by Assoc. Prof. Wattanapong Rakwichian, Director of SERT)

Hydro Power Development in India: A Move Toward Privatization

Out of India's 84 044 MW of estimated economically-exploitable hydro potential, less than a quarter is currently being developed. In terms of energy units (kWh), the total potential is estimated to be 600 bn units per year. Much scope exists for further development. And with rapid socio-economic development, India is suffering from acute power shortages.

There is currently an imbalance in hydro:thermal mix in power generation. From a high of over 50% in 1962-63 in the total power generated, the share of hydropower steadily decreased to its present 26% level. It is felt that the sector should aim at a 40:60 hydro to thermal (including nuclear) mix. Reasons for this slackening in hydropower development include lack of resources with state electricity boards (SEBs) and inadequate cashflow; problems related to land acquisition, rehabilitation of oustees, strict regulations on environment and forest production; inter-state river disputes and political interference and the longer gestation period of hydropower projects. To boost SEBs in this area, the Government of India set up a number of corporations, which it wholly or partly owned, during the 1970s and 80s, to undertake big hydropower projects. However, these too suffered from lack of resources.

When the Government decided to open up the power sector for private promotion

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and investment, the package of incentives, took into account the need to encourage investment in hydropower and bring down the hydro:thermal imbalance in the power generation mix.

There has now been a very encouraging response by private promoters, including both wholly privately-owned and joint venture (in partnership with an SEB) project proposals. While a number of such proposals envisage big water storage reservoirs, it is expected that hydro projects in India will increasingly be run-of-river.

Another area increasingly attracting the attention of private investors is small (2-15 MW), mini (0.1-2 MW) and micro (up to 100 kW) hydro schemes and many state governments have been inviting private investment. Another promising area is retrofitting and uprating (R & U) of existing hydropower plants. Fifty seven such stations with installed capacity of 10 000 MW, have been earmarked for this treatment. There are various options open to a private investor in the R&U area: a lease-rehabilitation-operate-transfer, outright purchase of assets, or a joint venture with the SEB/owner-utility.

Given the potential and need for the hydro development, India has earmarked a package of incentives to attract investors in the country.

- no restrictions on the size or type of power projects through private investment
- for a project approved as a result of international competitive bidding, no clearance from the Central Energy Authority (CEA) would be required where the project cost does not exceed Rs 4bn (US$130M). For a project obtained in any other manner, the waiver operates where cost does not exceed Rs 1bn (around US$32 million).
- a new private power company would be allowed debt:equity ratio of 4:1, with up to 100% foreign equity participation permitted
- import of power equipment is permitted and customs duty has been reduced to 20%
- there is no condition to balance the outgo as a result of devidend by earning through export, as is generally imposed on foreign ventures in other sectors in India
- a 16% return on equity has been provided, with an option to designate it in the currency of the subscribed capital (to guard against exchange rate fluctuations)
- the rate of depreciation for assets has been liberalized
- for power plants commencing commercial operations before 31 March 1998, a tax holiday in respect of 100% taxable profits for the first five years and 30% taxable profits for the following five years has been allowed and
- generating companies would sell power on the basis of a suitably structured two-part tariff. Earlier provided only for thermal plants, this concept was extended to hydropower projects also, with effect from January 1995. A government committee is currently (March '96) reviewing the existing tariff formulation rules in the light of experience and feedback received till now.

(Source: Salai, I. M. 1996. Wooing the Investor. *International Water Power and Dam Construction*. April:28)

RESEARCH ACTIVITIES

The Energy Program, School of Environment, Resources and Development Asian Institute of Technology

- Electrical load forecasting in the Vientiane area: An application of a simulation model
  Researcher: Boungnong Bouttavong
  Advisor: Dr. R.M. Shrestha

- The use of direct beam sunlight for deep interior illumination
  Researcher: Siriwat Chedsi
  Advisor: Dr. Surapong Chirarattananon

- Integrated evaluation of pressurized fluidized bed combustion (PFBC) generation technology in the Taiwan Power Company's generation system
  Researcher: Chen Yi-Tong
  Advisor: Mr. J.B. Heredia

- Electric vehicles as a transportation option for Kathmandu valley: The economics of and implications for electricity planning and the environment
  Researcher: Shobhakar Dhakal
  Advisor: Dr. R.M. Shrestha

- Emissions from biomass energy systems in Thailand
  Researcher: Tanawat Chaiwatanarat
  Advisor: Prof. S.C. Bhattacharya

- A demand-side program on lighting and air-conditioning for Taipower
  Researcher: Chu Chia-Hsing
  Advisor: Dr. Surapong Chirarattananon

- Impacts of lifestyle and poverty alleviation policies on the energy demand of the residential and commercial sectors in Hochiminh City, Vietnam
  Researcher: Dien Quang Hieu
  Advisor: Prof. T. Lefevre

- The EMTP and the analysis of protection against lightning impulse for a 500 KV substation
  Researcher: Fang Min
  Advisor: Prof. Cun Yi Yu

Book Reviews

Fundamentals of Cogeneration

Brahmanand Mohanty and Aung Naing Oo Published by Energy Program, School of Environment, Resources and Development, Asian Institute of Technology, P.O. Box 4, Klong Luang Pathumthani 12120, Thailand. ISBN 974-8256-59-6, 1996, 117p.

The book is aimed at those readers who may not be familiar with the fundamentals of cogeneration and who may like to gain some basic knowledge before carrying out cogeneration feasibility study and project implementation. It covers the technical, economic and environmental aspects of cogeneration.

The introductory chapter covers basic concepts and definition of cogeneration, how does it make sense, where can it be applied, what are its benefits and what are the promising options available. The second chapter gives a technical overview covering different classifications, important technical parameters, incorporation of cooling and thermal storage system and project evaluation. Fundamentals and performances of Gas Turbine Cogeneration Systems and I.C. Engine Cogeneration Systems are covered in Chapter III and IV, respectively. Other important aspects like economic and financial aspects, environmental aspects, and policies and regulations of selected countries that favor cogenerations over the conventional systems, current obstacles and bright future for development of cogeneration systems are the topics covered by Chapters V to VIII. The final chapter IX presents two case studies on a commercial building and a textile factory.

The many illustrations and worked out examples given in the book makes it a very useful, easy to follow book for readers interested in cogeneration systems.

(The book is being distributed by RERIC and persons interested in copies are requested to contact RERIC in the address given at the end of this newsletter - Editor)

Energy End Use An Environmentally South Development Pathway

Published by Asian Development Bank, P.O. Box 789, 1099 Manila, Philippines. ISBN 971 561 013 7, xv + 244p.

Asia is in the midst of an electricity crisis resulting from booming economic growth that led to rapid growth in the use of energy. If energy supply capacities are to be expanded without promoting more efficient use of energy, the amount of capital invested is likely to eclipse the economic growth it seeks to sustain. An estimated US$500 billion will be used by 14 Asian countries (excluding Japan) for generation, transmission and distribution of power in this decade alone. And China and India are expected to account for 80% of the Asian total. The social and environmental problems associated with this expansion are enormous.

Now the technological innovations on energy efficiency have changed the relative costs of power generation and electricity conservation measures so that conservation is often cheaper than building new plants. This book covers a study that was developed through a collaborative effort between the Energy and Industry Department and the Office of the Environment of the Asian Development Bank (ADB) to illustrate potential energy savings in India through energy end use. India's power demand has grown 10% per annum and is likely to grow in the same pace for the next decade. The simplest way of meeting this demand is perhaps to use electricity more efficiently. Improvements in electricity end-use efficiency offer a cost effective and environmentally sound way of meeting the growth in India's demand.

This book emphasizes the end-users of electricity. It also looks at the transportation sector which accounts for the bulk of the petroleum used in most countries, and at cooking, which is one of the most basic energy needs and accounts for most of the biomass use in most developing countries. Chapters 2 to 6 look at several important end uses of electricity - lighting, residential appliances, pumping water, and industrial motors. Chapter 7 deals with Least-cost Electricity Planing and how the emphasis from the traditional supply-side orientation towards a least-cost strategy. The energy use in the transportation sector and its environmental implications are covered in Chapter 8. Bioenergy Alternatives for Cooking is the topic for Chapter 9. Finally, the book is completed with a chapter on barriers of energy efficiency, and interventions, strategies and current programs.

Although this book deals with the energy end-use situation in India, the book leads to formulating energy strategies that are compatible with, and contribute to, the solution of the other major problems - including North-South disparities, the poverty of the majorities in the developing countries and of minorities in the industrialized countries, environmental degration, the threat of global climate change etc.

Integrated Development and Economics of Energy Projects--A Reference Handbook

by Juan S. B. Heredia, Asian Institute of Technology, Bangkok, Thailand.. ISBN 974-8256-56-1, 1996, xix+274p.

The close dependency that exists between energy consumption, natural resources demand, environmental pollution and economic development has induced institutions worldwide to develop mechanisms for the planning and policy of the energy sector, in order to help them, as well as involved companies and entities, in the decision making process concerning the utilization of the different resources employed in the development of this sector.

Energy project development is a spe-

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cific, concrete activity; hence, when the energy planning and policy mechanisms are applied to a project, they materialize into specific units, for the effective management of the energy supply or the energy demand.

This handbook is a tool appropriate for use as a reference by decision makers, academic and consulting professionals, as well as for students of post-graduate programs in the energy sector. It refers to the development stages and analytical procedures of projects in this sector, for the assessment of their viability, their final approval and their financing.

The work is composed of three parts. The first part deals with the definition and discussion of the integrated development of energy projects. It includes the energy project context, whose target is to identify and define the project system environment and each of its components, as well as the interlinks and dependency aspects that characterize the latter. It also discusses the different phases of an energy project development, starting with the energy sector planning and the energy project identification, project analysis at different levels, and ending with the process of project evaluation after it is in operation.

The second part deals with the economics of energy projects, which includes a discussion of project characteristics as well as a complete development of the economic and financial analysis of projects, clearly emphasizing their conceptual and practical distinction and adapting analytical methods to properly tackle these subjects. The project financing process and project implications in the financial statements and on the profitability and solvency of utilities or energy concerns are also analyzed in this part.

The third part includes extensive discussions on project implications and project implementation limitations, related to its environmental components, particularly, ecological, socio-economic, institutional and administrative.

Finally, a complete practical case is included that illustrates the different subjects covered in this handbook.

For further information, please contact:

Mr. Huan S. B. Heredia
Neufelstrasse 16, 5430 Wettingen
Switzerland
Tel: 001-41-21-323 5053

Copies are available at:

Environmental Systems Information Center (ENSIC)
P.O. Box 4, Klong Luang,
Pathumthani 12120, Thailand
Tel: 66-2-524 5863, Fax: 66-2 524 5870
Email: enreric@ait.ac.th

RERIC Human Resources Development Programs

In keeping with the objective of promoting energy efficient technology and energy conservation in buildings and industries, the **Regional Energy Resources Information Center (RERIC)** is pleased to organize the following training courses.

MODULE 1: February 6 - 8, 1997
Computer Assisted Designing of Energy Efficient Buildings

This module will be based on a pedagogical software for buildings called CASAMO developed by the French Environment Management Agency (ADEME) and the Energy Program, Asian Institute of Technology (AIT). CASAMO is a computer tool for designing buildings with pleasant thermal comfort conditions or low energy consuming air conditioning, or for calculating the dimensions of an air conditioning system. The participants will be exposed to various aspects of building design (e.g. evaluating the comfort conditions in a building; calculating cooling loads when air conditioning is required; calculating the dissipated heat gain in an enclosure, solar radiation input or casual gains, and determining the effect of the building's inertia).

MODULE 2: February 10 - 12, 1997
Techno-economic Optimization of Cogeneration, District Heating/Cooling and Thermal Energy Storage

This module will be based on a software for Combined Heating, Cooling and Power Generation called Total Energy Supply (TES) also developed by AIT with the support of ADEME.

The TES software was conceptualized with the integrated energy systems approach for buildings and industries where electrical and thermal requirements co-exist. It allows to conserve energy and reduce energy cost by combining energy services in a central supply facility. It determines the techno-economic viability of a particular Combined Heating, Cooling and Power Generation (CHCP) technology.

The participants are expected to hold a minimum of Bachelor's degree in their respective fields.

COURSE DIRECTOR

Dr. Brahmanand MOHANTY is an Associated Faculty in the Energy Program of the Asian Institute of Technology (AIT), and also Regional Adviser for Asia of the French Environment and Energy Management Agency (ADEME). He holds a Doctorate in Energy from the Institut National Polytechnique, Toulouse, France. His experiences include:

- Specialization in energy efficiency and management in industries and commercial buildings
- Teaching post-graduate students and training of trainers in the fields of rational use of energy, energy management and energy recovery systems
- Development and dissemination of pedagogical tools for optimization of energy systems
- Co-operation and project development with national energy efficiency agencies in Asian countries
- Consultant to projects funded by national and international agencies and the private sector
- Analysis of energy efficiency policy making and implementation experiences of energy authorities in Asian countries

He is a member of the Editorial Board of the *Journal of Energy, Heat and Mass Transfer*, American Society of Heating,

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Module 1: Computer Assisted Designing of Energy Efficient Buildings

Time	Thursday, February 6, 1997	Friday, February 7, 1997	Saturday, February 8, 1997
8:30 - 10:30	Opening Ceremony Course Introduction Features of Energy Efficiency in Buildings	Case Study I: Design Improvement of a Building in Rio de Janeiro, Brazil	Group Project: Preparation of Data Sheets Required for CASAMO
10:30 - 12:00	Thermal Comfort and Energy Efficiency in Buildings	Case Study II: Design Improvement of a Building in Carla-Bayle, South of France	Group Project: Simulation of Building Performance Using CASAMO
13:30 - 15:00	Introduction to CASAMO Software	Case Study III: Design Improvement of a Building in M'zab, Algeria	Group Project: Parametric Study to Improve Building Performance
15:30 - 17:00	Hands-on Training on Computer using CASAMO	Discussion: Building Design Parameters in Tropical Humid Climates	Group Presentation of the Results of Simulation Discussion and Conclusion

Module 2: Techno-economic Optimization of Cogeneration, District Heating/Cooling and Thermal Energy Storage

Time	Monday, February 10, 1997	Tuesday, February 11, 1997	Wednesday, February 12, 1997
8:30 - 10:30	Opening Ceremony Course Introduction Fundamentals of Cogeneration I	Introduction to Total Energy Management Software (TES)	Group Project: Preparation of Data Sheets Required for TES
10:30 - 12:00	Fundamentals of Cogeneration II	Hands-on Training on TES and Sensitivity Analysis	Group Project: Simulation of Optimal Cogeneration System using TES
13:30 - 15:00	Combined Heating, Cooling and Power Generation (CHCP)	Case Studies I & II: Cogeneration in an Office and a Hospital in Malaysia and the Philippines	Group Project: Parametric Study to Improve Project Feasibility
15:30 - 17:00	How to Conduct Feasibility Study of CHCP	Case Studies III & IV: Cogeneration in a Hospital in the Philippines & Thermal Storage in an Office in Thailand	Group Presentation of the Results of Simulation Discussion and Conclusion

Refrigerating and Air Conditioning Engineers (ASHRAE), and Association des Ingenieurs de Climatisation, Ventilation et Froid (AICVF). He has published over 60 papers in the field of energy efficiency and management in international journals, conferences and workshops.

The course fees for each module is US $ 800. A licenced copy of the software with the accompanying user and reference manuals will be provided to each participant at the end of the course. Registration should be made early to secure a place in the courses or by January 15, 1997 at the latest.

Application forms and other details of the courses can be obtained by writing to:

Manager
RERIC/AIT
P.O. Box 4, Klongluang
Pathumthani 12120,Thailand
Tel: (66-2) 524 5866
Fax: (66-2) 524 5870
Email: enreric@ait.ac.th

International Events

INSIDE ASIA

22 - 26 December, 1996, Regional Workshop on Rural Electrification through Photovoltaic Systems and Rural Energy Planning with Renewables, Dhaka, Bangladesh.

Contact:
Prof. Muhammad Ibrahim
Secretary, Organizing Committee
Renewable Energy Research Centre
Faculty of Science
University of Dhaka, Dhaka
Bangladesh
Tel: 880-2-811898
Fax: 880-2-803559
cmes@drik-bgd.toolnet.org

6 - 10 January, 1997, The 3rd International Conference on Solar Cookers Use and Technology, Avinashilingam Institute for Home Science(Deemed University), Coimbatore, Tamil Nadu, India.

Contact:
3rd Int'l Conference on Solar Cookers
c/o Chancellor of Rajammal Devadas
Avinashlingam Deemed University
Coimbatore 641 043 India
Tel: 91-422-440 140
Fax: 91-422-438 786

8 - 10 January, 1997, Passsive and Low Energy Archtecture, Kushiro, Japan.

Contact:
Secretariate
PLEA 1997 Kushiro Conference
Kushiro, Japan
Tel: +81-33798-5122
Fax: +81-33798-5130

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13 - 19 January, 1997, Technical Exchange Conference of Solar & Biomass Energies, Haikou City, Hainan Province, China.
Contact:
Mr. Song Yuhua
Director of DCAST
No. 13, Block 4, People South Road
Chengdu 610041, China
Tel: 028- 5541487
Fax: 028-5212250

22 - 24 January 1997, The 20th Annual International Conference on Energy and Economic Growth - Is Sustainable Growth Possible?, New Delhi, India.
Contact:
Dr. Leena Srivastava
Dean, Policy Analysis Division
Tata Energy Research Institute
Habitat Place, Lodhi Road
New Delhi - 110 003, India
Tel: (91-11) 462 2246
Fax: (91-11) 462 1770

3 - 7 February 1997, First International Conference on Renewable Energy - Small Hydro, Hyderabad, India.
Contact:
CVJ Varma, Secretary
Int'l Association for Small Hydro,
CBIP Building
Malcha Marg, Chanakyapuri
New Delhi - 110 0221,
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10 - 11 April, 1997, Offshore Wind Energy in the Mediterranean and other European Seas (OWEMES '97), Sardina, Italy.
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8-11 July, 1997, 1997, ACEE Summer Study on Energy Efficiency in Industry, "New Industry will Procure Energy Efficiency Services in the 21st Century", New York, USA.
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Wood Energy, Forests and Global Climate Change

Biomass has been used as fuel for millennia. Until the mid-19th century, biomass dominated global energy consumption. Although the share of biomass has declined steadily over the century, it still contributes 14% of the world energy and 35% of the energy in developing countries. Wood fuels remain the most prominent biomass energy source. Only 11% of the world's forests are managed for goods and services. In recent years, serious environmental concerns like global climate change, acid rain and the deterioration in local air quality from the use of fossil fuels have revived the interest in biomass energy as a renewable, sustainable and environmentally benign energy source.

In developing nations, substantial biomass use in coming decades is anticipated to continue in the rural and traditional sectors in the wake of the persistent short supply of commercial fuels to meet the ever growing needs of the economies of these countries. Most biomass used in developing countries is collected or home grown by the households. It is used very inefficiently in traditional stoves with 10% conversion efficiency. Organized production of wood fuels (through commercial or co-operative sectors) and modernized conversion has the potential to make wood fuels a competitive commercial fuel vis-à-vis fossil fuels. Besides, decentralized biomass energy plantations have benefits like promoting rural industries, rural employment generation and curbing urban migration. Besides, energy plantations can become means to restore deforested and degraded lands in tropical and subtropical regions.

Carbon Emissions and Mitigation

CO_2 emissions from fossil energy consumption in 1990 are estimated to be about 6 (plus or minus 0.5) PgC (Petagram Carbon or billion tons of carbon). The following are some important statistics related to carbon emissions:

i) average estimates of carbon emissions, from human activities suggest that during 1850 to 1986, 195 PgC was released by fossil fuel burning and 117 PgC by deforestation and land use change,
ii) average annual emission of carbon during 1980's decade are estimated to be 5.4 PgC emissions from fossil fuels and 1.6 PgC from deforestation and land use change,
iii) concentration of atmospheric CO_2 increased from 288 ppmv (part per million volume) to 348 ppmv during 1980 to 1990, and
iv) carbon emissions contributed 55% to the change in radiative forcing during this period.

Wood constitutes both the sink and source of atmospheric CO_2. Carbon is absorbed by trees through photosynthesis, and is emitted while burning either by natural or anthropogenic causes, or through decomposition. The world's forests cover 3.4 billion hectares of land, about a fourth of the earth's surface. These forests store 340 PgC in vegetation and 620 PgC in soil.

The composition of global carbon emissions suggests that emissions from land use change have continued to rise and nearly equal a quarter of the fossil fuel emissions. The average annual deforestation in the 1980's decade in the tropics alone was 15.4 million hectares and this accounted for 75% of the net addition of 1.6 PgC to the carbon flux from all land use changes. Eliminating deforestation thus can reduce carbon emissions equivalent to 1.2 PgC annually. Evidently, decreasing the rate of deforestation is one very effective carbon mitigation option.

Carbon Sequestration

Fossil fuels continue to emit large quantities of carbon. Stabilization of atmospheric CO_2 will require either a large reduction in fossil emissions or sequestration of excess carbon by managing the forests. Deforestation has far exceeded afforestation (ratio of 8.5:1) in the tropics during the 1980's. The new plantations however are increasing rapidly. It is estimated that globally about 100 PgC (similar to the amount of carbon released over the last century) can be sequestered over the next century by a significant increase in the area (between 345 to 1,000 million hectares) of forests. The largest and

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most suitable areas for afforestation are in the tropics. Here, the growing population pressure may create a food versus fuel conflict unless the afforestation areas are carefully chosen from already deforested and degraded lands.

Forest and wood management options for C (carbon) conservation and sequestration can potentially make forests the net sinks of carbon. Some prominent options are:

i) controlling deforestation (including from causes like fire and pests),
ii) enhancing storage of carbon by reforestation and afforestation,
iii) increased combustion efficiency of wood fuels,
iv) substitution of wood fuels for fossil fuels and of wood products for other materials, and
v) increasing carbon stock within existing forests.

Wood products currently hold 25 PgC and it is possible to increase this amount by a factor of more than two by substitution of other materials by wood. Carbon sequestered in global annual wood production is currently estimated at 1 PgC. The most promising long-term solution to the energy and carbon emission problems is the replacement of fossil fuels by sustainably produced wood fuels. Estimates suggest that production of biomass for energy (including wood and energy crops) has the potential to offset fossil fuel emissions by 1-4 PgC annually by the middle of next century. Wood for fossil fuel substitution reduces carbon emission permanently, while afforestation withdraws carbon from the atmosphere only for a few decades. Wood management practices thus offer the most promising future carbon mitigation options.

Due to deforestation and degradation in tropical regions, Asian forests are net emitters of atmospheric CO_2. Considerable potential for C conservation and sequestration exist in Asian forests by adopting appropriate forest management practices. Studies suggest that by the year 2050, 24 PgC can be conserved or sequestered on the 214 million hectares (Mha) of forest land (133 Mha plantations and agroforests, 33.5 Mha for slowed tropical deforestation and 48 Mha for natural and assisted regeneration of tropical forests) on the available land in Asia which is about a third of the mitigation potential from the world's forests. Initially, the carbon saving comes primarily from slowing deforestation and regeneration. From the year 2020 onwards, more sequestration would be from plantations and agroforests.

Conclusion

There is a strong nexus between wood energy and climate change. Wood management offers vital options for mitigation of greenhouse gas emissions. Currently, wood fuels use is predominant in developing countries. Wood energy use is very inefficient. The energy efficiency of traditional wood stoves remains below 10%. If sustainably grown, wood energy is carbon neutral. Wood fuels grown commercially and used with modern combustion technology can be competitive with fossil fuels. Management of wood and forests furnish low cost and high potential carbon mitigation options. Future development of wood energy and forest policies are therefore vital to the cost effective global climate change regime. Conversely, climate change also has significant impacts on forests and forest ecosystems.

Wood energy, forests and climate change are vitally linked. The following are some vital wood related policies in the context of global climate change:

i) increase commercial wood fuel production,
ii) adopt sustainable wood growing practices,
iii) promote conversion of wood into readily usable energy forms (such as liquid or gas),
iv) adopt modernized wood combustion technologies, and
v) promote C conservation and sequestration through wood and forest management practices.

These policies suit not only the needs of managing climate change but are also consistent with global sustainable economic development.

(Shukla, P.R. 1996. Wood energy and global climate change. *Wood Energy News* 11(3): 7-10)

Solar Energy and Photoconversion

Although solar radiation is the ultimate source of most of the world's renewable energies, the term solar energy is usually applied to those technologies which derive heat, light and electricity more directly from the sun. Photoconversion - the conversion of sunlight directly into electrical or chemical energy - is one such technology.

The principles of photoconversion were first applied in the development of photovoltaic cells for electricity generation. Researchers are now exploring the potential for generating energy using various photobiological, photochemical and photoelectrochemical techniques.

Photobiology

It has long been known that all our fossil and biological fuels are derived ultimately from the process or photosynthesis. Each year this process is responsible for removing from the atmosphere of "fixing" enough carbon to meet the world's energy needs ten times over. However, natural process efficiency is very low (1-3%), and one of the main objectives of the current international research program is to design artificial photosynthesis systems which will mimic the natural processes but at higher levels of efficiency. The processes themselves are now relatively well understood and current research is therefore focusing on the development of appropriate membranes and catalysts, and on the creation of stable systems.

Photochemical and Photoelectrochemical Conversion

Photochemical conversion systems use the light energy absorbed by organic or inorganic molecules to initiate chemical reactions. A simple energy-storing reaction uses light to convert a low-energy reactant into an electronically excited state and thence into a higher energy product. When energy is required, the product can be catalytically

Electricity Generating Authority of Thailand (EGAT) Set for Privatization

In just five years, the Electricity Generating Authority of Thailand (EGAT) has moved from the status of an entrenched - and efficient - state-owned power utility to one that is fast succumbing to privatization.

The utility, with a turnover of 98.5 bn baht (US$ 4 bn) a capacity of 13,400 MW and an employee payroll of 33,900, will begin the most important phase of its long unbundling process next year. It will be corporatized and subdivided into limited liability units prior to becoming a full publicly quoted company in 1998.

The utility's management appears to have overcome internal resistance to privatization. It has done so against a background of near double-digit economic growth and a corresponding requirement for more electricity supply to feed the country's industrialization program.

In the early 1990s, company officials and conservative interests in the country of 60m people argued that the utility could meet the growth requirements on its own - by staying under state ownership while maintaining a strong profit motive. The international ratings agencies silently supported this view, always giving EGAT a high credit rating.

That internal imperative nevertheless has slowly yielded to what is probably southeast Asia's most cautious deregulation program - as carefully watched as it has been implemented. Since then, national electricity policy has seen the implementation of a small power producers program (SPP) and its big cousin, an independent (or large) power program (IPP) - independent generation schemes which would sell electricity to EGAT at commercial tariff levels.

Coupled with this has been a program to sell specific EGAT power units to private generators, such as the sale of Rayong Power Plant to the Electricity Generating Public Co., Ltd. (EGCO), spun off from EGAT. Finally, EGAT has actively become involved in buying electricity supplies from Laos and Malaysia and will lift gas from the Total/ Unocal-backed Yadana natural gas pipeline in southern Burma.

In short, not only is EGAT its own best customer for power supplies, its custom is vital to the success of Lao's fledgling hydroelectric power program, nearly all of whose output will be bought by EGAT (and much of which will be built by private sector joint ventures backed by concessional aid support), and to Burma's nascent energy development program.

In the past year, EGAT's financial investment has averaged 25 bn baht (US$996m) per year which has been guaranteed by the government. And now that figure has doubled to 50 bn baht, the private sector has been encouraged to play a part in the power industry. The main objectives are to reduce the government's financial burden on the public sector investment and to enhance competitiveness in pricing and efficiency.

During the five-year period of the forthcoming 8th National Economic Plan, the investment for power expansion is estimated at 408.5bn baht, of which 238.5bn baht will be for EGAT's power projects and the rest, 170bn baht, for the projects developed by the private sector.

EGAT last year delivered a net profit of 18.9bn baht, up 58% from 12.03bn baht. Revenues were 98.5bn and 76.8bn, respectively. Installed capacity for the year was 13.4 GW, and peak generation stood at 12.26 GW.

Electricity sales stood at 72.78m kWh, up 14%. It delivered 92% of all electricity

(contd. on p. 4)

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converted back to its original state, releasing its stored energy.

Current research is concentrating on more complex photochemical reactions in which only the initial stage is light-driven. Particular attention is being paid to: the generation of hydrogen from either water or hydrogen sulphide; the reduction of carbon dioxide (CO_2); and the reduction of nitrogen to ammonia. Considerable technical difficulties remain, particularly regarding the creation of systems which are stable, but this area of photochemical conversion does appear to offer the stability necessary for energy storage.

Photoelectrochemical solar conversion uses light energy to generate electrons. These are then used either to produce a current or to initiate and maintain chemical reactions. Such systems can be used, in principle, to generate hydrogen from water and to reduce CO_2 to a variety of compounds. Although the systems currently under review are both unstable and inefficient, the longer-term prospects are more promising. Conversion efficiencies similar to those achieved using photovoltaic technologies are now believed to be possible, with photoelectrochemical systems offering a greater degree of flexibility.

Current Research

Many of the solar energy R&D programs initiated during the early 1970s contained a significant photoconversion element. The EEC program, for instance, funded 58 contracts in the photobiology, photochemistry and photoelectrochemistry fields between 1974 and 1984. Research is continuing in a number of academic and research institutions in individual European countries, notably Switzerland, Germany, France, the Netherlands, Italy, Spain and the UK.

Most of the research venues, however, lie outside Europe, mainly in the USA, the Newly Independent States of the former USSR and Japan. There are two important stimuli: the potential for producing non-polluting hydrogen fuel from water; and the fixing of CO_2 to reduce atmospheric concentrations of this major `greenhouse' gas.

(ETSU. Technology Status Report No. 007 Photoconversion. UK.)

(contd. from p. 3)
in the country, with the rest delivered by small producers and by Laos and Malaysia.

At present, the utility's fuel mix is natural gas 34%; bunker oil 27%, lignite 18%; hydro 8%; diesel 3% and alternative energy, a fraction of a percent. It also purchases 10% of its electricity from other sources.

Future Plans

The company will see the current privatization program amplified - there is still a long way to go with both the SPP and IPP programs still in the tendering and project award stage.

The deregulation program will see the corporatization and partial privatization of the host company. To this end, EGAT recently announced it had named three consulting groups to advise it.

The consultants will advise on the structure and the number of privatized companies to be spun off from EGAT as well as on the means of mobilizing additional funds from the public, such as share and bond issues and funds raised from asset sales, in the process of the privatization.

The target is for EGAT to restructure its organization by transforming itself into companies with limited liabilities by next year. It would become a public company in 1998. In preparation, it has already divided its organizations into six business branches and five operative units

The six business branches are transmission, power plants, operation and maintenance, mining, construction and engineering. The five operative units are policy and planning, accounts and finance, administration, new business ventures and hydropower.

EGAT's financial advisers recommend that the company list its planned subsidiaries, including the Bang Pakong Electricity Plant Co., Ratchabyry Electricity Plant Co. and the Mae Moh Electricity Plant Co. on the local stock exchange as well as on the bourses of London and New York.

The three groups have a combined capacity of 15,000 MW, compared with 2,000MW of Egco, which operates the Rayong and Kanom power units. Egco has raised over 25bn baht from the stock market to finance the acquisition of plants from EGAT.

As for the long-term outlook, EGAT has Southeast Asia's most advanced demand side management (DSM) program, revolving around sophisticated load management.

The DSM is expected to cut down peak-load demand in five years by 322,000 kW, the amount of a big thermal unit, and subsequently lead to a saving of 1,826m kWh of electricity demand, worth about baht 4.8bn.

Nevertheless, the gap between supplies and potential demand (and real demand) remains wide and has necessitated the setting of an ambitious megawatt-availability plan. According to the latest plan, from 2001 onward, the system's reserve capacity will be raised from the previous 15% criteria to 25% of system capacity. New capacities totaling 30,929 MW will be added in the 1995-2001 period, boosting EGAT's capacity of 43,918 MW by the end of the period.

EGAT says that these capacities will come from EGAT's own projects, purchases from Laos and Malaysia and from IPPs.

EGAT planned to buy a total of 4,180 MW power capacity from IPPs expected to be commissioned in the 1996-2002 period. This amount would account for one half of the total added capacities planned for the period.

(1996. EGAT gets set for the marketplace. *Power in Asia* September: 6-8)

Harnessing the Micro Hydro Potential in Developing Countries

A Bristish Overseas Development Agency (ODA) funded project being carried out by Intermediate Technology aims to develop a low head propeller turbine that can be manufactured economically in developing countries in local workshops for applications in rural areas.

Small water turbines are becoming increasingly popular for providing power in remote areas of developing countries. The cost of these micro hydro schemes should be no more that $1000/kW to be affordable by rural households in the world's poorer areas. Higher scheme costs can be afforded in richer areas or where power is used during the daytime for income generating activities. Even at $3000/kW micro hydro can be cheaper than either wind or PV systems, and can also be cheaper than diesel provided that the load factor is greater than 25%.

The strongest market for micro hydro power in developing countries is for electricity generation, either as municipal schemes providing power for an entire village, or as very small domestic schemes providing power for only a few households. Municipal schemes are often used as alternatives to grid extensions, and are promoted by many governments and international donors. The subsidies provided by these agencies often help to bring the cost to the consumer down below the $1000 per kW limit. Domestic schemes, on the other hand, usually receive no financial support and meet the cost limits by a combination of mass-production, direct coupling of the turbine and generator, and installation by the purchaser.

Post-harvest processing for local needs used to be the main market for micro hydro power in developing countries. This market is now saturated in some countries, but there is still a strong market for small machines based on upgraded indigenous designs. There is also an emerging market for agro-processing for income generation such as herb drying and coffee processing.

In the longer term, grid-connections are likely to become a significant market for micro hydro power, although at present few governments in developing countries permit the sale of electricity to the grid. As the first grid-connected schemes will be on high and medium head sites, the market for low-head grid connections will probably take many years to develop.

At the present time, there are almost no micro hydro electric schemes operating on heads of less than 10 m. This is not due to

Photovoltaic Lighting Systems in Rural Areas
A Pilot Project in Rural Botswana

Photovoltaic lighting is considered a viable and promising plan for rural areas around the world where grid provision of electricity is not available. One such pilot project is being tested in the rural village of Manyana in Botswana. The project will provide guidance on how a larger scheme can be designed to allow more households to benefit from solar power.

The use of solar energy is particularly appropriate in a country like Botswana where excellent solar radiation with daily sunshine averaging 8.8 hours is available. The Energy Division of the Ministry of Mineral Resources and Water Affairs initiated a pilot project in the Village of Manyana in 1992. It comprised: 42 residential PV lighting systems; 1 PV system for lighting and refrigeration in the clinic; 6 PV street lights; and 6 solar water heating systems.

The Rural Industries Innovation Center in Kanye signed an agreement with the Botswana Government in April 1995 to take over the running of the residential lighting systems of the Manyana Project for two and a half years. One of the objectives of the agreement is the establishment of a scheme suitable for the household purchasing of the product. This will act as a pilot project for installations in other villages.

The Energy Affairs Division of the Ministry wishes to determine the acceptability of PV lighting systems to the rural population and whether they are willing and able to pay for PV installations.

The Manyana project is helping in this evaluation. At Manyana the 42 users have signed individual agreements to purchase PV installations over a period of 2 years. The monthly installments vary according to the number of lights in the systems: the payment for a two-light system is P28 (US$8.75) and for a six-light system P100 (US$31.25) per month. User willingness and ability to pay is high: of the 42 loan takers, all but five have begun payments and the remaining number hope to begin in the near future.

In the light of the Manyana project, the Energy Affairs Division of the Ministry has commissioned a "Photovoltaic Rural Electrification Feasibility Study". Inhabitants of three villages have been interviewed and primary findings are positive. Most people would like to have PV lighting systems and express a willingness to pay for the service.

Proposed funding for the initial phase of the PV rural electrification scheme will be through a revolving loan fund. The Botswana Government will contribute 70% to the fund, the Renewable Energy for Africa (REFAD) will provide the remaining 30%. More funds will be required if the scheme is to become a country-wide project. Loans will be amortized over 4 years with monthly payments similar to those present being paid at Manyana.

A valuable lesson has been learnt in Manyana concerning repayments: because of the seasonal nature of incomes in rural areas in Botswana, there should be greater flexibility for repayment of the loan. The monthly repayment system should not be rigidly adhered to.

PV lighting makes economic sense for households wishing to have access to electricity. Even if grid electricity were to become available in remote areas, the cost of individual installations can be as much as P 6,000 (US$1,875).

Monthly bills for grid electricity depend on usage and the cost is recurrent. This is not the case for PV lighting systems. For the owner of the PV system, the main cost is borne in the first four years. Thereafter, the only cost is for replacement of batteries and light bulbs.

Another important lesson learnt from the Manyana project is the importance of identifying a local electrician to provide supplies and service to the systems.Both the observations at Manyana and from results of the survey show that user acceptance of PV lighting systems is high.The lessons learned from this renewable energy demonstration project in Botswana can be very useful in the planning and implementation of such projects in many rural villages around the world.

(Gecha, J. and Irvine, J. 1996. Photovoltaic lighting in rural Botswana: a pilot project. *Renewable Energy for Development* 9(2):6)

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a lack of power at lower heads: in general the amount of power available on rivers increases as the head is reduced. Instead, the main constraint appears to be that the pelton and crossflow turbines which are being made by local manufacturers are too large and rotate too slowly on low-head sites to be used economically to drive generators.

The most appropriate water turbine for use on low-head sites is the propeller. While this type of machine is reasonably well developed in Europe, it has not been used successfully in developing countries. The propellers that have been built in developing countries have tended to suffer from poor performance and are generally unreliable due to problems with seals and bearings.

The study recommends that the best way to support micro hydro power in developing countries is to assist with the development and transfer of suitable propeller turbines. Initially, this work should concentrate on municipal schemes of 5 kW - 25 kW on heads of 4m - 8m, and on domestic schemes of 1 kW - 5 kW on heads of 1m - 4m. Future developments should include work to extend the head range of municipal schemes downwards to take advantage of the large number of very low head sites (e.g. canal drops) around the world.

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[Source: 1996. Low head micro hydro potential. *Energy Efficiency* 3:5]

1995 Energy Figures for Thailand

In 1995, Thailand's final energy consumption increased 11.2% from the previous year. Modern energy consumption which comprises petroleum products, natural gas, condensate, coal and lignite, hydro power and others grew 14.1% while renewable energy (fuel wood, charcoal, paddy husk and bagasse) grew 2.9%. Details of energy situation are as follows:

PRIMARY ENERGY SUPPLY

In 1995, Thailand's total primary energy supply amounted to 72.8 Mtoe, an increase of 11.9% over the previous year, of which 55.2% came from indigenous sources and 44.8% from imported sources.

Indigenous Sources

Domestic primary energy production in 1995 was 39.6 Mtoe, an increas of 5.5 % over the previous year. the details are as given in Table 1.

Import

Total energy imported in 1995 reached 33.8 Mtoe, with an increase of 19.5% over the previous year. The total value of energy import was 113,432.5 millions Baht with an increase of 24.7% over the previous year.Details on energy import by types are as given in Table 2.

Export

Total energy exported for 1995 was 1.2 Mtoe, a decrease of 0.2% over the previous year. Condensate was a major item which accounted for 54.4% of the total energy exported. The rest were petroleum products, natural gasoline, electricity and renewable energy which were 38.3%, 6.3%, 0.6% and 0.4% of the total energy exported, respectively.

FINAL ENERGY CONSUMPTION

The total final energy consumption for 1995 was 48.8 Mtoe, an increase of 11.2% over the previous year. Details by type and by economic sectors are as given in Table 3.

(1995. *Thailand Energy Situation 1995*. Department of Energy Development and Promotion (DEDP), Ministry of Science, Technology and Environment)

Table 1. Indegenous Sources

	1995 Average	Total Production	% Increment from 1994	% of Total Indigenous
Crude Oil	23 836 bpd	1.2 Mtoe	- 10.2 %	3.0 %
Natural Gas	1096 MMscfd	9.8 Mtoe	+ 5.7 %	24.8 %
Condensate	29 964 bpd	1.4 Mtoe	- 2.1 %	3.4 %
Lignite	50 455 tons/day	5.5 Mtoe	+ 6.9 %	13.9 %
Anthracite	14 tons/day	0.004 Mtoe	-	-
Hydropower (electricty)	-	1.5 Mtoe	+ 48.7 %	3.8 %
Others (geothermal, solar cell, wind)	-	0.001 Mtoe	-	-
Renewable Energy (fuel wood, paddy husk and bagasse	-	20.2 Mtoe	+ 4.4 %	51.1 %

Table 2. Import

	1995 Total Import	% Increment from 1994	% of Total Import
Petroleum	32.2 Mtoe	+ 18.2 %	95.2 %
Coal	1.5 Mtoe	+ 58.3 %	4.5 %
Electricity	699.1 GWh or 0.06 Mtoe	- 19.7%	0.2 %
Renewable Energy	0.013 Mtoe	+ 7.1 %	0.1 %

Table 3. Final Energy Consumption

By Type of Energy	1995 Total	% Increment from 1994	% of Total
Petroleum Products	26.4 Mtoe	+ 13.2 %	54.2 %
Natural Gas	0.8 Mtoe	+ 33.8 %	1.6 %
Coal and Lignite	3.7 Mtoe	+ 17.8 %	7.5 %
Electricity	6.1 Mtoe	+ 14.0 %	12.5 %
Renewable Energy	11.8 Mtoe	+ 2.9 %	24.2 %
By Economic Sectors			
Agricultural Sector	1.6 Mtoe	- 0.1 %	3.2 %
Mining Sector	0.03 Mtoe	- 25.7 %	0.1 %
Manufacturing Sector	15.8 Mtoe	+ 13.5 %	32.3 %
Construction Sector	0.03 Mtoe	- 17.7 %	0.6 %
Residential and Commercial Sector	12.3 Mtoe	+ 6.0 %	25.3 %
Transportation Sector	18.8 Mtoe	+ 14.8 %	38.5%

SMALL SCALE WIND ENERGY SYSTEMS

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EDITORIAL

Bits and pieces just from anywhere this time. From Peru and Nicaragua in South America, and from Vietnam and China in the Far East. (Africa, are you still there...?). In the UK windpumping seems an everlasting research topic and we are glad to know that. We decided to write something about the opportunities the Internet may have for us. High technology, but the experts know there is nothing as complex as a windpump - not even a battery charger!

Happy Christmas and a fine New Year to all of you (please keep writing).

Jan de Jongh and Remi Rijs, editors

Windpump Markets and Technical Development in Vietnam

The Existing Market

Vietnam with its many islands and 3000 km coast line, is acknowledged to have good potential for wind energy. Many settlements in the area have faced a lot of difficulties with respect to power supply for irrigation. The products grown in these areas are mainly rice, pepper and coffee. There is also industrial tree planting, prawn farming and salt production.

The market for windpowered water pumping is very large and seems to be unexploited in Vietnam. Only 5,309 hamlets of a total of 8,791 have access to electricity (about 60 %), and there are many islands out of reach of the electric grid. Domestic water supply is done by human labor or diesel pumps, which are expensive. Windpumps would provide an attractive alternative here.

The total prawn farming area in Vietnam is estimated at 280,000 ha in 1995. There is also extensive fish farming, and production of crabs, eels, turtles, and minh hai, all requiring very large amount of water.

Finally, there is great potential for windpumps in agriculture and salt production.

Technical Development (Before 1990)

In Northern Vietnam, the horizontal-axis sail wind turbines and the D4 type combined with a wooden paddle pump, were built for salt production. The wheel diameter was 4 m, and the blade number between 8 and 10. This kind of windpump could not be used widely as the wooden paddle suffered frequent damages. Eight units were installed during a period of five years.

In Southern Vietnam some Australian Southern Cross windpumps were installed in Baria, Vung Tau, before 1975. These machines have been in use until 1978, when they were stopped due to technical troubles and a lack of maintenance staff.

Some Taiwan windpumps for salt production were also installed before 1975 and pumped 20 m^3 to 30 m^3 per hour at a head of less than 1 m. To repair them, the farmers replaced the original rotor blades with wooden ones. They also managed to reproduce the pump rotor.

After 1990

Since 1990, the Research Center for Thermal Equipment and Renewable Energy (RECTERE) has held many state projects on wind energy. RECTERE has implemented more than 600 windgenerators and about 70 windturbines for water pumping in locations such as Xuan Loc, Duc Tring, Dong Nai, Thu Duc, and Phan Thiet. These are high head machines manufactured in Vietnam according to a Dutch design (the Diever 450).

Two years ago, RECTERE designed the flexible blade vertical-axis windturbines HL300, HL250, HL200, which combine self-starting ability, a revolution regulating mechanism, and semi-aerodynamic blades. This kind of wind turbine is used for water pumping in the salt production and prawn farming. It is also used in combination with two piston pumps or to drive a wooden paddle, as is done in Vinh Hao for water circulation in algae cultivation.

Perspectives

Recently, the Vietnamese Government has demonstrated its interest in power supply for production and domestic use. On September 28, 1996, the RECTERE workshop was visited by party chief Do Muoi, minister of Education and Training Tram Hong Quan, former minister of Science, Technology and Environment Dang Huu, and other high officials. Do Muoi stimulated the people working at RECTERE to continue their efforts in wind energy research. Though RECTERE has achieved many good results in wind energy projects, it is limited in its technology and capacity. Additional efforts are therefore essential to satisfy the enormous demand for wind water pumping in Vietnam.

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Duong Thi Thanh Luong, The Ho Chi Minh City Technical University, 268 Ly Thuong Kiet St., District 10, Ho Chi Minh City. Vietnam. Fax: +84 (8)654 355.)

Small Windchargers for Nicaragua?

People feel a compelling need to have a television and electric lighting, specially in zones where electricity is not commonly available. In the central part of Nicaragua, about 20 % of the rural families use a 12 V television fed from a car battery in absence of a more sophisticated electricity supply. To charge these batteries they have to travel a considerable distance every one or two weeks to a place where there is a generator or a grid. The costs of transport and charging vary between 30 and 60 cordobas per month (about US$ 3 to US$ 7).

Solar Home Systems

At present the most popular technology for small-scale electrification of the rural area is undoubtedly the small photovoltaic (PV) Solar Home System. Such a system usually consists of a PV-panel of approximately 30 Wp to 50 Wp, a battery and a charge controller and generally provides sufficient power for a small black-and-white television and one or two lamps.

It has been shown that a Solar Home System is a reliable and -on the long term- also more economical method for battery charging. Nevertheless, a Solar Home System still costs about US$ 750.00 on the average, and the initial investment is recovered very slowly. For the poorer people, this amount is simply prohibitive. For Nicaragua, where the interest rates are high, these limitations certainly hold.

Windchargers

Experience and existing information reveal that electricity generation using small windchargers involves an investment two to four times smaller than that required for a Solar Home System, provided that wind speeds are sufficiently high (average speed above 3.5 m/s). According to data and studies, a.o. from the INE Instituto Nicaragüense de Energía there are many regions in Nicaragua, where wind battery charging might be economically feasible. Until now, however, windchargers have not had much success in the country since:

- it is an unknown technology;
- there is only one brand available (from the USA);
- the importation of foreign equipment involves a lot of bureaucracy, and
- import duties are rather high.

Foreign windchargers with output powers ranging between 100 W and 1 kW exist in the USA, United Kingdom, The Netherlands, and China. These advanced machines are too expensive for the Nicaraguan market and cannot be produced or copied in the country.

Local designs

The only possible solution is is to design small battery chargers in Nicaragua. Various countries have done this before, of which China (Mongolia) is the most encouraging example.

The CESADE (Centro de Estudios y Acción para el Desarrollo) think about modifying the rope-and-washer windpump ('aerobomba de mecate') for use with a small DC generator that could easily be obtained or imported in Nicaragua. All parts of the windturbine can be produced locally (as is already done for the windpump), the generator is the only part to be purchased elsewhere. By this way, one would obtain a windcharger of a familiar, accepted technology, with the same ease of operation and maintenance as the existing rope windpump. The price of a 50 W windcharger is estimated at approximately US$ 250.00, far more affordable than a Solar Home System; the cost of energy (US$/kWh) is probably less than half that of its competitor.

Finally, The CESADE believes one should make use of experiences in other countries whenever possible, and would appreciate very much to receive response, ideas and suggestions on this article.

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Progress on the New IT Power Windpump

The design for the new, innovative windpump of IT Power was developed under a grant from the European Commision. Since then the project has been supported by the UK Overseas Development Administration (ODA). The second phase of the ODA project, to continue the development of the new windpump design and initiate the technology transfer to manufacturers in developing countries, began in 1995. This phase has developed the lessons learnt in testing the first prototype and incorporated them into a design for a 1.8 m to 2.0 m machine. The detailed design has been finalized, engineering drawings have been produced and the UK-based pre-production prototype is currently being manufactured. After construction and installation (January 1997) the machine will go through a test phase so that any minor problems can be identified and incorporated into the final design, and the engineering drawings modified accordingly.

IT Power already has a number of collaborators in various countries. Partners in India, South Africa and Zimbabwe are working on costing the machines in their own countries and IT Power is currently finalizing the licensing agreements with these partners. Prototypes will be built by a small number of licensees before commercial production begins next year.

(Frances Crick, IT Power Ltd., The Warren, Bramshill Rd, Eversley, Hampshire RG27 United Kingdom.
Fax: +44 (118)973 0820)

Sixth International Course on the Implementation of Wind Energy

From April 7 - 18, 1997, the Netherlands Energy Research Foundation (ECN) and Renewable Energy Development vof (RED) have scheduled the sixth edition of their yearly wind energy course. This course is intended for decision makers and project managers from government bodies, project developers from industry, and project evaluators from finance institutes. The event will take place at Petten, the Netherlands. Information can be requested from Mr. Frans van Hulle at fax number: +31 (224) 564 480; or at the ECN homesite on the WorldWideWeb: http://www.ecn.nl/.

Structural Dynamics of Water Pumping Windmills

Research at University College London has looked at the implications of structural dynamics on several small water pumping windmills using field data and theoretical models. The motivation for this work is to increase the life of fast running windpumps by increasing the understanding of their structural response.

Modern steel water pumping windmills are developed to be lighter and simpler than their predecessors. The recently designed rotors have a low number of blades and run relatively fast. A combination of a fast running rotor and a flexible support structure means that structural dynamics play a very important role in the longevity of water pumping windmills.

A wind pump was modeled as a set of non-linear simultaneous differential equations which were then solved numerically with a finite difference time-domain approach. This approach gave the maximum amount of flexibility in the model, though not with the minimum effort. The control system, pump system and wind turbine structure were all considered in the same model. Once the initial model had been created it was a simple matter to perform studies on parameters such as the pump depth, tower stiffness or passive control system.

A modern fast running windmill has been tested while driving a 49 mm pump with a borehole depth of 36 m. With no softness in the system the topside structure receives an impact load from the pump every cycle. This typically occurs at frequencies from 1.0 Hz to 2.5 Hz, depending on the windmill and pump size. The passive control system used in small machines is not able to regulate the speed of the rotor to any great accuracy. It is therefore difficult to design a mechanical wind pump to run safely in a compliant mode. The behavior of the passive control system was found highly dependent on the friction in the yaw bearing. This is a maintenance issue that has a direct implication on the structural integrity of the windpump.

Wind loads other than direct wind pressure forces, such as vortex shedding, have been found to be significant in some cases. This is particularly a problem if structural or aerodynamic damping are very low. Measurements have been taken to show how dynamic wind-induced loads can cause significant structural response even if the windmill is not operating.

The conclusion to the work is that the life of a modern water pumping windmill can be increased by application of structural dynamic and fatigue analysis. It has been shown that the simplest and most reliable method of collecting data is to run a test rig under a range of conditions rather than to attempt to make complex simulations on a computer. The configuration of the machine and the pump is critical to obtain an understanding of the loads involved. Pumping from a deep well will load the windpump structure in a very different way from a shallow well even when pumping against the same head. It is necessary to test a machine in a variety of pump configurations because of the complex relationship between pump rod loads and pump rod length. Longevity can be improved if structural softness is considered in the transmission system. Aerodynamic and structural damping can effectively reduce the response of a machine.

This work was funded by the Engineering and Physical Sciences Research Council (UK). The field work was carried out at Silsoe College, Bedfordshire, UK, and at ECN Netherlands Energy Research Foundation, Petten (The Netherlands).

(Robert Pumphrey, nCode International Ltd. 230 Woodbourn Rd., Sheffield S9 3LQ, United Kingdom, Fax: +44 (114)275 8272)

Experiences with the Waira Battery Charger in Peru

'Waira' is the word for wind in the Andean language Quechua. It is the name of the project in the development and installation of small wind energy conversion systems which has been ongoing for almost six years. The first designs were intended to power a sailboat or a small house. In the following years, new designs were introduced reaching to 1.2 kW, sufficient for lighting of a small group of houses or for domestic water pumping. Recent installation has been mostly in the highlands (3500 m above sea level) within a state funded program to supply power to community houses for lighting and television sets equiped with a parabolic antenna. Other interesting projects were related to the lighting of fishermen's piers in remote harbors and also in some farms.

The project had satisfactory results, but trouble in some others. The main problems were only the following:

- Proper selection of the site and evaluation of wind resource: This is fundamental for the success of a project and ideally one would install an anemograph at a promising site for two or three months to assess the local wind potential. However, people are not always willing to pay for such a study so we have to rely on measurements and observations made in short visits or even worse on the sole statement: "yes, there is lots of wind".
- Acceptance of technology by the people: This is specially important in sponsored projects. Beneficiaries should actively participate in the project so that they do not feel as if the technology has been imposed on them. Participation allows people to get familiar with the equipment, to learn about its limitations and to understand the requirements for maintenance.

At present the project team is working on some improvements in the electric components in order to make the system more reliable and resistant to mishandling.

(Grupo, Pontificia Universidad Católica del Perú, Av. Universitaria Cdra. 18 s/n, San Miguel, Lima, Perú, Fax: +51(14)61 17 85)

Errata: Windpumps in Gujarat (June, September 1996)...

The Gujarat Energy Development Agency GEDA informed us that the main author of mentioned articles is Ms. Daksha Vaja, using information collected by Mr. Pradib Rajeshirke and herself (both of GEDA).

Small Scale Wind Energy and The Internet.

The Internet, the interconnected network of computer systems all over the world, is quickly gaining popularity among people everywhere, also in the South. The rapid evolution of modern telecommunications technology has dramatically widened its scope. If you have a personal computer, a modem and a telephone line, a commercial provider will link you to the Internet. And if you have not, often somebody not too far away from you may have it.

As the editor of SSWES, I have noticed that many people active in the field of renewables indeed have access to the Internet and electronic mail (E-mail), although often not without some difficulty. Lately, industry and government institutes have extended their Public Relations activities to the Internet, and have opened a 'home-site' on the 'World Wide Web'. Many of them look like a full-colored glossy magazine, and include 'hyperlinks' to guide you to other documents containing additional information.

Manufacturers of small wind generators have also found their way to the Web, especially the US-based ones. Among them are for example:

- Mike Bergey: http://www.bergey.com/
- World Power Technologies, manufacturer of the Whisper windchargers: http://www.webpage.com/wpt/
- Marlec (UK), producer of the small Rutland windcharger: http://dspace.dial.pipex.com/marlec/

A useful guide to manufacturers and renewable energy-related businesses throughout the world is found in:

- The Source for Renewable Energy: http: //www.rmi.net/theSource/renewableEnergy/

Other good entries to start searching on renewable energies are:

- US Department of Energy - the Office of Energy Efficiency and Renewable Energy: http://www.eren.doe.gov/
- American Wind Energy Association (AWEA): http://www.igc.apc.org/awea/
- British Wind Energy Association (BWEA): http://www.bwea.com/

Of course this list gives just a few of all the entries on wind energy and renewables on the World Wide Web. There are many more, and not all of them will prove useful either. Most entries are found in the US and in Europe, but more and more institutes in the South are finding their way to the Web as well.

If you are a scientist, consultant, engineer or government person in a developing country, you can now actively search what you are looking for. The Internet may show you about the existence of new products, or bring you into contact with your peers at the other side of the world. It contains case studies on battery chargers and solar pumping, and documents including energy policies of state governments. And not in the least, it offers unexpected possibilities to finance your projects.

So if you can have access to the Internet, do not hesitate to use it!

(Remi Rijs - SSWES editor)

150,000 Small Wind Generators in China

In the exploitation of rural energy sources, China has put emphasis on the development of small wind generators. The Sixth, Seventh and Eighth (1981-1995) Five Year Plans allocated special investments for the research and development of small wind generators, while manufacturers could access preferential loans with low interest to improve their products and expand production. Some local governments also have granted subsidies, for instance in Mongolia where a manufacturer receives US$ 25, for each unit sold.

After more than ten years of development, the Chinese small wind generator industry has accumulated ample experience on design, manufacture, and product testing. This has greatly improved quality and performance. The annual production is now about 20,000 units; in 1995, about 150,000 units were in operation in China, of which 130,000 were in Inner Mongolia.

The Shangdu Pastoral Machinery Plant of Inner Mongolia, producing units of 100W and 2 kW, has seen its production increase at an average rate of 58 % per year. The annual profit has more than quadrupled and amounts now to several ten thousand dollars. The 15,000 small 50 W wind generators in Inner Mongolia produce yearly 2.4 GWh electricity, while 70,000 sets of 100 W machines produce 18.2 GWh. This is equivalent to an amount of 19,500 tons of standard coal.

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"Small Scale Wind Energy Systems" is a quarterly publication of the Regional Energy Resources Information Center (RERIC), AIT, Bangkok, Thailand. It is distributed as a supplementary sheet with the "RERIC News" and by direct mailing. Citation is encouraged on the condition that the source is indicated. For subscription, articles or reactions please contact the editors: Renewable Energy Development v.o.f., PO Box 513, WS 1.49, 5600 MB Eindhoven, The Netherlands. Fax: +31(40)246 41 51. Tel.: +31(40)247 31 91. E-Mail: ydir@tnf.phys.tue.nl.

Publication does not imply agreement of the editors. Contributions should preferably not be longer than 300 words. For longer articles please contact the editors. The editors reserve the right to shorten reactions and articles.

The Impacts of Improved Cookstove Dissemination: A Case Study from Rural Nepal

Biomass ranks as number one energy source in many parts of the developing world. It is used directly as firewood, agricultural residues or through charcoal. Other biomass-based energy forms like agricultural residues for biogas plants, briquettes and gasifiers are all new inventions and effective ways of using biomass which people are trying to come up with. They all still exist, however, at negligibly small levels.

Nepal, like many other developing countries, has a mainly rural based population (more than 90%) dependent on biomass fuel as the major source of fuel. Biomass fuel, namely firewood, agricultural residues and cowdung, amounts for up to 91% of the total energy use in Nepal. The domestic sector accounts for the major part of energy consumption (about 91.3%) as compared to the other sectors in Nepal. With the increasing growth in population, forests (wood fuel) decrease correspondingly at similar rates. It is in view of this that efforts have to be made in order to combat this situation and both government and non-governmental organizations have been combining efforts to reduce fuelwood consumption at domestic level through the promotion of the improved cookstove (ICS).

A research study to determine the impacts of utilization of the ICS technology at household level and also to determine its impacts in the villages at large was conducted in two villages in Nepal. The two selected villages were Uggratara and Malpi in the Kavrepalanchok district of Nepal.

Fuel Supply

There is a high dependency on biomass fuels in both Uggratara and Malpi. Firewood accounts for about 80%, followed by agricultural residues at 16.6% and the nominal percentage of kerosene of between 4-8%. The average firewood consumption of Uggratara and Malpi was found to be 460 kg per capita per year and 410 kg per capita per year, respectively.

Accordingly to village sources it has become very difficult to find firewood. This is also supported by the estimated firewood supply and demand balance (from forest and private land), which shows that both of the villages have a firewood deficit of up to 70%. This situation mainly affects the economically weaker population of the villages who have limited land holdings. These groups have either to depend on free firewood collection from the forest or purchase the fuel if they do not belong to the users group of the community forest. It was one of the strategies of the government to hand over the forests to the potential forest users group in these two villages.

Cookstove Dissemination

To combat the energy problem, the improved cookstove program was implemented in 1994 in Uggratara by a local NGO (Focus Nepal) and in 1991-92 in Malpi by a government organization (Woman's Development Division & Research Center for Applied Science and Technology). The main aim of the ICS promotion were to reduce the fuel wood consumption at domestic level. The total numbers of ICS units installed in Uggratara and Malpi was about 70 and 100, respectively. The non-governmental organization's program proved to be more beneficial than the governmental organization's program, in which only about 10% of the total stoves installed are still in operation. This drop could be attributed to the lack of follow-ups, maintenance services, monitoring activities, etc.

Impacts

The ICS was found to have a considerable positive impact on its users:

- the ICS helps to reduce the time for the collection of firewood. The average time spent per day for the collection for the traditional stove is 28 mins. per day (Uggratara) and 20 mins. per day (Malpi), while the time saved by ICS is 25% and 30% in those villages;
- if maintained in good condition, the ICS (in the case of Uggratara) saves about 18-20% of firewood;
- the use of the ICS has positive effects on health. More than 50% of the users stated that they suffered neither headaches nor eye irritation nor respiratory problems after using the ICS (in the case of Uggratar); and
- a simple ICS technology has proved to be attractive for those who have to spend money on fuel, because if used and maintained properly, the ICS could save a minimum of 61 Rupees per month (1$ = 55 Rupees).

The research study also confirmed, however, that the ICS did have some negative impact with users:

- if the ICS is not properly maintained, its performance is even worse than that of the traditional stove. In the case of Malpi, firewood consumption increased by 9% due to the lack of repair and maintenance;
- if there are problems with the chimney, the ICS does not remove smoke from the kitchen. In the case of Malpi 77% of households have chimney problems and, as a consequence, the users do not derive any health benefits; and
- there is no significant change in meal preparation through the ICS and traditional stoves.

Conclusions

Based on the case study of these two villages, it can be concluded that firewood occupies a special place in the rural energy system of these villages, owing to the importance of the domestic consumption for which it is mainly used and the fact that it is mainly produced within the system itself. Based on the prevailing firewood consumption rate, which does not work in balance with the forest production and owing to the ever increasing growth of the population, both the forest and privately held land can no longer today sustain local rural needs: large deficits in firewood are the result.

(contd. on p. 8)

SOFTWARE

Software on Energy Conservation

CASAMO - A pedagocical software for buildings

CASAMO is a computer tool for designing buildings with pleasant thermal comfort conditions or low energy - consuming air conditioning, or for calculating the dimensions of an air conditioning system.

Important features of the software are as follows:

- hour by hour changes of characteristic comfort variables inside a building,
- hourly calculation of cooling loads required to maintain the indoor temperature below a set level,
- these may be used as the basis for sizing the air conditioning system,
- study of a main area with or without a ventilated or unventilated attic,
- comfort study of one (or more room(s)) in a building,
- study of the most exposed living area, rather than the entire building,
- analysis for a single day representing the worst climatic condition in the year,
- study how the various parameters affect overheating,
- and thereby narrow down the approach to the best solution.

Total Energy Supply (TES) - A Software for Combined Heating, Cooling and Power Generation (CHCP)

TES is an intelligent, flexible, speedy, user-friendly software for consultants, engineers, utilities and cogeneration developers. The software was developed to serve the purpose of assessing the feasibility of CHCP projects.

The TES software was conceptualized with the integrated energy systems approach for buildings and industries where electrical and thermal requirements co-exist. It allows to conserve energy and reduce energy cost by combining energy services in a central supply facility.

As its major objective, the package aims to determine the techno-economic vaibility of a particular CHCP technology.

From the given demand patterns of electricity, heating and cooling utility, energy and equipment unit capacity costs and other financial parameters, the software predicts the optimum sizes and the scheduling of the CHCP plant, refrigeration system, auxiliary boiler, and marginal costs of the services provided. As an additional feature, the package estimates the reduction in pollutant emissions.

The software can provide the cash flow of the supply facility for a number of years. Lastly, the sensitivity of the internal rate of return (IRR) of the project with respect to factors such as escalations in energy price, equipment capacity costs, etc. can be investigated.

The core of TES software is a linear programming package.

Both of these software package were developed by the French Environment Management Agency (ADEME) and the Energy Program, Asian Institute of Technology (AIT).

The software comes in two 3 1/2" or 5 1/4" floppies and can run in standard personal computers (PC). A comprehensive manual includes a user's guide, technical manual and case studies. The cost of the each software package is US$300.

The software packages can be obtained through RERIC in the following address.

RERIC/AIT
P.O. Box 4, Klong Luang
Pathumthani 12120, THAILAND
Tel: (66-2) 524 5866
Fax: (66-2) 524 5870
email: enreric@ait.ac.th

* * * * *

RERIC on the WWW

- http://www.ait.ac.th/clair/centers/reric
- visit our homepage to find out more about our services and your benefits as RERIC members

Access RERIC Bibliographic Database through internet

- telnet clair.ait.ac.th
- use login id as *library*

(contd. from p. 7)

In term of total village energy supply balance, the contribution of 100-200 ICS units is insignificant, as out of about 70% firewood deficit only about 20% of these deficits could be reduced by the ICS (if 100% of households used the ICS in the case of Uggratara). Therefore there is still a deficit of 50%. For this reason, without mass dissemination on a national level (millions of stoves in rural villages of Nepal) it may still take several years before any impact, if any at all, is realized. In any case, effective resource management of the remaining forest resources is needed in order to reduce the rate of this energy imbalance.

(Gorkhaly, M. 1996. The impacts of Improved Cookstove Dissemination in Rural Nepal. *Appropriate Technology Forum* 8: 6-7)

BOOK REVIEWS

Household Energy and Agenda 21 HEDON Discussion Paper No. 1

Discussion Paper of HEDON Meeting, September 28-30, 1995, Lund, Sweden.

Published by HEDON and Edited by Bernard Ross, 1995, 35p.

This paper represents the position of a network named Household Energy Development Organization Network (HEDON). This network was established in January 1992 with the main aim of providing better supporting services for the Southern partners at various levels where they were needed.

The paper examines the contributions that appropriate household energy policies and practices can make to the aims of Agenda 21. These are in the areas of combating deforestation and desertification; protecting the earth's atmosphere; promoting education and the position of women; health, strengthening NGOs and the private sector; ensuring sustainable fuel supply; improving agricultural productivity; combating poverty; and improving planning and architecture with a view to energy conservation and efficiency.

This paper examines some of the problems arising from present modes of household energy use in developing countries, and looks at some possible solutions. Its central theme is that governments and communities must take measures to ensure that supply for future energy demand is covered, and that energy is used in the cleanest and most efficient manner possible.

The paper emphasizes the cross-sectoral nature of both the problems and their solutions which typically involve many authorities, including those dealing with energy, forestry, agriculture, health, transport, urban planning, education, environment and industry. A major area of concern is that the present donor, administrative, and government agencies are often too sectorally based and autonomous to provide effective policies and the necessary long-term strategic planning. New supra-sectoral structures and policies are called for involving the full participation of all these involved and affected.

This paper is intended for lobbyists and all those working in development and environmental protection.

Combined Heat and Power Lessons from the Japanese Experience of Cogeneration

by JITEX
Published and Distributed by Financial Times Energy Publishing, Maple House, 149 Tottenham Court Road, London W1P 9LL, England.
ISBN 1-85334-309-9 1995, x + 109p.

This report written by JITEX, a consultant company specializing in Japanese energy management and environment, explores and analyzes the experiences and lessons learned from Japan's cogeneration program. The report examines political, legal and tariff questions as well as the systems now operating in Japan. This can be of profound benefit for businesses and governments through out the world facing the same problems. The report also provides valuable insights to anyone interested in the future of power generation.

The many figures and tables given in the reports contains a wide ranged of data and information which makes the report easy to follow. Addresses of government organizations, engine and cogeneration system manufacturers, generator manufacturers relevant to the Japanese cogeneration development is also listed at the end of the report.

Combined Heat and Power is available for £350/US$560 from:

FT Energy Publishing
Maply House
149 Tottenham Court Road
London
W1P 9LL

Proceedings of Regional Follow-up Seminar Education and Simulation in the Field of Renewable Energy in South and South-East Asia

Edited by Anil Misra and Edu Knagge, Published by Tata Energy Research Institute, New Delhi, India.

ISBN 81-85419-22-1, 1996, viii + 205p.

This monograph covers the proceedings of the seminar on "Education/simulation in the field of renewable energy (RE) in South and South-East Asia" held on 22 March 1996 in New Delhi.

The proceedings is in four sections, namely (1) RE education, (2) RE technologies (RETS), (3) country presentations, and (4) PG course on RE in Oldenburg. This should be a valuable document for those engaged in the RE field.

The copies of the proceedings can be obtained from:

Outreach Cell
Tata Energy Research Institute
Darbari Seth Block, Habitat Place
Lodhi Road
New Delhi 110 003, INDIA

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(contd. from p. 9)

Technology and Testing of Solar Energy Concentrating Systems

R.A. Zakhidov
Published by "FAN', Uzbebek SSR, Taskkent 1978, and the English Edition Published by Gujarat Energy Development Agency, Vadodara, India.
ISBN 81-900282-2-7, 1996, 184p.

This monograph presents the fundamentals of design, fabrication and testing of mirror concentrating systems (MCS). The necessity of a systems approach to the study of MCS of solar devices is stressed and the importance of modeling as one of the main stages of designing MCS has been shown. Structural features of MCS, methods for shaping reflecting surfaces on glass, metallic and polymer substrates, and technology of coating reflective and protective layers are considered. Unique rotational devices for obtaining accurate paraboloidal surfaces are described. Attention has been paid to alignment problems. A number of schemes for automation of this process and effective methods of zonal alignment are described. Tracking systems of solar devices and means to perfect them are analyzed from the point of view of automated control. For the first time the possibility of the application of invariance principle has been considered for increasing the tracking accuracy.

Chapter I entitled "A New Approach to the Study and Construction of Modern Solar Installations" stresses on the necessity of taking a systems approach to the study of MCS, and considers the various stages of design of a concentrating system. Chapter II entitled "Specific Structural Features of Mirror Concentrating Systems" covers the choice of optical designs and structural solutions. The analysis of the methods of shaping reflector surfaces on glass, metallic and polymer basis is given in Chapter III. Chapter IV talks about coating the mirror with reflective and protective largers and their characteristics. Chapter V analyzes the quality control of the individual elements and the entire MCS. The alignment problem of MCS has been covered in Chapter VI and Chapter VII covers the control problems in the operational stage of MCS.

The book is meant for scientists and engineers engaged in the design, production and operation of concentration for utilization of solar energy.

Our goal is to help you turn information into knowledge . . . .

RERIC MEMBERSHIP BENEFITS for 1997

1. Receive the RERIC News (ISSN 0125-1775), Vol 20 (Nos. 1-4) 1997;
2. Receive the International Energy Journal (ISSN 0857-6173), Vol. 19 (Nos. 1-2)
3. Access database of RERIC and the Center for Library and Information Resources (CLAIR) through the Internet;
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International Events

INSIDE ASIA

9 - 11 April, 1997, International Workshop on Renewable Energy Application to Plantation and Other Industries, Madras, India.
Contact:
Dr. C. Palaniappan
Organizing Secretary
Int'l Workshop on R. E. A. P.O. I.
Planters Energy Network, 171/2
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Rajambadi, Madurai 625 021, India
Tel: +91 (452) 85607
Fax: +91 (452) 859139, 8597278

28 - 30 April, 1997, Coal Investment and Technology Asia '97, Managing Change and Upgrading Technology, Hong Kong.
Contact:
IBC Asia Limited
268 Orchard Road, #18-02
Singapore 238856
Tel: (65) 732 1970
Fax: (65) 733 5087
Email: enquiry@ibcasia.com.sg

21 - 23 April, 1997, Asian Oil & Minerals, Bali, Indonesia.
Contact:
Europe Energy Environment in London
Tel: 44-171 600 6660
Fax: *44-171-600 4044*

17 - 19 June, 1997, Sub-Saharan Oil & Minerals, Grand Baie, Mauritius.
Contact:
Europe Energy Environment in Johannesburg
Tel: 27-11-442 3230
Fax: 27-11-442 4198

14 - 16 October, 1997, Asia Pacific Initiative for Renewable Energy & Energy Efficiency '97, Jakarta, Indonesia.
Contact:
Alternative Development Asia Ltd, 5/F
3 Wood Road, Wanchai
Hong Kong
Tel: +852 2574 9133
Fax: +852 2574 1997
Email: altdev@hk.super.net

20 - 23 October, 1997, International Conference on Large Scale Water Resources Development in Developing Countries: New Dimensions of Prospects and Problems, Kathmandu, Nepal.
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Dr. Kiran Bhattarai
D & M Associates
EPC 4000
GPO Box 8975, Kathmandu, Nepal
Tel/ Fax: (977-1) 371 249
Email: KIRANB@kiranpc.mos.com.np

OUTSIDE ASIA

23 - 25 March, 1997, The Twelfth Annual Cogeneration & Independent Power Market Conference, New Orleans, LA., USA.
Contact:
Independent Power Report
1221 Avenue of the Americans
New York, NY 10020, USA
Fax: 212-512-2723

7 - 18 April, 1997, Sixth International Course on the Implementation of Wind Energy, the Netherlands.
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Fax: +31 40 2464151
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10 - 11 April, 1997, Offshore Wind Energy in the Mediterranean and other European Seas (OWEMES '97), Sardina, Italy.
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Fax: +39 3048 4203/6315/4643

8 - 17 April, 1997, Sixth International Course on the Implementation of Wind Energy, Petten, Netherlands.
Contact:
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1755 ZG Petten
Netherlands
Tel: +31 224 564115
Fax: +31 2245 63214
Email: vanhulle@ecn.nl

25 - 30 April, 1997, SOLAR 97: Energy for a Sustainable Prosperity, Washington D. C., USA.
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American Solar Energy Society
2400 Central Avenue, Suite G-1,
Boulder, CO 80301,USA.
Tel: +1 3034433130
Fax: +1 303 4433212
Email: ases@ases.org

5 - 7 May, 1997, The European Congress on Renewable Energy Implementation, Athens, Greece.
Contact:
Conference Secretariate, CRES
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Pikemi 190 09, Athens
Greece
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Fax: +30 1603 9911

26 - 30 May, 1997, CHT-97: International Symposium on Advances in Computional Heat Transfer, Cesme, Turkey.
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Email: g.devahldavis@unsw.edu.au

20 May - 21 June, 1997, International Workshop- Planning for Energy & Environment, The Netherlands.
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University of Twente
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(contd. on p. 12)

(contd. from p. 11)

27 -29 May, 1997, Sustainable Energy Trade Fair, Amsterdam, Netherlands.
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European Media Marketing Ltd.,
6th floor, 22-26 Albert Embankment,
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Fax: +44 171 793 8007

27 - 29 May, 1997, The World Waste-to-Energy Conference & Exhibition, Amsterdam, The Netherlands.
Contact:
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London SE1 7TJ
UK
Tel: +44 171 582 7278
Fax: +44 171 793 8007

5-7 June, 1997, Implementing Sustainable Energy in a Changing World, 23rd Annual Conference of the Solar Energy Society of Canada Inc. (SESI), Ontario, Canada.
Contact:
SESCI Conference '97
Ste. 702 -116 Lisgar Street,
Ottawa, Ontario K1A 0K1
Canada
Tel: (613) 234-4151
Fax: (613) 234-2988
Email: sesci@sympatico.ca

9 - 11 June, 1997, North Sun '97, The International Conference on Solar Energy at High Latitudes, Espoo-Otaniemi, Finland.
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Fax: 358/0/451 3195
Email: Peter.Liund@hut.fi

10 - 11 June, 1997, Conference and Exhibition: Small and Medium Hydropower Projects, Berne, Switzerland.
Contact:
Conference Secretariat
c/o ITECO Engineering Ltd.
Alte Obfelderstrasse 68
CH-8910 Affoltern am Albis
Berne, Switzerland
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15 - 18 June, 1997, WINDPOWER '97, American Wind Energy Association Annual Conference, Austin, Texas, USA.
Contact:
AWEA, 122 C Street
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30 June - 4 July, 1997, 14th European PV Solar Energy Conf., Barcelona, Spain.
Contact:
European Commission
Joint Research Center
H. Ossenbrink / EPVSECE 14
21020 Ispra (VA) Italy.
Tel: +39-332-785885
Fax: +39-332-789268
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8 - 11 July, 1997, ACEE Summer Study on Energy Efficiency in Industry, "New Industry Will Procure Energy Efficiency Services in the 21st Century", New York, USA.
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Washington D.C. 20036
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E-mail: ace3-conf@ccmail.pal.gov

27 September - 1 October, 1997, Hidroenergia: The 5th International Conference and Exhibition, Dublin, Ireland.
Contact:
Confernce Secretariat
Environmental Institute
University College, Dublin Rechview,
Chlonskea, Dublin 6, Ireland.

6 October - 8 November, 1997, Energy Management and Cleaner Production in Small and Medium Scale Industries (Training Program), Enschede, The Netherlands.
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Tel: 31-53-4893539/ 4894377
Fax: 31-53-4893087
Email: J. R. M. Borghuis
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The Regional Energy Resources Information Center (RERIC) is one of the five specialized information centers of the Center for Library and Information Resources (CLAIR), Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

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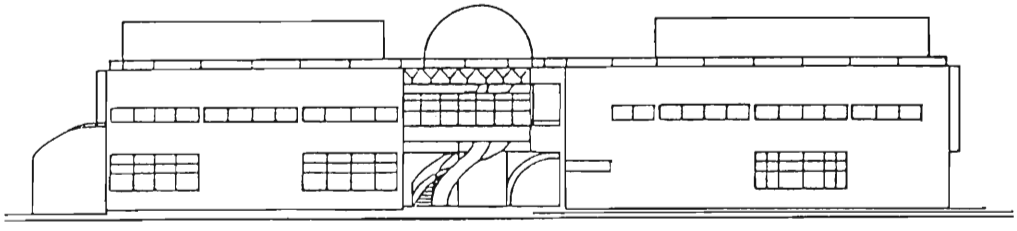
Energy Program Building at AIT: A Model of an Energy Conscious Building

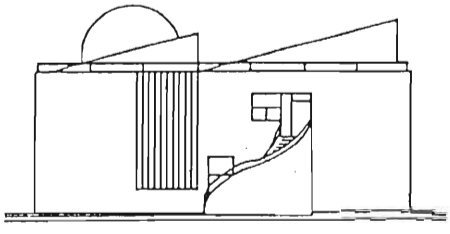
The Energy Program building at the Asian Institute of Technology (AIT), Bangkok was conceived and designed with the objective to conserve energy and save air conditioning cost, thus it incorporated many features characterizing "energy conscious" architecture. The building which was constructed in the early 1980s incorporated many energy conservation features such as:

- an east-west lengthwise orientation to minimize solar gain
- deeply recessed windows facing north and south to avoid direct sunlight penetration
- windows facing east and west equipped with adjustable aluminium lowers to cut off direct sun on the morning and evening
- walls on the east and the west ends with cavity and insulation;
- insulation of the false ceiling with fiber glass to minimize conduction and radiation losses;
- double glazing of windows to reduce heat infiltration, etc.

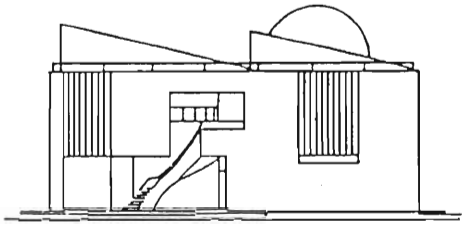
In addition, the laboratory spaces are naturally ventilated. The corridors are conditioned with the return air from the rooms. All the offices are equipped with fan-coil remits through which the chilled water supplied by a central cooling unit circulates. The roof is inclined at an angle of 14 °S with an objective to install solar thermal collectors in the future and operate a vapor absorption air conditioner.



North elevation.



East elevation



West elevation

An experimental study by Bouix and Mohanty showed that the air conditioning requirements of the building is found to be almost 50% less than that of a conventionally designed building completed with similar construction materials. A study of the thermal loads of the building using a computer package called `OASIS' has verified this finding.

The results of the applications of the above model showed that the various energy saving features adopted has helped save 35.6% of energy on an average whereas the peak cooling demand is reduced by 43%. Even in the case of the hottest months of March - April, the improved building design saves 28.2% of energy and its peak demand

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Supplement: Small Scale Wind Energy Systems

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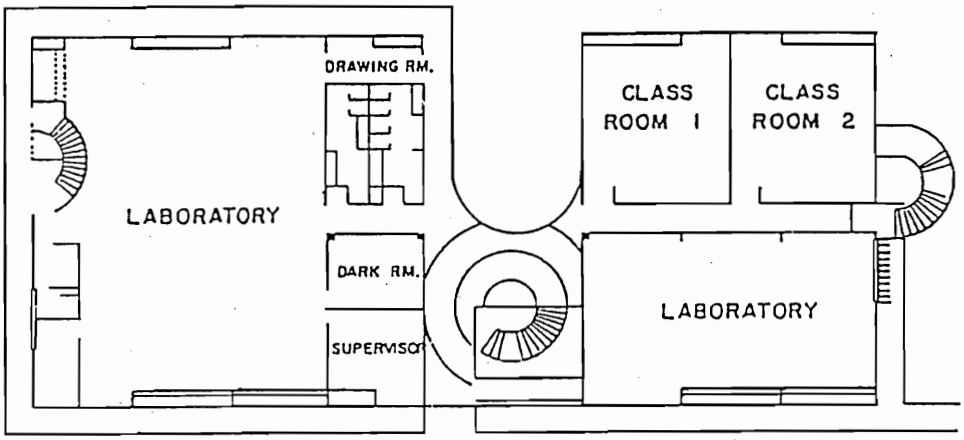
drops by 26.3%. This shows that in addition to lower bills for energy consumption, there is also a lower investment on the chiller and accessories and lower monthly peak electricity demand charge.

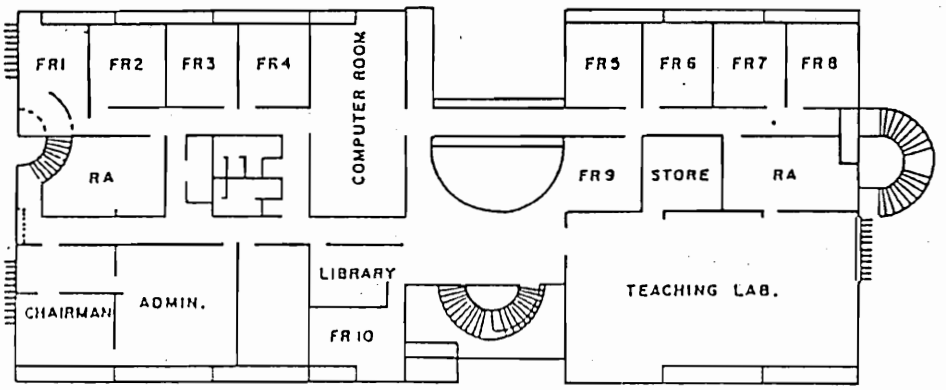
Considering the tarrif of Thailand, this building's electricity bill in the month of October alone represents a monetary savings of 38.7% as compared to a building without any of the features mentioned. Interestingly, the modifications incorporated in the building actually accounted for a little over 2% of the total building cost and are found to be even lower than the saving estimated in the limited investment due to the chiller size reduction.

The Energy Program building at AIT exemplifies the advantages of implementing energy saving measures without sacrificing the aesthetic and architectural aspects of the building. The building in essence is a very important product of the academic and research work carried out by faculty, staff and students occupying the same.

(Mohanty, B. 1997. Concept of energy conscious building design. Presentations in the RERIC Training Course on Computer Assisted Designing of Energy Efficient Buildings, Feb 6-8, AIT.)



First floor plan



Second floor plan

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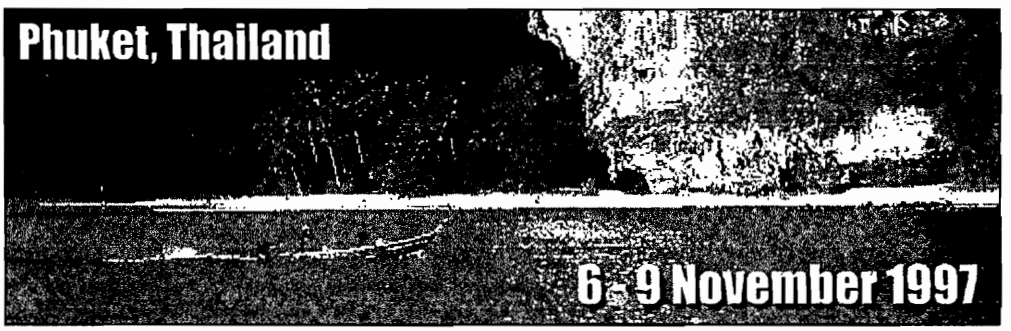

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email : terry@biotec.or.th

A Research Study on the Concept of Technical Information Centers (TIC) on Energy Efficiency and Energy Conservation in Thailand

The Energy Conservation Promotion Act (BE 2535) of Thailand aims to promote efficient use of energy in the country. The act stipulates energy conservation measures in industry and commerce. It has become effective for large buildings since mid-December and for industries it will become effective from July 17, 1997. The owners and operators of such buildings and industries now need to follow the regulations and develop targets and plans for energy conservation measures with the help of consultants. The Department of Energy Development and Promotion (DEDP) is assigned to implement the Act.

In order to ensure timely access of right information to the professional consultants, the scientific community, and the owners, management and technical staff of industrial enterprises and commercial buildings, the Regional Energy Resources Information Center (RERIC) has undertaken a project for DEDP to study the execution and operations of Technical Information Centers (TIC) for Energy Efficient Technologies serving the professional consultants and the scientific community. The Thai-German Energy Efficiency Promotion Project (TG-ENEP) has supported DEDP on this activity. This study was completed in January 1997.

The objectives of the study by RERIC were threefold, namely.

- to gather data of existing TICs in various sectors in Thailand: to analyze scope, form procedures and services of appropriate TIC,
- to assess the needs of clients/target groups, and
- to set up a conceptual design of TIC in the area of energy efficiency and energy conservation.

Accordingly, a survey of sixty one of the one hundred and fifteen major libraries and information centers in Thailand were conducted and their response analyzed to identify their strengths and weaknesses. A user needs assessment study was then undertaken in order to identify the needs and services they require. The users identified in the study were classified into six groups, namely:

- decision makers
- academicians/researchers
- engineers
- consultants
- manufacturers
- owners

Based on the survey of the existing centers and the user needs assessment, the study recommended various aspects of establishment, operation and evaluation of a TIC. The recommended TIC will attempt to fill the gap that exists in the availability of information related to energy efficiency and energy conservation in Thailand. It is also recommended that a sound networking of all stakeholders on energy be established in Thailand in order to share the resources and also not to duplicate/repeat what others are doing.

Renewable Energy in Vietnam

Renewable energy applications for the social and economic development in the rural and mountain areas of Vietnam have recently assumed importance with the increase of interest among those in the government, scientists and rural families. Although it is not yet widespread, the applications of renewable energy (small hydro, solar and wind) have been increasingly diversified in recent years.

At present, Vietnam has about 2500 mini and micro hydro power stations with an output of more than 100 kW, representing a total capacity of 100 MW - 200 MW. The existing small hydro, however, is only 2.5 % of its potential which is estimated at 1530 MW. The small hydro power in Vietnam can be divided into two groups:

a) small hydropower station with capacity of more than 1000 kW, which links with the national/provincial electricity supply systems; and
b) decentralized mini and micro hydro power.

Currently, most solar PV module systems (about 80%) installed in Vietnam are for supplying electricity for communication, while the rest are used for lighting and other household consumption. In the south, several hundred solar PV panel systems are installed by Solarlab, with more than 200 systems supplying electricity to households. More than 20 PV system modules with capacity of 1200 Wp have been installed to supply electricity for communication. A large number of solar PV systems with various capacity ranges, have also been installed in the northern provinces.

Under the National Renewable Program, some wind machine models were developed for pumping and battery charging. Presently, there are 50 wind systems with a capacity of 150 W which have been installed to supply electricity for lighting and radio. However, most wind energy systems are at experimental stage.

(1997. Renewable energy application in Vietnam. *Vatis Update: Non-conventional Energy* 2(21):5)

Thailands's Electricity Supply in the Next Century

The recent years have seen significant changes in the Thai electricity industry. The reform process that are under way in the Thai electricity industry will herald a new chapter in the country's power sector in the next century.

Within the last 20 years, Thailand's power system has expanded rapidly in concert with the economic and social growth. The national installed generating capacity has grown over six folds in 20 years' time (1975-1995). Power transmission for all parts of the country have now been interconnected. In 1995, over 98% of the total villages nationwide have already had access to the national supply system.

Since the past few decades, Thai power industry has mainly been operated by three state enterprises. Electricity Generating Authority of Thailand (EGAT) has been entrusted with the mission of power development, generation and transmission for the whole kingdom, while two others namely Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA) are in charge of distribution system in their designated areas. Operations of state power enterprises have achieved a remarkable and continued success, providing adequate electricity supply to meet consumers' demand. The achievement is unparalleled by any public infrastructure in the country.

For the past decade, EGAT has urgently developed its generation and transmission facilities to cope with the sharp rising demand. This requires tremendous capital investment in each year, and thus causing a heavy foreign debt burden to the government acting as loan guarantor for EGAT. In the past EGAT's loan averagely accounted for over 30% of overseas borrowings of public sector investment in each year.

For years, the Thai government has firmly committed to the policy of privatization and encouraged private sector participation in state enterprises. An overriding objective is to lessen the government's financial constraints on public sector financing. The measure also provides means to increase operational efficiency of state enterprises and to create more competition in terms of price and service. The government's policy and guidelines of privatizing state power utilities has been announced in 1992. The policy has continuously been emphasized in the national development plan which relies even much more on private sector as the main engine for economic growth. Various measures including deregulation have been introduced by the government to provide incentives for and urge the private sector to invest in the power generation business.

In compliance with the national policy, EGAT has undertaken steps to restructure its organization and improve its operation to be more business like at an initial stage and privatized at a further stage. After the amendment of the EGAT Act, EGAT set up its subsidiary, EGCO which later bought Rayong and Khanom power plants from EGAT. EGCO then became Thailand's first Independent Power Producer (IPP) selling electricity from both power plants to EGAT. EGAT also began to purchase electric power from small private power producers. This brought an end to the age of power generation monopoly.

EGAT has primarily restructured its organization into business units and operative units. The business units comprising power plants, transmission, maintenance, mine operation, engineering and construction will soon be formed into separate companies. All except transmission will later be listed on the stock market. At the initial stage, the operation of transmission will be retained under EGAT for reason of national system security.

In parallel with the organization restructure, EGAT also announced its IPP program since 1994 to invite private sector participation in new power projects expected for operation from 1997 to 2003. The first IPP program offering the purchase of 4180 MW has progressed well at various stages of negotiation. A new solicitation of additional 4000 MW power purchase from IPPs will be announced sometime this year.

According to EGAT's long term power development plan, new power capacity totalling over 40 000 MW will be required during the 1996-2011 period to meet the national growing demand. The new capacity will come from EGAT's own power projects, power purchase from both small-and large-scale IPPs and the power exchange with the grid systems of neighboring utilities. More than 60% of the added capacity will be proposed for private undertaking under the IPP program. By the year 2011, IPPs are projected to share over half the country's power system capacity.

The upcoming 21st century will see a new era of the Thai power industry as it will slowly but firmly evolve from the previous heavily state-regulated monopoly into a more liberalized industry where private sector will play an instrumental role in the generation industry. The power sector will have new roles to play, not only to provide efficient and reasonably-priced public service for national development and the well-being of the people, but also to serve as a new important industry among other economic sectors as electricity will be considered more as an economic commodity. The private sector is envisaged to bring to the Thai power industry advanced technology, management know-how, ingenuity and more competition in efficiency, service quality and electricity price that will benefit consumers the most. The power industry will be regulated by the government at the early stage and in the long term by an independent regulatory body to ensure fair competition, overall system security and above all, to ensure private power enterprises act in the public interest.

(Panyamag, S. 1997. Thailand electricity supply in the 21 th Century. *Bangkok Post* (Feb 17, 1997): 9)

Health Effects of Global Warming and Ozone Layer Depletion

Global warming - due to greenhouse gas accumulation in the lower atmosphere - and stratospheric ozone depletion are increasingly recognized as two coexistent, partly related processes that threaten to upset Earth's ecological support systems, and affect human health both directly and indirectly.

A recent analysis of the potential public health impact of climate change concluded that an increase of few degrees in average global temperature would lead to: higher incidence of heat strokes and heat-related deaths; geographic shifts in tropical and infectious disease, and increased occurrence of death, injury and epidemics due to weather-related emergencies and flooding of coastal areas. The public health impacts of stratospheric ozone depletion relate to increased groundlevel exposure to UV-radiation, which is likely to result in greater incidence of blindness and cataracts of the eye; increased incidence of skin cancer among fair skinned people; and potentially an increase in the occurrence of immune system deficiencies. Research is being carried out in an attempt to better quantify these health impacts.

The health impacts that could occur as a result of climate change and ozone depletion could affect people in all kinds of environments. But some health issues relate to the built environment in particular. These include anticipated changes in groundlevel air pollution levels, as induced by higher temperatures and increased UV radiation, the expected increase in the number of heatwaves and potential exacerbation of the urban "heat island" effect. The possible side effects of technologies for adapting to these phenomena, such as increased use of air-conditioning, are also of concern.

The engineering profession clearly has a major role to play in developing and implementing countermeasures within the context of the Framework Convention on Climate Change. These measures must contribute not only to minimizing greenhouse gas emissions and production of chlorine radicals which are responsible for climate change and depletion of the ozone layer respectively, but also to helping societies to adapt to the impacts of these human induced processes. Construction of buildings, heating systems and air-conditioning systems that are energy-efficient will be of especial importance.

(Slooff, R.; McMichael, A.J.; and Kjellström, T. 1996, Global warming and stratospheric ozone depletion: Two sources of risk to human health in the built environment. *WHO Environmental Health Newsletter* 26: 10-11)

Solar Energy to Deliver Electricity to Homes in Rural Indonesia

An International Bank for Reconstruction and Development (IBRD) loan (US$20 million) and a Global Environmental Facility (GEF) Trust Fund grant (US$24.3 million) will support the sale and installation of solar home systems to deliver electricity to rural homes as well as to small shops. This is the first large project of its kind in Indonesia.

Over 115 million Indonesians, out of the 195 million, still have no access to electricity and most are not likely to get it in the near future according to Asun Sunghvi, a senior energy economist at the World Bank. This project will provide electricity to one million homes in rural Indonesia.

The IBRD loan will provide credit to commercial banks, who in term, will make loans to solar home system dealers - mostly small businesses. Because few rural households can pay on a cash basis, the dealers will provide credit for 4 years. The customers will make a down payment of about US$75 to US$100 per unit and pay US$10 per month for 4 years. The GEF grant will be used for down-payment subsidies of about US$100 per household.

The project will introduce a modern source for electricity to rural people who cannot be served by the state electricity company. Today, most Indonesians in the country's rural areas have no artificial lighting sources other than candles, flashlights, and, most commonly, 19th century kerosene lamps, which are highly polluting and dangerous. These provide dim lighting, which causes eyestrain. Further, the kerosene produces toxic fumes and dust particles that are flammable. Using solar energy reduces the harmful emissions of carbon dioxide by decreasing the use of kerosene and diesel fuel, and reduces dependence on imported fossil fuel.

By increasing access to electricity and lighting, they also extend daylight activities. This has a positive effect on the quality of education and learning experienced by children who can study in better lit environments after sunset. It also allows increased income-generating activities. Solar streetlight increases freedom of movement and participation in common activities after sunset.

For more information contact:
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Washington DC, USA
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email: kversak@worldbank.org

(1997. Solar energy to light up million homes in Indonesia. *Sustainable Energy News* 16:20)

Trust Fund for Renewable Energy in Peru

Introduction

With the establishment of the Trust Fund for Renewable Energy (TFRE) in Peru a vehicle has been created to overcome one of the main constraints to the dissemination of renewable energy technologies. The Trust Fund will provide small loans for renewable energy projects to households and micro industries through intermediaries (NGOs and equipment suppliers). The Fund will be managed by Corporación Financiera Para El Desarrollo (COFIDE), a second tier bank; the loans will be disbursed through first tier financial institutions within the existing COFIDE network. The contribution of the Dutch Development Cooperation to the Funds is US$5.3 million.

The Problems

In Peru, Renewable energy technologies have proven to be competitive energy options, in particular in remote areas. One of the main barriers for dissemination of renewable energy technologies, especially for people in the low and medium income groups, is a lack of access to small credits. Local banks are reluctant to provide the required financing, because loans to low income groups and the rather unknown renewable energy technologies are perceived very risky. The Trust Fund has been designed to overcome these perceived risks through dedicated credit lines for proven renewable energy technologies, establishment of a guarantee fund and technical assistance and promotion services. The aim of the Trust Fund is to improve the living conditions of low income Peruvians and to contribute to sustainable development by creating access to renewable sources of energy.

The Fund

The Trust Fund performs two functions: the finance function (including risk sharing) and the technical assistance and promotion function. The finance function is performed by COFIDE, and has two components: a revolving loan fund (RLF) and a guarantee fund. A special Program Promotion Unit (PPU) is responsible for the Technical Assistance Program, including a resource and information center, technical assistance to financial and promotion institutions, monitoring and evaluation of renewable energy projects, and area promotion campaigns.

COFIDE is a state-owned financial institution with the aim (as a second-tier bank) to contribute to the enhancement of investments in the country and to increase national production through the promotion of investment projects, start-up of new companies and support to those already in operation. COFIDE has a national coverage, both in urban and rural areas, through a network of more than 40 (first tier) financial institutions.

A Board of Trustees (3 members) is responsible for financial management supervision of the Fund. The main task of the Board of Trustees is to ensure that the proper policies and mechanisms for financial control are in place. Legally responsible for the Trust Fund is a Board of Directors (5 members), consisting of representatives of the actors involved: COFIDE, promotion institutions (e.g. NGOs), financial institutions and suppliers of renewable energy equipment. The Board of Directors has delegated financial management of the Trust to COFIDE in its capacity of fiduciary, and the promotion function to the PPU.

During the first phase of two years, non financial services (promotion and technical assistance) can be financed through a grant, managed by the PPU. The policy is to focus project activities initially on the following areas: Arequipa, Cusco and Puno in the south, and Cajamarca, Lambayeque and Piura in the North. During the second phase (as of the third year), the non-financial services will be financed through capital returns on the Fund in order to guarantee the sustainability of the fund. Whether this approach is feasible, is one of the challenges of this Trust Fund.

Project Cycle

The Trust Fund has been established to finance projects which can not be financed by regular credit facilities. The PPU has among others the task to inform the public on this possibility, and to train both financial institutions in appraisal of renewable energy project proposals, and promotion institutions on how to prepare bankable project proposals.

Potential applicants for obtaining a loan through the Trust Fund for Renewable Energy (TFRE) are intermediary organizations: promotion institutions (mainly NGOs) and suppliers of renewable energy equipment; beneficiaries are both households and small enterprises. The first step in the process is for the applicant to prepare a project outline using a standard format provided by the PPU; these outlines will be appraised by PPU. In the selection process of project outlines, one of the aims of PPU is to obtain a balanced loan portfolio with respect to the technology supplied, and the NGOs and suppliers involved. Approval of the project outline also indicates in principle the willingness of co-financing or risksharing by the TFRE.

If the outlines suffice the criteria set, the applicant is requested to prepare a full fledged proposal for submission to a local financial institution, e.g. a commercial bank. The project proposal will also have to indicate the technical assistance required. The cost for TA will be included in the proposal; PPU can decide whether to fund the TA component of the proposal through its Technical Assistance Program.

The local financial institutions are entirely autonomous in their approval of renewable energy project proposals, and can finance approved proposals under their regular credit facilities, or approach COFIDE/PPU for financing, rish sharing or technical assistance. The local financial institution is responsible for debt collection and project supervision, and will be autonomous in establishing the interest rates to the clients. COFIDE (second tier) lends to the local financial institutions (first tier) at about 12%.

Extent of support

The program provides financing

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SMALL SCALE WIND ENERGY SYSTEMS

Published with financial support from the Netherlands Ministry for Development Cooperation
Editors: Renewable Energy Development v. o. f.

EDITORIAL

In this March 1997 issue, we have both windpumping and windcharging. HGa from the UK informs about progress on the windpumping network in Asia. From the Philippines, the use of local windpumps is reported. The Shandu Factory in China gives a short introduction to its range of windcharger products, while from Mauritania there is news about the Alizés project for rural electrification.

Yet, we would like to have more people in the South writing us. Mail, fax, or e-mail us your news from anywhere, even if you do not have time or inspiration to write a complete article: we are here to help you. Especially in the small-scale wind business, your experiences could be valuable to others. So tell us!

Jan de Jongh and Remi Rijs, editors

Wind-Electric Power for Communities in Mauritania

The use of renewable energy technologies for small-scale electric power generation is just beginning in Mauritania. Within the framework of a US$ 40 million program for pumping in West Africa, the EU Fund for Development is financing the installation of PV pumps in several areas of the country. However, in areas with reasonably satisfactory wind resources (monthly mean wind speed above 4 m/s), wind turbines can provide a more economical method for decentralized electricity generation. Mauritania is one of the windiest countries in West Africa. The sketchy wind data available reveal average wind speeds ranging from 4 m/s to over 8 m/s over much of the country, which would make small wind generation systems more economical over their lifecycle than small engine generators and PV, its only practical competitors.

The UNDP/GEF Wind-Electric Project

The Alizés Wind-Electric project was designed to build on the Alizés water pumping project between the Mauritanian Government (Ministry of Water and Energy, Division of Energy) and the French NGO GRET. This aimed at establishing village-based water supply using mechanical water pumping windmills. By requiring (and achieving) financial and social participation by the villagers, the program now provides clean water on a reliable and continuous basis in 100 villages. The new wind-electric project makes direct use of the resources and infrastructure established by GRET, the local private sector, the villages and the Government.

Project Background

Mauritania is a West African country bounded to the north by West Sahara and Algeria, to the east and south-east by Mali, to the south by Senegal, and to the West by the Atlantic Ocean. The land area is slightly over one million sq. km., but with only two million inhabitants. Two thirds of the land is desert; the southern region is Sahelian. Only in the flood plain of the Senegal river, the border with Senegal, there is abundant water and rich soil suitable for intensive cultivation. Ten percent of the population lives in the desert, the majority lives on just fifteen percent of the land, primarily in the Sahelian, coastal and Senegal river regions. The subsector of concern in the present project includes the unelectrified population in both the rural areas and the approximately 1 million people in the peripheral zone around the capital, Nouakchott.

Because the rural population density is very low, provision to the villages of basic services such as water pumping, health care, and lighting is difficult and expensive. Even in the more densely populated southern region, villages have only a few hundred inhabitants. A village like Keur-Macène with more than 1,000 inhabitants is considered large. Few villages have any access to electricity.

The lack of electric power in most parts of the country is a major obstacle to improvement in these areas. Electricity is a key input to address these issues (although obviously not the only input necessary). The specific applications of electric power in the rural area include: household lighting, radio and television; water pumping (including deep pumping beyond 30 m); water treatment; surface pumping for irrigation; battery charging; refrigeration; miscellaneous (electric fencing and other needs); community needs such as health stations, schools, mosques, shops, workshop and public lighting.

Implementation

In the months of April to June 1996, the Dutch supplier LMW installed 14 wind turbines with capacities of 1000 Watt - 2500 Watt rated power. These turbines are mainly used for charging 12 V/50 Ah batteries, which will be used in private houses with one or two 8-10 Watt tube lights and sometimes a black/white TV set per

(contd. on p. 2)

(contd. from p. 1)

household. The families in the villages pay 200 MU (= 1.5 US$) monthly and 200 MU per charging. One family will need about 3-4 chargings a month. The batteries are equiped with a charge controller to protect the battery against overcharging and discharging. The battery and controller are stored in a protecting wooden box. The controller and the tube light are locally produced.

LMW has several years of experience in Mauritania in wind electric power supply. In 1992, it supplied three wind turbines LMW1003 to GRET through the French company EED in Lille. These turbines have been installed in the southwestern part of the country. One of them has been installed in Tighent and is used for battery charging. Tighent is a large village with e.g. a school and a hospital, and the batteries serve a grid which supplies the small shops in the village. When there is sufficient power, private users' batteries can be charged as well.

The second LMW1003 has been installed in a village near Rosso. It is only used for battery charging. An operator takes care of the system and cashes payments from the inhabitants. A refrigerator has been removed because it consumed too much power.

The third wind turbine is used for pumping water in the village Keur-Macène along the river Senegal. The water is pumped from the river and stored in a tank for 24 hours to precipitate. From the first tank the water is pumped into a second storage tank and will be further processed to clean it for use as drinking water. A storage tank on a hill is 400 m away from the wind turbine. A local network is created in the village. The three installed wind turbines show the benefits from wind energy: economical by electric light in shops; social by lighting and TV in households; health by clean water.

Local Cooperation

For the execution of the new project, LMW started collaboration with two local companies, one for local production of towers, installation and after-sales service and one for the supply and installation of the electrical works.

During the execution of the project Mr. Kuikman has given training for the production of the tower, frame, tail and tail vane, and for service and installation. In the next phase of the project, which will start in the second half of 1997, another 85 wind-electric turbines will be delivered. A substantial part of the systems will be produced by local enterprises, though the materials for the production will be imported from the Netherlands.

(Johan Kuikman, Fortis Wind Energy Systems Haren, The Netherlands, Fax: +31-50-534 0104)

The Windpumping Network in Asia

A UK Overseas Development Administration project to stimulate windpump activities in China, India, the Philippines and Vietnam, has formed associations of the key players within each country to formulate national plans for windpump market development. In addition, an international workshop to promote collaboration in the region was attended by representatives from each country and served as a forum for the introduction of a database of windpump publications developed by the project consultants.

Previous articles in "Small Scale Wind Energy Systems" describe a market analysis for windpumps in the region (supplement to RERIC News Vol. 17 nos. 3 & 4) and the objectives and methodology of the current project (Vol. 19 no. 1), coordinated by Hga (UK) with support from Gamos Ltd (UK) and RED vof (The Netherlands).

Preparations

The project started in each country with a workshop attended by representatives of the key organizations in the country. Following this workshop, national associations were formed which developed their terms of reference (TORs) and national strategy plans to be presented at the international workshop.

International workshop

The international workshop was hosted by the Center for Scientific Research (CSR) at Auroville, India in November 1996. Four representatives of each local association participated as well as the consultant team. After a first session analyzing the barriers for windpump market development, three groups were formed to discuss possible solutions, addressing the problems from different perspectives.

Policy and Integration

It was suggested that the associations were an effective way to co-ordinate representation of the windpump industry in the formulation and implementation of policy and that:

- realistic national level policies are required
- policies should not necessarily result in subsidies as these can lead to unsustainable growth
- policies should focus on demonstration, dissemination and training
- the promotion of windpumps should be integrated within a renewable energy, rural water supply and development strategies.

Markets and Users' Awareness

A major barrier to windpump development is a lack of awareness or mistrust of windpumps which often have poor reputations. Therefore, promotional information needs to be gathered from successful demonstration projects and made available to policy makers and potential users.

Technical, Manufacturing and Sales

It was agreed that windpumps could be made more reliable and hence attractive to the market by taking the following actions:

- an integrated approach to machine supply, including finance, insurance, borehole development, installation and on-going maintenance
- improve the flow of information to share world-wide windpump experience
- produce manufacturing, installation and operating guidelines, perhaps backed up by some form of certification
- provide guarantees, warranties or service contracts
- ensure adequate and suitable information (and tools and parts) are provided to assist user servicing.

Country Initiatives

Proposals From China

The Chinese representatives proposed two major projects:

- a smaller project to irrigate approx. 700 ha of the land with groundwater outflow from an existing reservoir using locally produced windpumps
- a project in Cangzhou, where almost 7000 ha could be desalinated using locally made windpumps and underground drainage pipes. It is estimated that 30 000 farmers will finally benefit from this project.

It is proposed that both projects be funded by a combination of local and foreign funds.

Proposals From India

The Windpump Network India (WPNI) will undertake several activities aimed at developing local and government initiatives to stimulate windpump development and achieve mature technologies by:

- improving existing windpump designs in India
- importing and testing proven models from abroad for various applications
- strengthening market research
- investigating innovative funding arrangements for windpumps
- organizing training and awareness raising programs for government officials, institutions and manufacturers
- lobbying for more favorable government policies toward wind pumping in India
- stimulating manufacturers to impart proper operation and maintenance training for windpump users.

Proposals From The Philippines

The representatives from the Philippines outlined the development plans of the Wind Energy Association of the Philippines (WEAP) which divide into three components:

Technical

- a program of technical evaluations of existing windpump installations
- test center to test new and improved designs before commercialization
- continued efforts to improve the designs for application in local conditions, particularly to resist typhoons and be effective at the generally prevailing low windspeeds.

Marketing

- demonstration sites will be selected for various applications
- technology fora will be conducted for target users and decision makers. This has been a successful strategy for promoting new technologies to farmers' co-operatives, local NGOs and local government decision makers.
- promotion of the importance of after-sales service and an integrated approach to new installations.

Policy

Using its position in the government supported Renewable Energy Association of the Philippines (REAP), the association will lobby for an amendment of the Non-Conventional Energy Bill to encourage renewables.

Proposals From Vietnam

Technical knowledge of windpumping and its applications in Vietnam is still limited and therefore the proposed program will initially collect data regarding wind resources in Vietnam, technical exchanges on wind machine design and manufacture, and investigation of available technologies suitable for local conditions. The second project stage will move into demonstrations of appropriate windpumps for various applications. An interesting potential market is for low lift pumps to serve shrimp farms and salt pans. Other potential applications include small irrigation schemes for vegetables and cash crops, and domestic water supply. There is also strong interest in small wind generators.

Database Development

A key issue to emerge during the course of the project was the need for appropriate and adequate information to assist the regional networks. A database has been developed on windpumps and project management, financing, development issues and manufacturing. The CD ROM database includes photos, video clips, manufacturers data, technical papers and related literature. Some key publications are included in their entirety, while from others a primary source or a library is referred to. The CD ROM is currently available only to the four local associations but it is hoped financing is found for wider distribution and continued improvement.

Conclusions

The creation of windpump associations within each country appears to be an effective way to stimulate and co-ordinate the windpump sector; previously many association members carried out activities in isolation from fellow association members. The networks encourage a more co-ordinated lobby to policy makers and lead to a more integrated approach to face common challenges. At the workshop in Auroville it was widely agreed that an international network would be beneficial. Currenly a group of one representative of each country association is investigating the possible formation of such a network.

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CWD publication "Windpumps for Irrigation"

This work, edited and published in 1990 by the Dutch Consultancy Services Wind Energy Developing Countries, covers all necessary information to assess the viability of wind pumping for irrigation in developing countries. Farming systems, technology, collection of climatic data, windpump output, irrigation demand, storage, economics, and project setup are described. The book contains 97 pages and a limited number of copies is available from the editors, at US$ 8,-, incl. postage.

Advances in Chinese Wind Generator Technology

The Shandu Animal Husbandry Machinery Factory (SAHMF) in Inner Mongolia, China, is the only factory assigned by the Ministry of Machinery Industry to produce wind generators in series. With 21 years of experience in product development and production methods, SAHMF's wind generators were the only ones which passed the Ministry's reliability tests. The company now produces three different types of wind energy equipment. The annual production already reaches 10 000 units, or about 65% of the total number of wind generators produced. Products are not only sold in China but also abroad.

Since 1975, the factory has cooperated with many colleges and institutes for product development. Among them are the Institute of Prairie, the Chinese Academy of Agricultural Sciences, the Tsinghua University, the Harbin Electronic Engineering College, the Huazhong University of Science and Technology, and others.

Emphasis is on technology improvement. In 1988, a new wind machinery manufacturing technique was acquired from the SVIAB Company in Sweden. At present, thirty different types of wind energy equipment can be produced, ranging in capacity from 50 W to 5 kW. Both wind generators, water lifting windpumps and combined wind-solar cell units are produced. All systems offer good performance at low wind speeds, and the tendency is to further simplify the structures. Our principal wind generatore types are mentioned below:

- wind generator FD-100; strong, efficient and fatigue-resistant, by using an integrated, glass fiber reinforced plastic wind wheel. Good properties at low speed;
- wind generator FD 2.5-300; unique corrosion protection with high-innerdamping, climateproof blades. The generator is resistant against corrosion, dust and mildew;
- wind-solar system FD 6-5 kW; composed of a wind generator, a large solar unit and a storage battery. Solar energy will take over during low wind speeds or lack of wind. This system is useful in an alternating climate.

When looking on water-lifting wind machines, SAHMF produces a pull-bar pump and a large-flow windpump. These pumps are suitable for areas with high wind resources, to lift water from deep wells, to provide drinking water for men and animals and for irrigation.

The factory is devoted to the development and usage of wind energy as well as to the research and production of wind generators. Regarding the future, the effective usage of wind energy and solar energy will become the subject of mankind, exploring new energy. SAHMF wishes to contribute to the energy problem by making high quality, large-power wind generators, and when possible in cooperation with others.

(Yang Bing, Shandu Animal Husbandry Machinery Factory, No. 28 Xinxing Road, Shangdu County, Inner Mongolia, China Fax: +86-474-690 2461)

Indigenous Windpumps in Barangay Utod, Philippines

To our own surprise, locally-made windpumps are being used in Barangay Utod, a rural village in the municipality of Pulupandan, Negros Occidental, in the Philippines. These windpumps were spotted on a mission of our Affiliated Non-Conventional Energy Center of Silliman University, in an effort to monitor existing non-conventional energy systems in our area of coverage (Negros Occidental, Negros Oriental and Siquijor).

The windpumps are made of crude materials. Four rotor blades made of used, corrugated galvanized iron sheet, are attached to wooden spars which form a cross. The mounting frame and the pump rod are made of bamboo. The pump cylinder, at the same time serving as the pump riser, is made of a PVC pipe. One end of the shaft is fastened to the rotor, whereas the other end moves the crank mechanism driving the pump rod.

It should be noticed that the windpump has no tail vane. However, the system does not need such a mechanism because the salt making activity is recurring from January to April, when the prevailing wind is the Northeast Monsoon. The rotor plane is therefore permanently positioned perpendicular to the direction of the prevailing wind.

The production of salt from sea water is a major economic activity in Utod. The use of windpumps eliminates the burden of drawing sea water, thus saving human energy which can be used for productive purposes. This development is a good example of the people's ingenuity to create their own technology in harnessing free energy from nature, to facilitate their lives.

(Mario J. Manginsay, ANEC - Silliman University, 6200 Dumaguete City, Philippines, Fax: +63(35) 225 2900)

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exclusively for renewable energy technologies, such as solar photovoltaics, micro hydropower, solar water heaters, windmills for water pumping and electricity generation, solar dryers, biogas installations and improved woodstoves.

The clients has to pay at least 20% of the project cost; as a consequence, the loan will not exceed 80% of the project cost. The loan is further limited to US$ 100,000 per renewable energy project; exceptions require approval by the Board of Directors but shall not exceed US$ 200,000. If the clients are households, the loan shall not exceed US$1,000 per household. It the clients are micro enterprises, the maximum loan is US$ 10,000 per enterprise.

(Contributed by Mr Winfried Rijssenbeek, SEM Coordinator, Dutch Government Support Group for Energy and Environment, Kastanjelaan 5, P.O. Box 64, 3830 AB Leusden, The Netherlands)

Sustainable Energy Project in Thailand

A joint 5-year project between the Appropriate Technology Association (ATA) in Thailand and the Danish Organization for Renewable Energy (OVE) has been initiated in Thailand.

The objectives of the project are:

- to increase the capacity of ATA and the Thai NGOs on identifying, organizing, and implementing sustainable-energy activities.
- to increase the awareness of the Thai public on environmental and social impacts of different energy solutions as well as of the prospects for sustainable energy development.

The project is funded by the Danish Cooperation for Environment Development and will involve other NGOs in both countries besides ATA and OVE. The activities will be carried out in Isaan, the North-eastern part of Thailand, where ATA has been in operation for many years.

Further information may be obtained from

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(Tobiesen, F. 1997. Joint INFORSE 5-year project starts in Thailand. *Sustainable Energy News* 16:10)

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RERIC HRD Training Course Held

The RERIC Human Resources Development (HRD) training course titled `Computer Assisted Designing of Energy Efficient Buildings' was held successfully during 6 - 8 February, 1997 at the Asian Institute of Technology (AIT), Bangkok, Thailand.

The participants were exposed to various aspects of building design e.g. evaluating the comfort conditions in a building; calculating cooling loads when air conditioning is required; calculating the dissipated heat gain in an enclosure, solar radiation input or casual gains, and determining the effect of the building's inertia.

(Course Director Dr Brahmanand Mohanty (left) with CLAIR Executiuve Director Dr. Robert D. Stueart and RERIC Manager Mrs. Lilia R. Austriaco)

(A partcipant from Thailand receiving the certificate from the Course Director)

The course was attended by seven participants from Indonesia, the Philippines and Thailand. Dr. Brahmanand Mohanty, an Associated Faculty in the Energy Program of the Asian Institute of Technology (AIT), was the course director.

RERIC will be organizing similar training courses in the future which will be announced in the near future.

The course was based on a pedagogical software for buildings called CASSAMO developed by the French Environment Management Agency (ADEME) and the Energy Program, AIT. A licensed copy of the software with the accompanying user and reference manuals were provided to the participants at the end of the course.

(The participants with the Course Director and RERIC staff)

Renewable Energy Targets of India

Energy demand in India is increasing at the rate of 9% per annum and supply is not keeping pace. One study has shown that India would have to spend RS 860 billion (U$27 million) annually to the year 2020 to just satisfy its energy demand, if the present energy use patterns persist.

Recognizing the potential of renewable energy, India embarked on a massive program of developing renewable energy alongside conventional grid power. An ambitious target of generating 2000MW of power from renewable energies has been set for 1995-1997.

Besides grid augmentation, renewable energy technologies offer possibilities of distributed generation at or near points of use. The Strategy and Action plan has accordingly given special emphasis to the generation of grid quality power from renewable energy sources.

Wind Energy

In 1995, installed wind power generation capacity passed the 500 MW. By the end of March 1995 (with 732 MW installed), India ranked third in the world after USA and Germany. India is also implementing the world's largest wind resource and assessment program. According to one estimate, India has a wind power potential of around 20 000 MW. A national wind resource assessment program has been implemented in which a total of 530 wind mapping stations have been sanctioned.

Solar Energy

Both solar thermal and solar photovoltaic routes are being studied, with a view to establishing a sound technology base and manufacturing capacity, and to provide operational experience to utilities and industrial users.

About 70 companies are involved in the manufacture of solar photovoltaic modules and photovoltaic systems in India. Thirteen companies are in regular production with an output estimated at 4 MWp to 8MWp a year. Two 100 kW grid interactive solar photovoltaic (SPV) power plants have been installed in Uttar Pradesh. Each project provides 25 kW to the grid. The balance of 75 kW supplies domestic/street lights and irrigation pumpsets.

During the past few years, many organizations have started using SPV systems for a variety of applications on an economically viable commercial basis. Telecommunications continues to be the largest single user with SVE systems being used to provide power for rural telephones, railway signalling, low power transmitters and a range of other special usages in remote areas. Also some 8000 villages in remote areas with low requirements have utilized standalone SPV street lights.

Biomass

Programs are also being developed for direct combustion and grid interactive gasification using biomass and agricultural residues. Biomass can be used effectively for generation of power by direct combustion, gasification, and methane derived from industrial effluents.

With the expertise gained in decentralized rural electrification from renewable sources, India is poised to accelerate the pace of rural electrification in the remote areas through hybrid energy mixes. The need to meet energy short falls is particularly serious, and it is the mix of central government and state financing policies which will alleviate this problem.

[1997. Rural electrification programs in India. *CASE International Solar News* (February 1997): 4]

Promotion of Renewable Energy Systems in South East Asia (PRESSEA)

PRESSEA is an on-going project to establish an information network for European renewable energy systems and technologies for rural electrification in 5 selected countries in South-East Asia (Indonesia, Malaysia, Philippines, Thailand, and Vietnam). A pilot market study in the biomass sector will be conducted in two countries (Philippines and Thailand). The results from this will be a good example of the information which can be fed into the network. The project aims to complement other European Commission (EC) initiatives in the region eg. the ASEAN-EC Energy Management, Training and Research Center (AEEMTRC) and the EC-ASEAN COGEN Program.

The provision of electricity for rural communities not served by grid suppplies in developing countries is one of the main aims of the energy programs of the multilateral development banks and the international funding agencies.

In the countries of South-East Asia there is a growing level of activity by these international organizations in supporting investments and loans aimed at stimulating the increased take-up of renewable energy technologies for rural electrification.

This phase of the project will assess the potential for establishing a renewable energy information network and will identify potential local partners. A network will enable a two way flow of important renewable energy information between interested European Union companies and South-East Asian partners. Asian partners will benefit from access to up to date information on European renewable energy technologies, products, information on successful renewable energy projects and also case studies of best practice as well as contact details for possible project partners. This will help to stimulate the introduction and implementation of renewable energy technologies in the region.

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BOOK REVIEWS

How global is global and how warm is warming?

ISBN 81-854519-19-1, 1996, 20p.

Introduces the problem of global warming and climate changes, underlines the issues and challenges involved, highlights the projections of rising temperatures and effective responses from the international community.

Changing coastlines: effects of climate change

ISBN 81-85419-20-5, 1996, 20p.

Provides an overview of the issue of sea level rise and its impacts on coastal zones.

CO_2 mitigation and the Indian transport sector

ISBN 81-85419-18-3, 1996, 27p.

Deals with the growing demand for transportation in India, and the contribution of motorized road transport to climate change. It highlights the nature and magnitude of transport-related greenhouse gas emissions in India, and identifies possible approaches to mitigate them.

TATA Energy Research Institute (TERI)
Published by TERI, Darbari Seth Block, Habitat Place, Lodhi Road, New Delhi - 110 003 India.

This series of publication presents a complete picture of global warming, its major sources of greenhouse gases, and the major impacts it will have. The many figures, tables and case descriptions equip the readers with the complete picture of this important topic. This series will serve as a good reference for people of different background in getting an overview of the problems and prospects of global warming.

Motor Vehicle Air Pollution: Teacher's Guide One Week Training Workshop

WHO/EHG.96.14, 116p.

Prepared by the WHO Global Environmental Technology Network (GETNET)

This teacher's guide covers a curriculum that has been developed for use by teachers in a one-week workshop on motor vehicle air pollution. The workshop's goals are to provide an overview of the subject, an understnading of the health effects associated with pollution from motor vehicles, and an introduction to potential control measures. The aim of the workshop is to enhance knowledge and skills in the management of motor vehicle pollution problems, and to increase awareness of resources in the field of motor vehicle air pollution management.

Workshop participants may be drawn from a wide range of disciplines. They may include public health officials, teachers at universities or other post-secondary eductional institutions, and managers of environmental programs. The workshop is designed to encourage and facilitate future collaboration among participants in the management of motor vehicle air pollution problems in their countries.

The guide gives a detailed course outline for the whole week along with worksheets, reference materials, case studies, background data, exercise, evaluation forms etc to be used for the workshop.

* * * * *

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International Events

INSIDE ASIA

17 - 19 June, 1997, Sub-Saharan Oil & Minerals, Grand Baie, Mauritius.
Contact:
Europe Energy Environment in Johannesburg
Tel: 27-11-442 3230
Fax: 27-11-442 4198

23 -26 June, 1997, Demand Side Management, Mandarin Singapore, Singapore.
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AIC Conferences
12 Prince Edward Road
#03-01, Podium A, Bestway Bldg,
Singapore 079212
Tel: (65) 322 2700, 222 8550
Fax: (65) 223 3554

17 - 19 July, 1997, Improving Billing, Metering & Customer Care Management for Utilities in Asia, Hilton International, Kuala Lumpur, Malaysia.
Contact:
IBC Asia Limited
268 Orchard Road
#18-02, Singapore 238856
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Fax: (65) 733 5087/ 736 4312

22 - 24 July, 1997, ISAAE '97 Int. Symposium on Advances in Alternative/ Renewable Energy, Johor Bahru, Malaysia.
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Locked Bag 791, 80990 Johor Bahru,
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24 - 29 August, 1997, ISES 1997, Future Globe in the Sun, Korea.
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Seoul 135730, Korea.
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10 - 12 September, 1997, Vietnam Electricity Expo '97, Hanoi, Vietnam.
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6 - 7 October, 1997, CLEAN ENERGY '97 International Conference and Exhibition on Future Energy and Energy Saving, Hotel Portman Shangri-La, Shanghai, P. R. China.
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Project Management International
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12 - 16 October, 1997, CIOGE '97-- China International Oil & Gas Exhibition In conjunction with 15th World Petroleum Congress, China.
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14 - 16 October, 1997, Asia Pacific Initiative for Renewable Energy & Energy Efficiency '97, Jakarta, Indonesia.
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20 - 23 October, 1997, International Conference on Large Scale Water Resources Development in Developing Countries: New Dimensions of Prospects and Problems, Kathmandu, Nepal.
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2 - 4 November, 1997, OGE '97-- 2nd Indian International Oil & Gas Exhibition & Conference, India.
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6 - 9 November, 1997, Second ASEAN Renewable Energy Conference, Phuket, Thailand.
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11 - 12 December, 1997, Climate Convention, 3. Conference of the Parties, Kyoto, Japan.
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Secretariate for the Framework Convention on Climate Change, Bonn, Germany.

OUTSIDE ASIA

5 - 7 June, 1997, Implementing Sustainable Energy in a Changing World, 23rd Annual Conference of the Solar Energy Society of Canada Inc. (SESI), Ontario, Canada.
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Fax: (613) 234-2988
Email: sesci@sympatico.ca

9 - 11 June, 1997, North Sun '97, The International Conference on Solar Energy at High Latitudes, Espoo-Otaniemi, Finland.
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(contd. on p. 12)

(contd. from p. 11)

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10 - 11 June, 1997, Conference and Exhibition: Small and Medium Hydropower Projects, Berne, Switzerland.
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15 - 18 June, 1997, WINDPOWER '97, American Wind Energy Association Annual Conference, Austin, Texas, USA.
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22 - 27 June, 1997, European Sustainable Energy NGO Seminar, Slovakia.
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30 June - 4 July, 1997, 14th European PV Solar Energy Conf., Barcelona, Spain.
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21020 Ispra (VA) Italy.
Tel: +39-332-785885
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8 - 11 July, 1997, ACEE Summer Study on Energy Efficiency in Industry, "How Industry Will Procure Energy Efficiency Services in the 21st Century", New York, USA.
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27 September - 1 October, 1997, Hidroenergia: The 5th International Conference and Exhibition, Dublin, Ireland.
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Ireland.

6 October - 8 November, 1997, Energy Management and Cleaner Production in Small and Medium Scale Industries (Training Program), Enschede, The Netherlands.
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19 -22 October, 1997, 13th Annual Canadian Wind Energy Conference & Exhibition '97, Chateau Frontenac, Quebec City, Quebec, Canada.
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19 - 21 November, 1997, 4th European Conference on Energy Efficient Lighting, Copenhagen, Denmark.
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20 - 25 September, 1998, World Renewable Energy Congress V., Florence, Italy.
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Dwellings in Thailand Start to Harness the Sun

Solar power is already widely used in Western households, and now after years of experimentation in Thailand it has finally made its way into the first group of selected houses in Bangkok and the suburbs.

The pioneer project is designed to bring the natural source of power into common usage in Thai households in the near future. Installation of the solar-power system in the first 10 houses is complete, with the Electricity Generating Authority (EGAT) paying 45% of the total cost and the house-owners paying the rest.

EGAT, in cooperation with the National Energy Policy Office (NEPO), launched the pilot project to have 10 selected households produce electricity from solar cells.

Workers from the Electricity Generating Authority of Thailand install solar cells on one of the 10 houses selected for the alternative-energy program.

Solar energy is of course not new to Thailand, a country with ample sunshine, and solar cells have been visible around Bangkok for some time at certain government establishments and big private-business premises. EGAT's pilot project, however, is to introduce the innovative concept of energy conservation made possible by the advance of solar technology.

In the past, any excess supplies of electricity from solar energy could be stored for only a short period and were often wasted. Under the newly introduced project, each of the 10 households will generate electricity for its consumption and supply excess capacity during off-peak hours to the main electricity grid.

The solar-cell household will become a "mini" power plant to provide electricity for public consumption.

According to Pinit Siripruekpong, the chief of EGAT's Alternative Energy Sources Division, the installation of solar cells in households would serve a dual purpose, saving electricity costs for participating households and helping EGAT meet rising electricity demand, especially during peak consumption hours.

Pinit pointed out that in the long run, as more households turned to the use of solar energy, the project would have a significant impact on environmental preservation because the country could become less dependent on other sources of energy which cause environmental degradation. Fossil fuels cause the greenhouse effect, while nuclear power requires costly cleanups, according to Pinit.

According to an EGAT's study, the country has a total of 150 power plants with

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a generating capacity of 16 000 MW, enough to meet this year's demand of 15 000 MW plus a required reserve capacity of 18.8%.

In the next decade demand for electricity is expected to rise to 41 000 MW, almost three times the present capacity.

Pinit said EGAT would have no choice but to keep on building power plants, a move which could create environmental nightmare if the public were not encouraged to cut down on electricity consumption. The problem of meeting rising energy demand has been aggravated by a shift in consumption habits. With progress in industrialization, the peak hours of electricity consumption have moved from early evening to the period between 10 a.m. and 2 p.m., and peak-hour demand is growing at an accelerated rate.

The household produced electricity from solar energy could help to offset the peak-hour demand because the households usually have excess supplies during the day.

Since August 1997, EGAT has been recruiting volunteer households to join its project for electricity savings by converting to the use of solar energy. Out of the initial response from 400 Bangkok residents, it selected 10 households to participate in the first phase of the project. About 120,000 people have subsequently applied and are waiting to join the second phase, scheduled to begin in the next six months.

Installation will cost about US$ 13,000 (Baht 548,400) per household. Project manager Udom Kunarat said solar cells, each having an operating life of 20 years, had been installed in all 10 households and were already in service.

Udom estimated that each participating household would save at least 10% of its monthly electricity bill after the conversion to solar energy, not counting additional saving from the selling of excess supplies for public consumption.

The net electricity charge for participating households will be calculated on the net electricity supplies from the main grid, which might be needed to supplement the solar energy during peak hours, less the excess supplies which the households send out during off-peak hours.

Each solar cell installed has the capacity to generate about three hundred to four hundred units of electricity a month, while the participating household consumes an average of three thousand units per month. If 100,000 households join the program and help save about 10% of electricity consumption, EGAT could shut down a small power plant.

[1998. Dwellings in Bangkok start to harness the sun. *The Nation*, 23(48153):A2]

World Bank Support for Sustainable Energy in Sri Lanka

One of the outcome of the World Bank initiatives for renewable energy is a US$ 24 million loan for the Sri Lanka Energy Sevices Delivery (ESD) Credit Program. This loan, combined with a US$5.9 million grant from the Global Environmental Facility (GEF), shows what the World Bank and similar large financial institutions can do if they decide to lend money for renewable electrification in rural areas of developing countries. The loan is for investments in grid-connected renewables (wind and mini-hydro), off-grid renewables (village hydro and solar home systems (SHSs)), and energy-efficiency measures in building. The expected outcome is 26 MW of installed renewable-energy capacity, with the off-grid component supplying electricity to as many as 32,000 rural customers (households and small businesses) that do not have access to electricity now.

The program also includes grants for technical assistance to develop projects and raise awareness. The following are part of the grant and cover, in full or in part, preparation of feasibility studies, business plans, and loan documentation for off-grid projects; a national promotion and information campaign on off-grid projects; a system to verify that solar home systems and village hydro systems meet agreed specifications; and a Consumer Protection Facility.

The renewable-energy technologies included in the program are windturbines (a 3 MW windfarm organized by the Ceylon Electricity Board, CEB); small hydro-power (below 5 MW, grid-connected and for local village grids); and PV systems, mainly as solar home systems. These technologies are all well proven and are used commercially in developing as well as in industrialized countries. With the possible exception of some of the hydropower plants, they represent a large addition to imports. In as much as they replace fossil fuels imports, however, they will benefit the trade balance of Sri Lanka in the long run.

In principle, other kinds of renewable energy technologies may be included, but since the technical assistance in the program focuses on the above mentioned technologies, it will most probably be difficult. One of the most obvious other candidates would be family-size biogas plants that often is a more cost-effective solution than a solar home system for rural families that own cattle or pigs. For roughly the cost of a solar system, a biogas plant can provide the same amount of light plus gas for cooking. It also improves the fertilizer value of the manure. Biogas plants add relatively little to imports, and thus they would have little impact on the Sri Lanka trade balance. This also makes them less interesting to the companies from industrialized countries that provide other technologies.

This program is one of the best examples on how to overcome the constraints of World Bank lending (large-scale, intergovernmental operations) to reach dispersed, off-grid rural power projects, which often is the most cost-effective way to provide electric services to a dispersed rural population.

[1998. World Bank support for sustainable energy in Sri Lanka. *Sustainable Energy News* (20): 6-7]

New Energy Source in Waves

The Department of Energy (DOE) of the Philippines in close coordination with local and international groups embarked on a project to develop and establish wave energy systems in the Philippines to supply the growing energy needs of the nation.

Representatives from the DOE, National Power Corporation, National Mapping and Resource Information Authority, PAGASA and the National Oil Company met with the members of the Oceanographic Company of Norway (OCEANOR) to discuss the possibility of establishing such facilities along the country's seaboard. OCEANOR is one of the foremost proponents of the water energy systems.

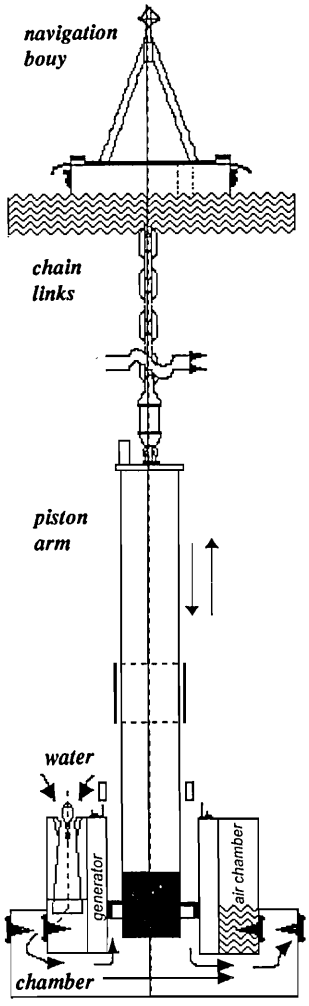

Fig. 1 A schematic of the off-shore wave power converter.

A discussion on the prefeasibility study for wave power in the Philippines highlighted the meeting. The project was aimed at evaluating potential sites for wave energy systems, and determining the technical and economic viability and environmental impact of the project.

After an initial survey of probable sites, OCEANOR consultant Dr. Stephen Barstow gave a conservative estimate of wave energy in the country. The country's eastern seaboard alone had a yearly energy output average of 23 000 MW or 23 GW. This can be translated into 200 TWh of annual reserve, according to Barstow. Sites surveyed included Batanes, Ilocos Norte, Pangasinan, Catanduanes and Palawan provinces.

Dr. Barstow also delved on various topics essential in the establishment of the wave energy systems. The objectives of the project, basics of the ocean waves and ocean wave energy, meteorology, and technologies for ocean wave power generation were discussed. Dr. Barstow presented an overview of several commercial wave energy systems which are currently in operation.

The feasibility study on wave energy is part of the Philippine Energy Plan for the period 1996 to 2025. Recognizing the global trend for the use of renewable energy technologies, the DOE envisions ocean energy systems to contribute to the country's energy supply mix in the long run.

Tapping the Energy

There are two broad categories of wave energy devices: the off-shore devices which are located in deep water, and the shore-mounted such as the oscillation water columns (OWC). Generally, the devices situated in deep water benefit from the greater incident power since the wave power is attenuated as they run into shallower water. It is, however, more costly to install and maintain off-shore systems than shore-mounted facilities; although the former delivers more energy.

The first country to tap wave energy is Japan. In 1965, they developed the OWC floating navigation bouy converters. From this, they were able to develop larger devices under a program for self-sufficient alternative energy sources. Wave energy in Japan, unfortunately, is relatively limited compared to energy produced in the European waters.

The movable body designed by the Japanese initially converted wave energy to dynamic energy, then into electricity or heat. The primary conversion may be a direct progression into reciprocating or rotating motion, pressure or water current.

Figure 1 shows a schematic of an off-shore OWC floating navigation bouy converter. The up and down movements of the wave forces the bouy to pull up or push down a piston arm. The arm, in turn, sucks in water or pushes out water inside a chamber. This chamber is anchored to the sea floor. Water sucked in enters the chamber through another chamber which contains a turbine-generator. Thus, the water moving in the chamber runs the turbine-generator which produces electricity.

By 1970s, there were a number of researches on wave energy. This trend lead to the development of two prototype wave power plants near Bergen, western Norway in the mid-1980s: the Kvaener Brug's multi-resultant oscillating wave column and the NORWAVE's tapered channel system.

The Kvaener Brug's multi-resultant OWC consists of a vertical cylinder placed on face of a cliff, the base being open to the sea. The wave motion, in turn, forces air into the cylinder which contains a pneumatic self-rectifying (two-way) turbine fitted at the top of the cylinder. The air movement in the cylinder runs the turbine which, in turn, runs the generator that produces electricity as shown in Fig. 2.

(contd. on p. 4)

DECADES Databases: Planning an Energy Future

Every source of electrical power produces impacts on human health and the environment. In order to respond to the priorities indentified by the 1992 Rio Summit on Environment and Development, the International Atomic Energy Agency (IAEA) joined forces with eight other international organizations* to examine the health and environmental effects of different electricity generating systems. This work evolved into an IAEA-led interagency project called "DECADES".

DECADES has subsequently assembled one of the world's most comprehensive databases on technical, economic and environmental aspects of different energy sources for electricity generation, and has developed sophisticated computer software for power sector planning. The reference Technology Database includes an inventory covering all current and prospective energy sources - coal, oil, gas, hydro, nuclear, geothermal, solar, wind, wave and biomass - and encompasses the full energy chain concept, allowing comparisons not just between electricity generating plants but also by considering all steps of the chain from tapping of the resource to final disposal of wastes. Some 35 countries are constructing their own databases on this frame, customizing them for their own conditions and decision making.

Software (known as DECPAC) has also been developed for integrated electricity system analysis. It can help a country-user to screen, compare and assess different electrical system expansion strategies, taking into account various environmental burdens such as emissions of SO_2, No_x and "greenhouse gases" from the full energy chains, including mining, transportation, fuel fabrication and waste disposal.

During the second phase, DECADES will be enhancing the basic model to cover even more comprehensive coverage of environmental burdens, and to quantify impacts on crops, human health and economic infrastructure. Other challenges being addressed are enhancing the model for forecasting the future energy and electricity needs in developing countries, demand side management and regulatory analysis. The IAEA is disseminating the DECADES databases and software globally through training programs and co-ordinated research efforts. Further information may be obtained from the Planning and Economic Studies Section, Division of Nuclear Power and the Fuel Cycle, IAEA, Vienna, Austria.

** Organizations participating in the project are European Commission, Economic and Social Commission for Asia and the Pacific (ESCAP), IAEA, International Institute for Applied Systems Analysis (IIASA), OECD Nuclear Energy Agency (OECD/NEA), Organization of Petroleum Exporting Countries (OPEC), UN Industrial Development Organization (UNIDO), World Bank and World Meteorological Organization (WMO).*

[1997. Planning an energy future: Agenda 21 and the DECADES programme. *IAEA Technical Co-operation - A Partner in Development.* Vienna: IAEA]

(contd. from p. 3)

New Energy Source...

On the other hand, the NORWAVE tapered channel system is made up of a funnel-shaped channel which "catches" wave energy. Waves move inshore along the channel steepening as the channel walls narrow. Towards the end of the channel, the water flows above the wall into the reservoir. Water from the reservoir flows back to the sea again through a hydroelectric turbine, thus producing electricity. The system is shown in Fig. 3.

Setting Up Wave Energy Systems

In setting up wave energy plants, it is very important to have an idea of the behavior of ocean waves. Ocean waves are highly irregular, and each individual wave has its own unique wave height, period, and form. Thus, in order to measure wave, researchers take the mean of the wave height and the wave period, and derive the approximate wave energy from these values.

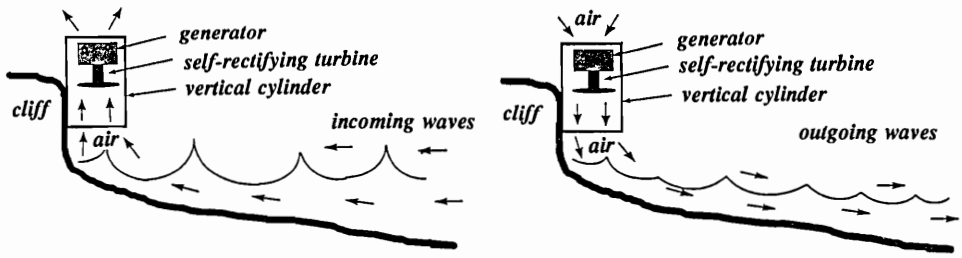

Fig. 2 The Kvaener Brug's multiresultant OWC.

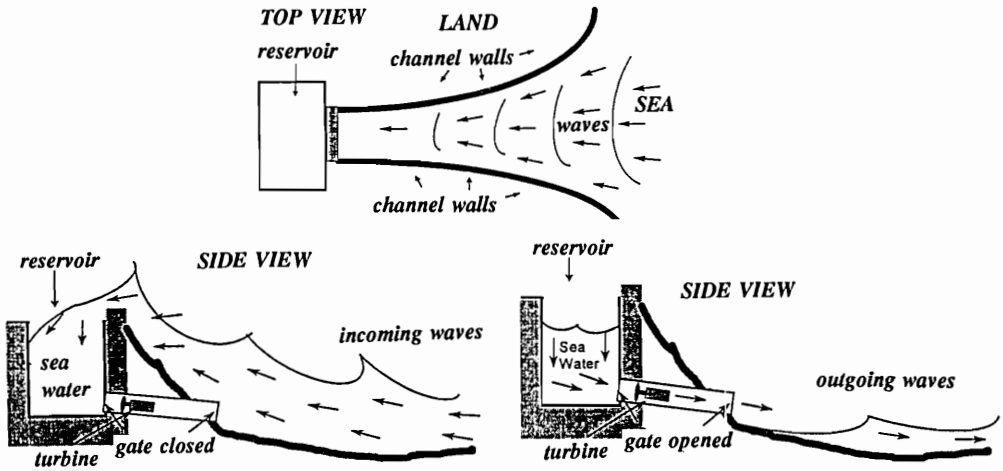

Fig. 3 The NORWAVE tapered channel system.

Conflict Over Energy and Environment

Britain's conflicting energy and environmental policy objectives have been highlighted by a recent government review, with not only gas plant, but also a wind station caught up in the controversy. On one hand the government is alarmed at the continuing proliferation of gas fired power plant at the expense of the country's declining coal industry, while on the other hand gas is best placed to help the U.K. meet its tough environmental targets. So, too, are renewables, but they do not even merit a mention in the review of energy sources for power generation.

The review, annouced by Prime Minister Tony Blair on 3 December 1997, was accompanied by an immediate government moratorium on consents for all new power plant above 10 MW. All affected proposed power projects, with one sole exception - a wind farm - are gas fired, evidence that the "dash for gas" shows no sign of abating. Britain's switch to gas following privatization of the electricity supply industry in 1990 has been instrumental in helping the country meet comfortably its Rio commitments on carbon dioxide emissions.

Yet the real issue at stake is security of supply. On 1 December 1997, David Jones, chief executive of the National Power Grid Company, expressed his concerns for security of supply against the background of the vast amounts of gas fired generation coming onto the market. Not only do gas plant fail to provide the system-stabilizing inertia of steam turbine generators, they also force consumers be overly reliant on one energy source. Jone's fears were illustrated as far back as December 1995 when the UK grid system came within a whisker of collapse. During a period of peak demand, three large gas fired stations failed to generate due to lack of fuel under their interruptible gas supply contracts.

Another reason for the review is that on the day of the announcement several bus loads of miners were on their way to Westminster to protest at the continuing contraction of the coal industry. That the decision to impose a moratorium is largely political is born out by the total lack of warning or any prior knowledge among officials at the Department of Trade and Industry.

Disappointingly, no direct mention of renewable energy is made in the review's terms of reference. But it is to consider the objective of sustainable development, including the meeting of environmental targets. Moreover the role renewables play in increasing diversity of energy supplies should argue strongly in their favor.

The wind farm caught up in the moratorium on consents for new power plant above 10 MW is a giant 80 MW project, proposed some years ago by Ecogen for Humble Hill in the Kielder forest, Northumberland. The project, however, would almost certainly be eligible to be exepted from the government's block on consents. Exemptions are also on the cards for industrial combined heat and power (CHP) plant.

[1998. Conflict over energy and environment. Wind farm caught on moratorium on new power plants. *Windpower Monthly* 14(2): 26-27]

In addition, waves do not all travel in one direction, but are spread about. With this, certain devices were also designed to measure the mean wave direction.

Wave energy plants are site specific, according to Dr. Barstow, who conducted site surveys of potential locations of wave energy systems in the Philippines. It is important to know the behavior of ocean waves or "wave climate" in a certain region before setting up the wave energy systems.

Dr. Barstow's report on "Wave Energy Resource Mapping for Asia and the Pacific", somehow gives an idea of the wave energy in the Philippines. He indicated that the South Pacific wave climate "is more complicated in many respects than any other region in the world. As many four crossings wave trains can be present at any one time." There is the dominant south easterly trade driven wind seas, and the swells arriving from the southern ocean at any time of the year. Swells can also come from the Northern hemisphere storms in the summer and from the northeast trades blowing north of the equator.

Typhoons regularly affect the South Pacific. There are also dominat climate fluctuations in the South Pacific, such as the El Nino, a southern oscillation which leads to anomalies in the winds of this region.

Producing newer devices to harness wave energy will take some time, although there are already existing prototypes. Wave energy is a long-term technology. Many of the present prototypes vary from the 50 kW navigation bouys to the 500 kW OWCs.

But research and development continues, researchers predict that this technology will generate low cost electricity in the future. In Japan, for example, production cost estimates indicate that as technology improves, the prices relatively decrease. All technologies show a decrease of cost per unit produced, as a result of the experience gained and of more economic methods of production.

Wave energy may not be as viable as other sources of energy. Nonetheless, it remains a viable and clean source of energy.

[1997. Philippines sees new energy source in waves/Catching the energy in the waves. *Energy Infonet News* III(3):1 and 3-5]

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NEWS Around the Globe

Bangkok to Launch Electric Passenger Boats

Long idle because of safety problems, the Bangkok Metropolitan Administration's (BMA) hybrid electric passenger boats are ready to begin cruising.

The grand opening of the city's three hybrid electric shuttle boats will be held on 4 April 1998 in Klong Phadung Krungkasem in Bangkok. The boats will run from the pier in front of the Ministry of Education to Government House and the Marble Temple.

The boats will be used for tourism purposes, being the highlight of the city's project to renovate the canal in accordance with the city's plan to promote tourism around Rattanakosin Island.

Star World Engineering Co., a green technology production company, has been awarded a two-year lease to operate the boats in the canal, introducing the pollution-free boats to Bangkok residents and tourists visiting the historic canal. The boats are noise- and exhaust-free.

About US$ 230,000 (Baht 10 million) has been allocated for building the boats with 40 seats each. The project is aimed at providing pollution-free boats to serve waterway passengers in public canals.

The National Electronics and Computer Technology Center (NECTEC) was commissioned to design and construct the boats.

The maximum speed of the boats is 25 km/h. A low voltage three-phase induction motor is a prime mover driving the propeller. Two sources of power come from deep cycle batteries and a small diesel engine. Each boat has 63 batteries.

The fiberglass boats were never put into actual use even after several trial runs because of concerns about safety.

The boats need to charge their batteries every four-six hours and will be able to run for about eight hours per charge.

[Bangkok Post, 24 February 1998]

Jakarta, KL Plan to Build a US$ 2 Billion Coal Plant

Despite Southeast Asia's recession, a consortium of Indonesian companies has announced bold plans to build a US$ 2 billion power plant in the Riau archipelago near Singapore. The islands are being developed as a freeport and export industries center.

The Indonesian consortium is set to collaborate with a group of Malaysian companies to build a coal-fired plant at Cirenti in the Indragiri region of the Riau islands.

The government says that at completion the proposed plant's total output will be a whopping 5000MW, which will supply both Sumatra and neighboring Malaysia. The project is at a very early stage with feasibility studies still to be carried out.

The Indonesian consortium will be formed with three state enterprises - the national power company PLN, the national coal company PT Tambang Batu Bara Bukit Asam (BA), and PT Krakatau Engineering Corp. (KEC); and two private national companies PT Nusantara Ampera Bhakti and PT Selaras Development Indonesia. The Malaysian consortium will comprise Tenaga Nasional Berhad (TNB) Renong and Sikap companies.

After the first phase of the production, the plant will have an output of 1200 MW. Officials of PLN say the first phase of the plant is to cost around Rp. 1.2 million per kWh or a total of US$ 1.5 billion to US$ 2 billion.

Once the plant reaches full capacity, total investment will rise to US$ 6 billion, or around Rp. 6 trillion.

This cost will be born between the Indonesian and the Malaysian consortium where the Indonesian consortium will be a majority shareholder, as raw materials come from Indonesia.

When completed, the Cirenti plant will be the first large scale energy export. The electric power from the plant would be channelled with a transmission system from the Cirenti to Sumatra to Malaysia through the Riau islands and crossing the Malacca straits. The electricity produced will be channelled through the overhead transmission line of 150 km and a submarine cable of 20 km.

The Minister of Mines and Energy I.B. Sudjana claimed that the plant could eventually sell power to other parts of mainland Southeast Asia. A second 500 kV transmission system could provide power to Thailand. In this way, the minister said, the development of the steam power Cirenti plant in its turn can be realised as a joint venture between ASEAN nations, as has been discussed in 1994 and 1995 in the ASEAN ministerial meeting in Bali.

[Power in Asia, 9 February 1998]

Energy Efficiency Improvements for Russian District Heating Systems

The staff of Resource Management Associates (RMA) of Madison, Inc. recently completed work on a major USAID-funded project in Russia. RMA worked with the staff of three Russian district heating companies (DHCs) to prepare business plans for efficiency improvements to their district heating systems (DHSs), located in Tula, Cherepovets, and Kaliningrad. Russian DHSs require substantial renovation to improve operational characteristics and reduce operating costs. Insufficient funding of DHS repair and renovation activities necessitated the development of business plans to attract financing from outside monetary institutions.

The project provided the rationale and planning documents required by the multinational banks who will, in turn, convince Russian and international commercial bankers and investors that energy efficiency loans at DHSs are viable. The investment programs will target the 30% to 40% energy savings available to DHS using proven technologies. The savings resulting from

the investments will decrease customers tariffs and allow loan repayment, as well as reduce a host of negative environmental impacts. Because of the short payback periods for improvements and the replicability of the business plans, this project is viewed as a means to funding the wholesale renovation of Russia's DHSs.

Multilateral development banks showed serious interest in the plans developed by RMA/DHC teams. The World Bank recently included Kaliningrad in its loan program for DHS energy efficiency improvements. The Energy Efficiency Unit at European Bank for Reconstruction and Development (EBRD) is in an intermediate stage of approving the Tula DHS loan, and the Bank shows continued interest in working with Cherepovets DHC.

The business plans also serve as guides for DHCs across Russia and the former Soviet Union. The business plans and the engineering, economic, financial and environmental methods, and risk management strategies used in the business plans were presented to an attentive group of DHC managers at the conference in Moscow.

[Information, January 1998]

Gasification, The Gateway to a Cleaner Future

The aim of this conference is to build on the First and Second European Gasification Conferences held in London and Milan. The organizer is the Institution of Chemical Engineers. This Third Conference will be held in Dresden from 23 to 24 September 1998. Papers are being sought for the conference covering new developments in the areas of:

- feedstock for gasification;
- design improvements to the gasification process;
- adaptations to accommodate new types of feed stock;
- new R & D directions for gasifications;
- new products to optimize revenue from the gasification process;
- product synergies;
- environmental solutions using gasification;
- power generation via gasification of carbonaceous fuels.

The objective is to promote a greater understanding of the versatility of the gasification process. The title has been selected because gasification offers an important step to the cleaner and more efficient use of carbonaceous resources.

For more information about the conference, please contact IChemE Conference Department, 165-189 Railway Terrace, Rugby, Warwickshire CV21 3 HQ, U.K.

[Energy Digest 26(6)]

Saving Energy the ElectroFlow Way

Energy efficiency and savings are an important priority for many companies as it is a way to improve productivity while reducing costs. ElectroFlow Hong Kong Ltd., a member of the Carbandy Group since 1994, have been the exclusive franchiser of ElectroFlow™. ElectroFlow™, an electrical energy efficiency system custom designed for each client, addresses power quality and electrical savings for industrial, commercial and institutional applications. The company markets, designs and installs the system in Hong Kong, Macau and the Philippines. Users of the system include hotels, container handling operations, printing and publishing companies, and banks. The system is internationally used by a wide variety of industries.

ElectroFlow™ is an integrated modular system specially custom-engineered to effectively and economically optimize power quality with guaranteed electric savings, without any disruption to equipment and machinery. In Hong Kong, the systems have achieved savings of between 8% to 28% as well as providing clean balanced power to make equipment run smoothly and efficiently. This will also yield maintenance savings over time.

The system is versatile, and is designed to handle all equipment which is connected to one transformer, or can be designed to address all transformers and therefore all equipment downstream.

According to the company, the benefits of the system are numerous, but the major attraction is the energy savings possible. The system offers guaranteed savings through reductions in Kilowatt/kVA demands and kilowatt-hour consumption and related charges. ElectroFlow's director, J.S. Smillie said that savings can be guaranteed because proposals are given to customers after their electrical supply systems have been analyzed. The savings that the customers will achieve during the first five years are also estimated. The customers generally experience savings in excess of the estimates.

Another benefit is the improvement in power quality through voltage stability and reduction of harmonics and distortion while protecting equipment and machinery. The result is reduced maintenance and down time and longer lifespan of equipment, which translate to a cost saving.

The system's built-in features are also benefits and that the system's additional features can be chosen depending upon the needs of the customer. The range of built-in features include voltage improvement and stability, three-phase balancing, surge and transient protection, broadband harmonics reduction, power factor improvement, and increase capacity release. Optional features include brownout protection, intermittent supply failure protection, specific harmonics filtering, and phase loss synthesis.

The system has been designed to pay for itself, with the cost of implementing the system normally retrievable in two years. The cost of the system varies greatly according to a customer's electrical profile and size. Generally the cost would range from HK$ 100,000 for a small system to several hundred thousand for a large system. Customers have the option to install the system on a progressive basis.

When the system is sold to the customers, the company determines whether or not the customer's money can be saved and also whether there are specific electrical problems which need to be addressed. Approximately 60% of the systems are sold to customers seeking a reduction in their bills and 40% use the system to fix electrical problems.

[Asia Engineer, January 1998]

Japanese to Supply Fiber Optics to Grid System

A Japanese consortium comprising Furukawa Electric Co., Fujitsu Limited and NTT International has taken US$ 22.4 million contract for optical fiber systems links for Power Grid Corporation of India. The turnkey job involves total design, supply, installation and commissioning of optical fiber system links of approximately 1800 km in 30 months to cover the entire transmission network of the PowerGrid in the northern region.

The optical fiber will deploy advanced telecom management system with SDH equipment from Fujitsu and OPGW/AADSS optical fiber cable from Furukawa.

PowerGrid is finalizing a similar deal for its southern region. Tenders for the eastern and western regions are expected shortly. Offers received for the north-eastern region are under evaluation.

The public enterprise is envisage a nation-wide fiber optic network riding on its pylons. It intends to lease out the spare capacity to telecommunication service providers.

Meanwhile, Cegelec of France has announced two contracts with PowerGrid for electric network management systems for northern India to go into a service in January 2002 and data transmission system for an electric network in southern India which will become operational in the second half of 2000.

[Power in Asia, 9 February 1998]

Sustainable Energy Strategy for Scotland

Some 1400 MW of new renewable energy capacity would help Scotland towards achieving a 30% reduction in carbon dioxide emissions from 1990 levels by 2010, according to Friends of the Earth (FoE) Scotland. The 1400 MW, or 600 MW of declared net capacity (DNC), is a key part of package of measures for reducing emissions that includes energy efficiency, local authority targets for reducing road traffic, and making sustainable energy an overriding objective for energy industry regulators.

In its proposal for sustainable energy strategy for Scotland, FoE's 2010 goal is a step towards the 90% reduction in greenhouse gases by middle of 21st century. Today, renewables supply just over 10% of Scotland's electricity mostly from large-scale hydro. If the government meets its current Scottish Renewables Obligation (SRO) target of 150 MW DNC of new renewables, this will rise to around 18%.

FoE also points out in its "Achieving the Possible" strategy that when the Hunterston B nuclear station closes by 2011, replacement clean generating plant to meet around one quarter of Scotland's electricity will have to be in place if CO_2 emmisions are not to rise. FoE believes renewables could meet half of Scotland's needs by 2025 - requiring up to 2700 MW of capacity. An intermediate target of 1400 MW would coincide with the closure of Hunterston B.

Renewable energy development can bring economic and social benefits to both rural and urban communities, according to FoE. But the SRO, while it may help reduce emissions, does not allow for this added value. Instead, FoE proposes an obligation on utilities to buy a minimum percentage of renewables. Prices could vary according to the technology and contracts should be awarded on environmental and social ground.

[Windpower Monthly, February 1998]

Decentralized Cogeneration: Future of Energy Production

Decentralized cogeneration is seen as the energy solution for the future that can guarantee an answer to variations in solar and wind energy production. Future energy systems will be complex, as different energy forms will have to work together to ensure adequate supply of electricity and heat. To achieve appropriate integration of natural energy sources, some amount of conventional electricity-and-heat production technologies will be indispensable, where decentralized cogeneration, divided into several separate units, is applicable. The fuel for decentralized cogeneration can be natural gas, biogas or other biomass gases.

In Denmark, decentralized cogeneration plants with a total capacity of 1600 MW have been installed. Based on natural gas, most of the plants use gas turbines and combined cycle installations. Gas motors have also been installed in towns, villages, institutions, industries, etc., owned and run mainly by citizens or district heating cooperatives who utilize the heat and sell the power to the grid. About 35% of electricity in the Jutland-Funen area (two-thirds of Denmark) comes from such non-utility installations (including wind turbines). Compared with a modern coal station with NO_x and SO_2 filters, the new cogeneration technology is cheap to install. It is centered on the gas motor that is integrated into a single unit with generator, heat exchanger and controller.

[VATIS Update: Non-convetional Energy, January-February 1998]

Box Solar Cooker Discontinued

The fordable cardboard box cooker designed for easy transport for educators is no longer produced by the Solar Cookers International (SCI). The box, with a plastic window and shiny foil inside and out, served well and also found its way into many homes for regular daily cooking. It was, however, still too costly and bulky for most people in the world.

SCI is an informational clearinghouse for all types of solar cookers. Nevertheless for teaching purposes, SCI now uses the new panel-type cooker, which is equal in cooking power at much lower cost.

When the idea of solar cooking is introduced in a new area, SCI strongly believes that it is best to begin with the simplest, lowest cost device. Then later, locally-produced cookers are more likely to be as good or better than the original and still affordable for a wider range of people. It is easy to up-scale a product. It is harder to down-scale and still find interested customers.

[Solar Cooker Review, March 1998]

Solar Energy for Munich's New Trade Fair Center

The world's largest photo-electric roof is being installed at Munich's New Trade Fair Center, the venue of the 1998 Bauma Exhibition, 25th International Trade Fair, which will be held in Munich, Germany from 30 March to 5 April 1998. It will be the only such structure to have a plant that generates electricity from solar energy with a maximum total output of 1 MW. Thus, in the trade fair sector, it is believed it is making a unique contribution to electricity generation from a renewable source of energy. The photo-electric installations fit in perfectly with the overall concept of environmentally acceptable technology for the New Munich Trade Fair Center. The roof space will be provided for at least 20 years.

The plant cannot meet total electricity requirements when the trade fairs are in full swing, since some fairs need up to 28 MW. However, the energy generated is sufficient, for example, for the standby operation of the New Munich Trade Fair Center's ultra-modern information and communication system.

When the photo-electric installations have been put into operation, exhibitors and visitors alike will be constantly informed about the project and its efficiency. For example, current electricity generation values will be shown in special information areas. It will also be possible to call up information on the photo-electric installations at the electric information terminals situated throughout the trade fair grounds.

The Fair's organizer conducted energy study that looked at different supply systems which use conventional, separate heat and electricity generation or couple energy and heat in heat cogeneration plants. As a result, a heat cogeneration plant will be put into operation near the West Entrance. The study also included supply systems with future potential, particularly those using renewable sources of energy.

[1997. Bauma 98, *International Construction* 36(11)]

Solar Electricity for the New Munich Trade Fair

From the beginning of 1998, the world's largest photo-electric roof installations will generate around 1 million kW hours of electricity a year at the New Munich Trade Fair Center.

Facts and Figures

Location:	Above the six northern trade fair halls (B1 to B6)
Concept/planning:	Bayernwerk; the project is part of a DM 100 million program "Energiezukunft Bayern" (Bavaria's Energy Future)
Project Costs:	Aprox. DM 15 million
Financed by:	Bayernwerk, 50% Siemens AG, 10% Stadtwerke Munchen, 10% (Munchen's public utilities)
Promoted by:	Bavarian Ministry of Economics, Transport and Technology, 20% Federal Ministry for Education, Science, Research and Technology, 10%

Schedule

Initial plans:	Summer 1995
Award of contract:	Winter 1996
Beginning of construction:	Spring 1997
Beginning of trial operation:	Autumn 1997

Solar Energy Data in the Region of Munich

Average annual solar radiation:	1200 kW/hr per m² and year
Average annual sunshine:	1650 hrs/year

Technology: Solar Generator

Type of modules:	Frameless solar modules each with 84 monochrystalline silicon cells (SM 130-L) by Siemens Solar
Number of modules:	7,812
Number of cells:	656,208
Output per module:	130 kW
Maximum output:	1016 kW
Area covered:	7750 m²
Roof area available:	66 000 m² (six halls of 11 000 m² each)
Roof area used by photo-electric installations:	38 000 m² (6 350 m² per hall)
Frame orientation:	Oriented to the south, at a 28° angle to the horizontal
Frame installation:	Directly on the hall's roofing skin
Solar cell efficiency:	14.5%

Power Conversion

Converters:	Three dc/ac converters, each with 330 kW, are used in so-called masterslave slave operation (alternate and consumption-geared operation)
Type of operation:	Power fed directly into the 20 000 V medium voltage network of the New Munich Trade Fair Center

Power Generation

Full-load operation:	Around 1 000 hrs/year
Energy output:	Around 1 million kW/hr per year (meets up to 4% of the trade fair grounds' energy requirements, corresponding to the calculated energy requirements of some 340 average German households)
Solar energy use:	Directly by Messe Munchen
Carbon dioxide reduction:	Approximately 1000 t/year
Installations' expected life:	At least 20 years

BOOK REVIEWS

Power in the Philippines - Market Prospects and Investments Opportunities

Thierry Lefevre, Romeo Pacudan and Jessie Todoc. Published by Financial Times Energy Publishing, Maple House, 149 Tottenham Court Road, London W1P 9LL. Fax: +44 171 896 2275; Email: eninfo@pearson-pro.com ISBN 981 3069 24 4, 1997, 200p., US$650

The Philippine power sector today is in transition. The government is aggressively instituting reforms that are orientated towards market forces which translate into greater role for private sector investment.

Power in the Philippines gives the readers a full analysis of the current power industry and, by detailing the views of the government policy makers, the future shape of this growing sector. In particular it stresses the areas in which private investors can take advantage, such as demand-side management and electrification.

The report contains many case studies and all the latest industry intelligence the readers need to understand the market implications.

Case studies covered are:

- Philippine investment framework,
- energy efficiency and demand-side management, and
- energy and the environment

Key issues include:

- the structure and regulation of the Philippine power sector
- the Philippine power development plan
- the status of private sector participation in power generation
- investment opportunities in the power development plan and the newly privatized Philippine power market
- investment opportunities in energy efficiency
- IPP evaluation criteria and terms of the power purchase agreements
- the long-term power industry structure
- the future role of government

Also examined in the report are:

- current and projected Philippine power demand and generating capacity
- liberalization of the energy sector and the privatization of the National Power Corporation
- vital statistics of current and future independent power projects, including type of project, fuel type, generating capacity, proponent, bidding details, etc.
- facts and figures on the status and financial requirements of the electrification program in the Philippines.

History of the International Atomic Energy Agency The First Forty Years

David Fisher. Published by the International Atomic Energy Agency, Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna, Austria. ISBN 92-0-102397-9, 1997, 550p.

The focus of this book is on the history of the International Atomic Energy Agency (IAEA) as an organization. This is inevitably linked with the evolution of nuclear technology. Accordingly, the book sketches the fortunes of nuclear power since 1957, the main events that have affected confidence in nuclear safety and the evolution of nuclear arms control, insofar as this has affected IAEA safeguards.

The development of three of the Agency's main programs, nuclear power, nuclear safety and safeguards, has been largely shaped by events beyond the IAEA's control, but their impact on the Agency has been determined, to a considerable degree, by the ways in which the Board of Governors and the Director General of the Agency have responded to them. Hence the effectiveness of the Board and the personality of the Director General have had a significant impact on the authority and effectiveness of the organization.

Another major part of the IAEA's work has been to help transfer the practical applications of nuclear science to the developing world. In a relatively few cases this has involved nuclear power technology; far more commonly it has consisted of the transfer of the numerous and varied uses of radioisotopes and radiation - a broad stream of diverse and relatively small technical assistance projects, an activity seldom affected by turns in international politics, swings in national moods, a major nuclear accident or technological developments or fashions. The volume of such assistance has, however, been influenced by the flow of funds and the absorptive capacity of the receiving countries.

The book concludes with a brief discussion of some questions that the IAEA may have to answer before it turns fifty. The selection of these questions and the conclusions reached are the author's own.

International Directory of New and Renewable Energy

Published by James & James (Science Publishers) Ltd., 35-37, William Road, London NW1 3 ER, United Kingdom. Fax: +44 (171) 387 3998; Email: orders@jxj.com.

This publication lists about 4,000 renewable energy information centers from 170 countries with full contact details and description. A summary of areas of interest are listed for:

- national government organizations,
- information resources,
- research centers, and
- professional and trade associations publications (database, directories, and journals) in each country.

International Events

INSIDE ASIA

4-7 June 1998
Bangkok, Thailand
ENTECH POLLUTECH 98 Asia
Contact:
Miller Freeman (Thailand) Co., Ltd.
41 Lertpanya Bldg., 8th Fl., Suite 801
Soi Lertpanya, Sri Ayuthaya Rd.,
Rajathewee, Bangkok 10400, Thailand
Tel : (66-2) 642 6911/8
Fax : (66-2) 642 6919/20
Email: millerfreeman@mozart.inet.co.th
http://thai-exhibition.com

8-11 June 1998
Hong Kong, China
9th Global Warming International Conference and Expo (GW9)
Contact:
Prof. Shinyan Shen, Chair
International Program Committee
Global Warming International Center
(GWIC-USA), P.O. Box 5275
Woodbridge IL 60517, U.S.A.
Tel: +1-630-910-1551
Fax: +1-630-910-1561
Email: syshen@megsinet.net

1-4 July 1998
Bernaul, Russia
GIS for Nature Management Optimization for Sustainable Development of Territories
Contact:
Organizing Committee of InterCarto 4
Institute for Water and Environmental Problems, Siberian Branch of the Russian Academy of Sciences
105 Papanintsev St., 656099 Barnaul, Russia
Tel: 83852-36-78-52, 36-78-56
Fax: 83852-24-03-96
Email: iwep@iwep.altai.su

August and September 1998
Small-Hydro Conferences in Vietnam and Brazil
Contact:
HRC, Hangzhou Regional Center for Small Hydro Power, RC, D. Pan
P.O. Box 1206, Hangzhou, China
Fax: +86-571-8062934
Email: hrc@public.hz.zj.cn

30 September - 2 October 1998
Pragati Maidan, New Delhi, India
POWER-GEN Asia'98
Contact:
Times Conferences and Exhibitions
Pt. Ltd., Times Center,
1 New Industrial Road,
Singapore 536196
Tel: 65 284 8844
Fax: 65 286 5754

14-16 October 1998
Shanghai, China
Renewable Energy and Efficiency Asia Pacific '98 (REAP '98)
Contact:
Cassy Kurtzman
Alternative Development Asia Ltd.
1406 Leader Commercial Bldg.
54-56 Hillwood Road
TST, Kowloon
Hong Kong
Tel: +852 2574-9133
Fax: +852 2574-1997
Email: info@adal.com
http://www.adal.com

20-22 October 1998
Shanghai, China
International Conference and Exhibition on Renewable Energy and Energy Conservation for Buildings
Contact:
Rm. 1322, Bldg. 3
1486 Nanjing Rd. (W)
Shanghai 200040, P.R. China
Tel: +86-21-62479796
Fax: +86-21-62049481
Email: wjyao@online.sh.cn

25-27 November 1998
Tsukuba, Japan
Third International Conference on EcoBalance
Contact:
Ms Shoko Tsuda
Ecomaterials Forum, Kotohira
Kaikan Bldg., 3F,
1-2-8 Toranomon
Mintao-ku, Tokyo 105,
Japan
Tel: +81 3 3503 4681
Fax: +81 3 3597 0535
Email: mitoh@snet.sntt.or.jp

OUTSIDE ASIA

8-11 June 1998
Wurzburg, Germany
Biomass for Energy and Industry
Contact:
WIP, Sylvensteinstr. 2
81369, Munchen, Germany
Tel: +49 89 7201235
Fax: +49 89 7201291
http://www.wip.tnet.de

14-17 June 1998
Gold Coast, Australia
2nd Asia Pacific Conference on Sustainable Energy and Environmental Technology
Contact:
APCSEET'98 Secretariat
Tel: +61 07 3369 0477
Fax: +61 07 3369 1512
Email: apc@cheque.uq.edu.au

19-21 June 1998
Amherst, WI, U.S.A.
Midwest Renewable Energy Fair
Contact:
Susan Stein
P.O. Box 249, Amherst, WI 54406
Tel: +1 715 824-5166
Fax:: +1 715 824-5399
Email: mreainfo@wi-net.com
http://www.msn.fullfeed.com/ hulet/

6-10 July 1998
Wien, Austria
2nd World Conference and Exhibition on Photovoltaic Energy Conservation
Contact:
WIP, Sylvensteinstr. 2
81369 Munchen, Germany
Tel: +49 89 7201235
Fax: +49 89 7201291
http://www.wip.tnet.de

28-31 July 1998
Nevada, USA.
Hydro Vision 1998 Conference - Exploring Our New Frontiers
Contact:
HCI Publications
410 Archibald Street
Kansas City

(contd. on p. 12)

(contd. from p. 11)

MO 64111-3046, USA
Tel: (1) 816 9311311 Ext 108
Fax: (1) 816 9312015
Email: hydroworld@aol.com

29-31 July 1998
Southampton, U.K.
First International Conference: Oil Spill 98. Oil & Hydrocarbon Spills, Modelling, Analysis & Control,
Contact:
Liz Kerr
Conference Secretariat,
OIL SPILL 98
Wessex Institute of Technology
Arhurst Lodge, Ashurst,
Southampton SO40 7AA, U.K.
Tel: + 44 (0) 1703 293223
Fax: +44 (0) 1703 292853

13-17 September 1998
Houston, TE, U.S.A.
17th Congress of the World Energy Council
Contact:
World Energy Council
Fax: +1 202 331 0418

14-17 September 1998
Portoroz, Slovenia
EuroSun 98, ISES-Europe Solar Congress and Exhibition
Contact:
E-NET, Center for Efficient Use of Energy
1000 Ljubjana, Ambrozevtrg 5
Slovenia
Tel: +386-61-1729284
Fax: +386-61-1729283
Email: e-net@siol.net

20-25 September 1998
Florence, Italy
World Renewable Energy Conference
Contact:
World Renewable Energy Network
147 Hilaranton
Lower Earley
Reading RG6 4HN, U.K.
Tel: +44 118 961 1364
Fax: +44 118 961 1365

6-8 October 1998
Prague, Czech Republic
EEBW '98, 6th Energy Efficiency Business Week International Conference and Exhibition
Contact:
SEVEN, Slezska 7
120 56 Prague 2
Czech Republic
Tel: +420-2-2424-7552
Fax: +420-2-2424-7597
Email: seven@ecn.cz

20 - 25 September 1998
Florence, Italy
World Renewable Energy Congress WREC '98
Contact:
A. A. M. Sayigh,
World Renewable Energy Network,
147 Hilmanton, Lower Earley,
Reading RG6 4HN, U.K.
Tel: +44 118 96 11364
Fax: +44 118 96 11365

5 October - 7 November 1998
Enschede, The Netherlands.
Training Course on Energy Management and Cleaner Production in Small and Medium Scale Industries
Contact:
The Course Administration
Technology and Development Group
VOK/CT 180
University of Twente
P.O. Bow 217
7500 AE Enschede
The Netherlands
Tel : 31 53 489 4377/489 3539
Fax : 31 53 489 3087
Email : j.r.m.borghuis@tdg.utwente.nl

10-12 November 1998
Nevada, USA
ENVIRO-SOFT 98
Development and Application of Computer Techniques to Environmental Studies
Contact:
Liz Kerr
Conference Secretariat
ENVIROSOFT 98
Wessex Institute of Technology
Ashurst Lodge, Ashurst
Southampton
SO40 7AA, U.K.
Tel: 44 (0) 1703 293223
Fax: 44 (0) 1703 292853
Email: liz@wessex.ac.uk

10-13 February 1999
Perth, Western Australia
World Renewable Energy Congress 1999
Contact:
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Murdoch University
Murdoch WA 6150, Australia
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Email:mathew@essun1/murdoch.edu.au
http://wwwphys.murdoch.edu.au/acre

The Regional Energy Resources Information Center (RERIC) is one of the four specialized information centers of the Center for Library and Information Resources (CLAIR), Asian Institute of Technology (AIT), Bangkok. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The *RERIC News* is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership package along with the *International Energy Journal.*

For further details contact:

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Asian Institute of Technology
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Fax (66-2) 5245870, 5162126
Email: enreric@ait.ac.th
WWW: http://www.ait.ac.th/clair/centers/reric

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GREEN POWER: What Does It Really Mean?
The Quest for Standard Industry Guidelines

Some people want to know what "green power" means - and, by extension, "environmentally friendly". Does that mean low emissions, including nuclear energy? Is renewable energy automatically green? Should the simple fact of compliance with all standards imposed by the Environmental Protection Agency (EPA) afford the right to promote power generation as green?

Consumers, agencies and state and federal officials in the U.S.A want truth in the promotion of green power. Proponents of alternative generation claim consumers are willing to pay more for cleaner, greener energy. Residential customers of Detroit Edison, for instance, pay more than US$ 6.50 additional per month to support solar energy. In Colorado, the Governor's Office of Energy Conservation is using special funds to help offset the additional cost it takes to power the governor's home with wind. Only clear industry guidelines can ensure that everyone is actually getting what they are paying for.

Green power certification is proceeding on several different fronts. Commissions and legislatures are mandating resource disclosure of generation sources. Legislation at both the state and federal level are investigating the use of renewable portfolio standards. The Federal Trade Commission (FTC) is considering establishing voluntary guidelines for electricity promotion like those already established for other retail products in the FTC's 1992 "Guides for the Use of Environmental Marketing Claims".

At the Department of Energy (DOE)/ National Association of Regulatory Utility Commissioners (NARUC) forum in Washington, D.C., participants pressed panel experts for a definition of green power. A representative from the International Brotherhood of Electrical Workers, declared that a ban on the word "green" in all electricity promotional campaigns is preferred since the word can easily mislead consumers. The associate director of Federal Trade Commission's division of enforcement acknowledged a lack of guidelines and cautioned potential advertisers to think carefully about what message, direct or implied, that consumers will take away from product promotion.

The Conservation Law Foundation (CLF) is circulating its proposed "Green Guidelines for Electricity" among the electricity industry and legislators. The document (the third edition is dated 3 December 1997), borrows language and format from the 1992 FTC guidelines for environmental marketing. It aims to be a "starting point to make the generic FTC guidelines industry-specific".

The draft proposes guidelines for claims about the attributes of electricity or services connected with the generation, distribution or sale of electricity, "as they may appear in labeling, advertising, promotional materials, and all other forms of marketing, whether asserted directly or by implication, through words, symbols, emblems, logos, labels, certifications, depictions, company names, product brand names, or through any other names."

The bottom line is that product claims would be based on "competent and reliable evidence" just as the FTC requires in its environmental guidelines. That test will prove a challenge for companies vying to sell electricity, however. For, as the CLF draft guidelines point out, most customers would not maintain any direct wire connection to their power supplier in a world of retail direct access. It would be difficult, if not impossible, to "claim that electricity used by a given customer came directly and exclusively from that customer's supplier."

Disclosure Standards

Hand-in-hand with the push for advertising guidelines is the movement to require disclosure of generation sources. In 1996, NARUC passed a resolution calling for uniform disclosure standards of price, resource mix and the "environmental characteristics of... electricity purchases".

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In his industry restructuring bill, HR1960, Rep. E. J. Markey (D-Mass.) would require the FTC, in consultation with the EPA and the Department of Energy, to issue disclosure rules by 1 January 1999 that would cover generating source data, air and water emissions data, reliability data and price information. In S 687, Sen. J.M. Jeffords (R-Vt.) proposes to bring the Food and Drug Administration into the decision-making process, as well.

States are also getting into disclosure business. In November 1996, the Regulatory Assistance Project in Maine presented its findings on "Uniform Consumer Disclosure Standards for New England", to the New England utility commissions, which jointly had requested the study. The report recommends, based on customer research, that companies should use an "informative, succinct, easily understood and widely available" label that would convey four key pieces of information: price, contract terms, fuel mix and air emissions. Not only would such information be helpful to consumers, the report notes, but a disclosure policy "will also protect suppliers from unfair trade practice claims by setting clear rules of the road." The report also noted that disclosure might offer a secondary benefit: "Depending on the level of customer demand, it can result in cleaner resources and less pollution."

The Massachusetts restructuring law, HB 5117, signed by Gov. P. Celluci (R), orders the Department of Telecommunications and Energy to publicize uniform labeling regulations that will apply to all electricity suppliers in the state.

The Illinois restructuring law signed by Gov. J.M. Edgar (R), HB362, requires quarterly disclosure of fuel mix and air emissions as of 1 January 1999. The law specifically calls for breakdown by percentage in "pie-chart" format.

In Pennsylvania, the public utility commission proposed a rule requiring that suppliers provide the most recent annual average percentage of electricity supplied, per fuel, or the anticipated mix, when a customer requests the information, when a supplier first enters an agreement with a customer, and "as soon as possible when a significant change occurs in energy sources".

Table 1 Federal Standards for Renewable Energy

Defining what qualifies as green power in proposed federal restructuring legislation.

Bill	HR 655	S 687	S 237	HR 1960
Sponsor	*Schaefer (Colo.)*	*Jeffords (Vt.)*	*Bumpers (Ark.)*	*Markey (Mass.)*
Date Introduced	*10/2/97*	*1/5/97*	*30/1/97*	*19/6/97*
Renewable Energy Resource				
Solar (photovoltaic)		●		
Solar (thermal)	●	●	●	●
Geothermal	●	●	●	●
Tidal	●			●
Hydro			●	
Wind	●	●	●	
Fuel cells				
Methane (landfill or mine-gas)	●			
Waste	●	●	●	
Biomass	●	●	●	●

HR 655 would phase in a portfolio standard over 10 years requiring minimum percentage of generation resources supplied by renewable energy, calculated by supplier: 2% in 2001, 3% starting in 2005 and 4% by 2010.

Hydro resources are not taken into account in calculating total generation. "Waste" includes organic waste and dedicated energy crops.

S 687 would phase in a portfolio standard over 10 years through a system of renewable energy credits (one credit per megawatt sold) administered by FERC, requiring minimum percentage of generation resources, state by state, supplied by renewable energy: 2.5% in 2000, rising ratably to 5% in 2005, 6% in 2006 and 7% by 2007.

Hydro resources are not taken into account in calculating total generation. "Waste" includes organic waste, but excludes incinerated municipal solid waste.

S 237 would phase in a portfolio standard over 10 years through a system of tradable renewable energy credits administered by FERC, requiring minimum percentage of generation resources supplied by renewable energy, calculated by supplier: 5% in 2003, 9% by 2008 and 12% by 2013.

Hydro resources earn credits at rate of 0.5 per unit of energy. Credits earned at a rate of 1 and 2 per unit, respectively, for qualifying nonhydro resources constructed (a) prior to the act and (b) after enactment. "Waste" excludes municipal solid waste but does not include or exclude organic waste.

HR 1960 would phase in a portfolio standard over 12 years, requiring minimum percentage of generation resources supplied by renewable energy, calculated by supplier: 3% in 1998, with percentage rising along a sliding scale set by the Secretary of Energy to 10% by 2010. Allows states to impose additional requirements.

"Biomass" excludes burning of municipal solid waste.

Suppliers would not be allowed to use the term "green" or make claims that the energy sources benefit the environment; instead suppliers would make a reference to "renewable resources", as defined in 66 C.S. Pa Code 2803.

A California Case Study

Electricity customers in California will have several resources to turn to that can help them make sense of the disclosure and "green" puzzle.

SB 1305 signed by Gov. P. Wilson (R) requires generators to report comsumption by fuel type to the independent system operator on a quarterly basis. The ISO then will make that information available to the California Energy Commission (CEC) to verify and certify a generator's mix as renewable. The CEC is authorized to access similar data for out-of-state generators. Working with the state's Air Resources Board, the CEC also will report on air emission effects of electric restructuring by 1 June 1999.

Retail suppliers must disclose to both potential and actual customers whether their power is "net system power" or whether it comes from other sources. Interestingly,

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Energy Conservation to Reduce Global Warming

An international panel of global climate experts concluded during a public session in the 1998 ASHRAE (American Society of Heating, Refrigerating, and Air-conditioning Engineers, Inc.) Winter Meeting that the threat of global warming can be reduced if the world acts now to implement energy-conserving technologies in buildings and reduce energy consumption.

The panelists at the session also agreed that both approaches are technologically possible and economically viable.

In Japan, the construction industry significantly contributes to carbon emissions, especially producing building materials and operating buildings according to Kanji Sakai, vice president of the Society of Heating, Air-Conditioning and Sanitary Engineers of Japan, and general manager of the Technical Research Institute, Obayashi Corporation in Tokyo.

Sakai reported on ways to reduce the impact of buildings on carbon emissions during their entire life cycle. Sakai said that energy conservation is the most effective method for preventing global warming in the construction field. Other effective methods include prolonging the life of buildings and using sustainable and recycled materials.

The Japanese Ministry of Construction has declared that its building be built with the goal of a 30% reduction of carbon emissions over the life of the buildings, which is attainable using these methods, Sakai said.

Hal Levin, P.E., a consulting engineer in Santa Cruz, California, and member of ASHRAE's Committee on Building Impacts on the Environment, said that the impact of buildings on global warming is more than building operation. Other factors include raw materials, design, production of construction materials, transportation of materials, construction, commissioning, renovation, and demolition. He also advocated taking a systematic approach to buildings and looking at the dynamic interdependence between buildings, building occupants and the environment.

Western advertising and attitudes about consumption have directly impacted Poland's ability to address global warming, said Dr. Adam Gula, professor of Fuels and Energy at the University of Mining and Metallurgy and director of the Krakow Center of the Polish Foundation of Energy Efficiency in Krakow, Poland.

Poland and other central and eastern European countries, whose economies are in transition, face a great challenge to reconcile environmental protection with growing citizen pressure to quickly increase the standard of living. This increased demand and change to a more instant consumption society have resulted in some environmentally friendly habits disappearing, Gula said.

Modern Western energy-efficient technologies may help offset the growing demand for energy services, but more educational and awareness-raising campaigns are needed to educate the Polish people about the benefits of conserving energy and using less energy, Gula added.

Poland serves as a good example for the region, and it remains to be seen which will win the race: energy conservation or energy consumption, Gula said.

A study of five leading U.S. National Laboratories concluded that energy efficiency and low-carbon technologies have a high potential to cost-effectively reduce U.S. carbon emissions, while meeting the full energy needs of U.S. business and families, said Arthur H. Rosenfeld, Ph.D., senior advisor on energy efficiency for the U.S. Department of Energy, Washington, D.C.

Current projections suggest that a carbon emission reduction of 240 million to 380 million metric tons of carbon equivalent (MMTCE) is required to return U.S. emissions to 1990 levels. Under moderate technology and market assumptions, energy efficiency technologies alone can reduce emissions by 2010 by 125 MMTCE to 140 MMTCE, and this can be achieved with energy bill savings exceeding the required capital investments costs, Rosenfeld said.

Under very aggressive assumptions, a combination of energy efficiency, low-carbon technologies and relatively inexpensive coal power plant conversions can reduce 2010 emissions by 320 MMTCE to 360 MMTCE. The net cost of these reductions are estimated to be about US$ 10 billion per year or less than 2% of an estimated 2010 U.S. energy bill of US$ 600 billion, said Rosenfeld.

Rosenfeld added that achieving emissions reductions of this magnitude will require a national long-term commitment to develop and deploy these technologies and modest investment incentives. He also noted that there are other significant benefits in addition to lowering greenhouse gas emissions, including reducing some air pollutants, decreasing dependence on foreign oil and increasing industrial productivity.

[1998. Reducing global warming. Practical and economical. 1998 ASHRAE Winter Meeting. *ASHRAE Journal*, 40(3):18].

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Green Power...

Table 2 State Policy Initiatives for Renewable Energy

A sampling of legislative and administrative actions, both pending and approved.

State Legislation or Rule	Arizona *CD No. 59943*	California *SB 1305 SB 90*	Illinois *HB362*	Massachusetts *HB 5117*	Maryland *PSC Order No. 73834*	Maine *HP 1274 LD 1804*	Montana *SB 390*	Nevada *AB366*	Pennsylvania *Electricity Generation Customer Choice and Competition Act*	Rhode Is. *Utility Restructuring Act*	Vermont *SB62*
Date Enacted	26/12/96	8/9/97	16/12/97	25/11/97	3/12/97	29/5/97	2/5/97	1/10/97	1/1/98	7/8/96	Pending
Renewable Energy Resource											
Solar (photovoltaic)	●	●	●	●					●		●
Solar (thermal)	●	●	●	●		●		●	●	●	●
Geothermal		●				●		●	●		
Tidal				●		●					
Hydro		●	●	●		●			●	●	●
Wind		●	●	●		●		●	●	●	●
Fuel cells				●		●				●	
Methane (landfill or mine-gas)									●		●
Waste		●	●	●	●	●			●		●
Biomass		●	●	●		●		●	●	●	●

Arizona. By 1 January 1999, at least 0.5% of power must come from new photovoltaic or solar thermal source. The requirement will increase to 1% on 1 January 2002.

California. SB 90 creates a trust fund to support in-state renewable sources from 1998 to 2002; four accounts support new technologies and rebates for consumers.

Illinois. The act establishes a Renewable Energy Resources Program to foster investment in the development and use of renewable resources

Massachusetts. By 2003, 1% of electricity sales will come from new renewable generating sources, rising 0.5% each year through 2009 and increasing 1% each year thereafter. The law also establishes a Renewable Energy Trust Fund.

Maryland. The state had not defined the term "renewable" by early January 1998. However, the staff report does mention the promotion and utilization of electricity from cogeneration and waste. The commission chose not to adopt renewable portfolio standards or a charge to fund renewable energy objectives.

Maine. A minimum of 30% of supply portfolio of retail sales must come through renewable resources.

Montana. The act establishes universal system benefits programs to ensure continued funding of renewable resource projects.

Nevada. By 1 January 2001, 0.2% of the total amount of electricity consumed annually must come from renewable sources. This amount will increase biannually until the standard reaches 1%. Portfolio standards also must be derived from not less than 50% solar energy systems and be based on renewable energy credits, if applicable.

Rhode Island. For five years beginning 1 January 1997, customers will be charged 2.3 mills per kWh delivered to fund renewable energy resources and demand-side management programs.

Vermont. Renewable portfolio standards increase each year beginning in 1998 until 2007, when at least 4% of all retail electricity consumed in the state must come from renewable sources. Tradable credits are also established.

this disclosure provision does not apply to "advertisements and notices in general circulation media."

California consumers can also look for companies that display the *Green-e* logo, a part of the *Green-e* Renewable Electricity Program, created by the San Francisco-based Center for Resource Solutions. Besides requiring at least a 50% renewable energy supply for qualification, this voluntary certification program also requires marketers to disclose resources. The program uses the definition of "renewables" that is reflected in Public Utilities Regulatory Policies Act (i.e., sources such as solar, wind, geothermal, biomass, and hydroelectricity that is less than or equal to 30 MW).

Edison International's Earth Source product is one of the *Green-e* participants listed in a new Internet site unveiled last month by the Environmental Defense Fund (EDF) (*www.edf.org*). The site notes that EDF endorses the concept of electricity labeling and one section shows a probable state-by-state breakdown of electricity sources and pollutant emissions, based on monthly electricity costs.

The program manager stressed, however, that *Green-e* certifies a product, not a company name. So there's nothing to stop a company from calling itself, for example, Renewable Energy Source, Inc., while actually generating or reselling more traditionally generated electricity.

Janice Frankel, with the FTC's enforcement division, agrees that there's nothing inherently wrong with calling a company Green Energy Source, Inc., or something similar. But consumers need to be aware of how else a company is promoting itself. According to Frankel, there is a broad consumer protection authority under Section Five of the FTC Act, and in the past, the FTC has prohibited "inherently deceptive names."

[Rogers, L.M. 1998. Green electricity: It's in the eye of the beholder. *Public Utilities Fortnightly*, 136(4): 40-45].

Options for Dendro-Power in Asia

Experts from various organizations in Asia, Europe and the U.S.A. addressed the significant potential of dendro-power to contribute to national economic growth and employment generation in rural areas in Asia, as well as local and global environmental management. An Expert Consultation on "Options for Dendro-power in Asia" was organized in Manila, the Philippines, by the Regional Wood Energy Development Programme (RWEDP) in Asia on 1-3 April 1998.

The conclusions and recommendations of the RWEDP expert consultation are summarized below.

Options for Dendro-Power

Conclusions

- Dendro-power provides a significant potential to contribute to national economic growth and employment generation in rural areas, as well as local and global environmental management.
- With modern technologies, wood and other biomass can provide a competitive and sustainable fuel for processing and conversion into electricity in many situations. This position is expected to develop considerably when more expertise is gained with using biomass as a modern energy carrier.
- The development of dendro-power fits well in general trends towards deregulation and privatization in the power sector, and/or decentralized power supply in remote areas.
- Mainstream as well as niche markets for dendro-power do exist in RWEDP member countries in Asia. The government of these countries can formulate a strategy for the development of modern dendro-power.

Recommendations

- RWEDP member countries should explore the sustainable potential of wood and other biomass fuels to help meet their growing demand for electricity, in addition to the already existing use of these fuels for process heat.
- RWEDP member countries can initiate the identification and preparation of viable dendro-power projects in niche markets. Among potential niche markets are power plants based on combinations of woodfuel with agro-residues in order to overcome seasonality in the supply of the latter.
- Also, co-firing of woodfuels with coal and lignite using modern technologies should be explored and experience with large-scale supply of biomass should be gained in such applications.
- The potential of dendro-power for mainstream applications and major markets in suitable areas in Asia should be studied.
- Authorities should proceed with the implementation of clear regulations and mechanisms for wheeling and banking of power so as to accommodate independent power production.
- FAO and other international organizations should assist in providing information and preparing dendro-power policies, strategies and projects in member countries.

Biomass Energy Resource Base

Conclusions

- RWEDP member countries possess a large potential resource base for bio-energy fuels. The resource base consists of (a) agro- and forest residues that cause a disposal problem, (b) agro- and forest residues that have alternative uses but can be used under certain conditions and, (c) eventually wood and biomass specifically grown for energy purposes.
- However, site-specific data and evaluation of the resource base and its potential are not yet available. Efforts can be made to obtain detailed and site-specific information on present and future alternative uses of bio-resources.
- There is limited experience with large-scale woodfuel plantation, both technically and organizationally.

Recommendations

- RWEDP member countries should engage in establishing databases for evaluating the potential of bio-energy resources for modern applications in the power sector on an area-specific basis. Competing uses, supply patterns, markets and prices should be included in these databases.
- The potential of diversified biomass fuel supplies (dedicated wood plantations, available wood residues, other biomass) should be evaluated for feeding multi-fuel boilers and gasifiers.
- The potential of dedicated woodfuel plantations and residues from other sources should be inventoried in various areas in the context of complementing and competing interests. Special consideration areas are buffer zones around protected areas and areas where erosion prevention, water retention, biodiversity conservation, etc. can be obtained.

Projects, Technology and Management

Conclusions

- Several mature and proven small-scale and large-scale technologies for dendro-power plants are available and more technologies are emerging.
- Economies of scale provide substantial benefits for dendro-power plants. The feasibility of such options must be traded-off against constraints in the resource base, logistics of support, and other potential limitations. However, larger scale biomass energy systems should be considered.
- Vertical integration of activities in dendro-power (from biomass resource development to power generation) provides the most feasible approach in the initial stages of local market development since it shields the resource base off from competition.
- Expertise is available and can be further complemented to prepare and implement dendro-power strategies and projects.

(contd. on p. 9)

NEWS Around the Globe

Construction of *Village Green*: Energy Efficient Homes

U.S. President Bill Clinton will promote an administration partnership with the building industry to encourage the construction of energy efficient homes, something the White House says will make a major contribution to combatting global climate change.

The president is visiting a Partnership for Advancing Technology in Housing (PATH) pilot site known as *Village Green*, where building is about to begin on 186 energy-efficient homes.

Other pilot projects are under way in Tucson, the largest "sustainable" master-planned development in the United States, and in Pittsburgh, where a new neighborhood is being built on a decontaminated "brownfield" former urban industrial site.

The program includes tax incentives to encourage the construction and purchase of energy-efficient homes and Clinton plans to push Congress to dramatically expand the initiative.

The president's fiscal 1999 budget proposes a US$ 6.3 billion package of tax incentives and research money, including US$ 200 million in tax credits for qualified home purchases and US$ 1.4 billion in tax credits for the purchase of energy efficient appliances for buildings and homes.

The goal of the initiative is to cut energy use by 50% in new homes, and by 30% in 15 million existing new homes. White House officials say if those goals are met, consumers could save US$11 billion a year in energy costs by 2010. Also, the goal is to reduce annual carbon emissions in 2010 by nearly 24 trillion kg, the amount produced by some 20 million cars.

(CNN, 4 May 1998; http://allpolitics.com/1998/05/04/clinton.climate)

Green Gas Generator Using Potable Water as Industrial Fuel Gas

A Singapore-based company is offering technology for green gas generator, a technological breakthrough which uses potable water as fuel gas for industrial purposes.

The process converts, through electrolysis, water into a non-explosive and pollution-free fuel gas ("green gas") which has numerous industrial applications. Green gas is a well-favored alternative to conventional bottled gas, such as oxy-acetylene, both from commercial and operational perspectives. Green gas offers economy, safety, and environmental as well as technical advantages which have been separately tested and verified by the Singapore Productivity and Standards Board.

(VATIS Update: Non-Conventional Energy, March-April 1998)

Charcoal: An Ever-Popular Fuel in Thailand

Charcoal use, particularly among rural Thais, is still very high despite the availability of LPG, electricity and natural gas. In fact, 9.3% of Thailand's energy comes from charcoal.

The Royal Forestry Department of Thailand (RFD) has been playing a vital role in promoting the development of plantations to help communities which use wood, particularly in cooking. One project it has supported is Thai Plywood Company's Lad-Krating Plantation Unit, established in Chachoengsao province in 1968. Here fast growing trees, including *Eucalyptus spp*, *Leucaena leucouphala* and *Acacia mangium*, have been grown on a plantation covering approximately 32.6 million m². The total wood stock weighs some 100 million kg. Much of the wood is used to make particle boards, but low quality wood and harvest waste gets turned into charcoal.

Charcoal production began in 1988 as a way of dealing with the huge amount of harvest waste to meet the local need for charcoal. At the start of operations two 8 m³ brick beehive kilns were used, ogether with mud beehive kilns. There are now eight 8 m³ and four 20 m³ brick kilns. On average the smaller kilns produce 25 kg to 30 kg sacks per day and the larger kilns, 52 sacks.

Local workers run the operation, with each brick beehive kiln being overseen by one experienced employee. They work on a commission basis: the more charcoal they produce the more they get paid. Lad-Krating Plantation Unit pays 28 Baht (US$ 0.70) per sack or about 700 Baht (US$ 17.50) for each 8 m³ kiln of charcoal. It takes seven days and nine days to load, fire and empty the two sized kilns. Workers are required to wear masks but some find them too inconvenient. However, the workers say they are happy with their jobs and the amount they are paid.

The plantation unit chief says that charcoal production has been a success. It has no problems selling its stock, which in 1997 amounted to 15,904 sacks - up from 985 sacks in 1990 - at 100 Baht (US$ 2.50) per sack. Charcoal production is one of the main income sources for the Lad-Krating Plantation Unit. Most charcoal users are either locals or restaurants in Chachoengsao and neighboring provinces. Traders deliver the charcoal to shops and restaurants in small-trucks capable of carrying 20 sacks. The unit chief believes that charcoal has a strong future in rural areas because other energy sources had risen in price. It is also sold abroad. In 1996 the Kingdom exported 8.7 million kilograms of charcoal.

[Wood Energy News, March 1998]

The Challenge of Developing a Market for Renewables in Ecuador

Initiating a market transformation process to promote energy renewables in a country like Ecuador, where 25% of the population is still without electricity services,

is quite a challenge. The Renewable Energy and Efficiency Training Institute (REETI), a non-profit organization based in Washington, D.C., decided nine months ago to accept this challenge.

Market transformation implies a change from an old energy paradigm to a new one. In Ecuador, the old paradigm is dominated by large hydro schemes, supplemented by thermal energy, resulting in lots of pollution and erosion and little economic benefit to the population, apart from subsidized energy prices. The new paradigm is characterized by a portfolio of energy resources, including small and private renewables, reducing pollution and broadening economic benefits, reducing consumption while improving productivity and quality of life, and providing services to the 2.6 million people who are presently not supplied with electricity.

This is not a small change. It encompasses the whole energy sector, and the rural program is an important part. Making the whole economy more energy efficient and using renewables on the grid can make it possible to serve the population that is presently not on the grid.

In order to accomplish this market transformation in Ecuador, REETI, together with the Ministry of Energy of Ecuador, formed the Center for Renewable Energy and Energy Efficiency in May 1997. This Center fosters the use of renewables and energy efficiency as a solution for the inadequate energy supply in the urban and the rural communities. Two core programs have been started at the Center:

- the Micro Hydro Plant Development Program (for plants that generate less than 50 MW) follows two strategies. The first is to ensure financing for the micro hydro projects through funds of the main Ecuadorian development bank, Corporation Financiera Nacional. The second involves providing technical evaluation of the projects, so that they comply with environmental and engineering criteria.

- the Energy Efficiency Technical Assistance Program helps Ecuadorian industries improve their productivity while saving energy. Through REETI, several ESCO's (Energy Service Companies) will come to Ecuador to carry out energy audits and to implement and finance the actions needed as a result of the audits.

In its next year program, the Center plans to become involved in a national Rural Electrification Program using renewable energy.

(Energia News, February 1998)

Solar Timber Drying Kilns

Timbmet Ltd, Oxford, Britain's largest importer and merchant of hardwoods, has taken over from the British Overseas Development Administration (ODA) in sponsoring a scheme to improve the quality of the timber-drying process in tropical countries.

When timber is allowed to dry naturally in air, the moisture content will still be about 18%. In the tropics the figure needs to come down to 12% or the wood will distort in use. In the temperate zone, where it may often be used in centrally-heated houses, a moisture content as low as 8% or even 6% may be necessary.

A solar kiln takes longer to dry the timber than a conventional kiln but is much simpler, and uses electricity only to drive the fans that carry the heated air through the timber stacked inside. Light from the sun passes through a clear glass or plastic outer glazed surface to strike a black plate. Air circulated over the plate by electrically-driven fans rises in temperature and is then passed through the timber stack.

Solar kilns are cheaper than electrical ones and can be made in the countries they will be used. A manual, *Solar Heated Timber Drying Kilns* by Robert Plumptre and D.L. Jayanetti gives a full account of design and operation for great variety of kilns, including small greenhouse types for high latitudes, and medium-sized ones for low latitudes. Issued by TRADA Technology Ltd., the manual incorporates Oxford Forestry Institute research.

(Energy-Wise News, February 1998)

Anti-Reflection Coating for Silicon Solar Cells

Researchers at the Jadavpur University, Calcutta, India, have studied the role of anti-reflection (AR) coatings in the microgrooved solar cells having different slat angles. An expression for the reflection coefficient at various slat angles for unencapsulated and encapsulated cells have also been derived. When the slat angle is less than 55°, the influence of AR coatings is minimal, while the improvement of the shortcircuit current may be as high as 22% at a slat angle of 70.5°.

Encapsulated cells with small groove angles (less than 55°) have greater efficiencies than cells having groove angles in the range of 90° to 120°, but exhibit larger variation in efficiency with changes in the flat-top area coverage. The optimum thickness for single layer AR coated (ZnS) encapsulated cells and also for SiO_2 coated unencapsulated cell is 1,250 A. For more information, please contact: Department of Electronics and Telecommunications Engineering, Jadavpur University, Calcutta 700 032, India.

(VATIS Update: Non-Conventional Energy, March-April 1998)

Domestic Energy in Indian Household

The Bundelkhand region of North India is characterized by a depleted resource base, energy crisis and low productivity of land; all of which lead to rampant loss of livelihood opportunities. Energy, therefore, plays a crucial role in the economy of this region. The fuel mix here is characterized by a dominance of bio-fuels, including wood and non-wood biomass, agro-residues and to a large extent cow dung. Only 12% to 13% households use commercial forms of fuel, while 50% use wood and other woody biomass and about 37% use cow dung.

A study of fuel types shows that there is overall a good diversity in fuel usage. Although there is a distribution in the fuel usage pattern, biomass continue to have a large share in the total domestic energy. In

this region, mainly in rural areas, existing fuel for cooking purposes can be categorized as "mono", "di", and "multi" usage of material. "Mono" material usage is a single type fuel which is usually either dung or wood or kerosene. Di-material usage is the use of a combination of two types of fuels, usually dung-wood, dung-kerosene or wood-kerosene. Multi-material usage would include three-four types of fuel, viz, dung-wood-kerosene or dung-wood-kerosene-LPG. The distribution of three different categories of fuel usage in the representative villages of Bundelkhand indicates that di-material usage of fuel (dung-wood) is common in every village. Trimaterial usage of fuel is high in Kochhabhawar (dung-wood-LPG) because of existence of more diversity of livelihood activities compared to other villages.

Further the energy utilization and fuel use are also directly linked with the issues of livelihood and so interventions for the livelihood technology like brick kilns, pottery, etc. for effective fuel use is also crucial.

(Development Alternatives, April 1998)

Germany: Power from Renewable Energy Will Rise to 4.5% in 2005

Germany will be using renewable energy to generate 4.5% of its electricity by the year 2005. This forecast was announced by the Association of German Engineers (Verein Deutsche Ingenieure, VDI) at its mid-November conference on the "Launch of Renewable Energy Plants" in Neuss, a town in the German State of North Rhine-Westphalia. 21 billion kilowatt hours of electricity was produced in 1996 with the help of renewable resources. That was 4.5% of power consumption from the public grid.

Backed by research and development institute, German industry has developed technologies and facilities for the use of virtually every form of renewable energy. Germany leads the world in this technological sector. Its pre-eminence is due at least in part to government assistance. Thus, federal funding began in 1974 after the oil crisis, and peaked in the early 1990s. The VDI says, however, that government funding has been on the decline since 1994.

The greatest expansion has been in the development of technology for the production and grid input of wind-generated electricity. Germany has played a leading role here. Since 1990 the trend has far exceeded expectations in terms of both plant technology (technical availability, cost reduction, plant size, etc.) and forecast growth rates.

As a result, wind energy has become a factor that markedly contributes to value added and also creates jobs: Now already upwards of 10,000, counting employees of direct suppliers, too, it has good export prospects, particularly if it can build on a reliable domestic market.

The VDI also sees good prospects for the photovoltaic sector. Unfortunately, as the engineers association hastens to add, German corporations like Siemens and ASE that are the cutting edge of photovoltaic technology have moved production to the United States.

Given current sales of roughly 100 MW per year and annual growth rates of 15% to 20% in Germany, more and more small and medium-sized German companies are likely to move into the market in future.

Germany has always been seeing rapid growth in the use of flat collectors in the low-temperature range, with yearly growth rates of up to 25%. There has been no increase in the use of biomass, on the other hand, except in combustion.

Consequently, in view of the increasing global energy requirements and the finite nature of resources as well as the pollution caused by the use of consensus in German society that a larger proportion of energy should be supplied by renewable sources. Those involved disagree, however, on how to facilitate market access for renewable energies.

The VDI believes that renewable energies will be indispensable in the long run and capable of competing with what are now the predominant energy carriers. The association refers to a study by Shell according to which renewable energies will be economically competitive from 2020 onwards.

(GATE, German Appropriate Technology Exchange, January/March 1998)

Interactive Games Provide Awareness on Energy

A design team in Melbourne, Australia has designed an interactive CD-Rom, *Spazmo's Energy Quest*, which is designed to get children thinking about energy efficiency and renewable energy.

In the year 2050, alien *Spazmo* is forced to land on the Earth to find energy for refuelling his spacecraft. Each energy saving made is used to re-energize the spacecraft and re-green the Earth. The disk has one main game and five other energy activities. Along the way the player comes into contact with solar and wind power, budgets home hot water, and races against a sneaky power ghost, in a series of beautiful atmospheric scenes.

Victoria utility CitiPower Pty has bought the rights to distribute *Spazmo* to all 3000 primary and secondary schools in Victoria. They plan to increase public awareness while modifying consumer behavior and use of electrical energy. Teachers rated *Spazmo's Energy Quest* at almost 10 out of 10 on animation, story, sound, educational value and content.

Spazmo's creators would like to hear from New Zealand energy companies or others interested in forming a relationship for distribution. The product could be re-badged with their logo. The CD-Rom retails at A$ 99 but the makers are offering it at around A$ 60 a unit. It runs on 100 MHz-plus Windows and Mac machines with at least 16 MB of RAM.

For more information, please contact: Arthur D'Aprano and Elvira Vacirca, Screen Art Productions, 457 Church Street, Richmond, Victoria, Australia. Tel: 61 3 9427 9922 Fax: 61 3 9427 7372.

(Energy-Wise, February 1998)

(contd. from p. 5)

Options for Dendro-Power...

Recommendations

- RWEDP member countries should seek international cooperation for the preparation and implementation of dendro-power projects. Partners can be technology suppliers as well as specialized technical and financial consultants and others.
- At the same time, RWEDP member countries should make efforts to further develop local technologies and expertise required for dendro-power plants, including manufacturing capabilities for dendro-power equipment.
- South-South cooperation in research and development efforts for dendro-power development should be promoted. RWEDP member countries should seek cooperation with bilateral and multilateral organizations for supporting research and development on dendro-power in Asia.
- State-of-the-art proven technologies should be selected for current applications in Asia. New, emerging techniques (such as gasification; BIG/CC) are to be considered seriously. Asia can be a major market for such advanced systems, because of available capital and infrastructure and often cheap biomass supply in the form of residues.
- The feasibility of a demonstration project for dedicated dendro-power generation should be studied [1]. For the Asian context especially multi-fuel systems are of interest.

Energy and Climate Policies

Conclusions

- The sustainable use of wood and other biomass fuels provides a strong support to the implementation of international policies with regard to global climate change.
- Many industrialized countries have made substantial progress in applying modern technologies for biomass fuel utilization. Also developing countries are gaining experience in these options.
- Financial support mechanisms are being developed by international financial institutions and/or industrialized countries that enable developing countries and economies in transition to apply the modern bioenergy options.
- More and more large actors, such as utilities, oil companies, etc., are coming in which could be major partners for RWEDP member countries in developing and implementing dendro-power.
- The role of governments is to provide policies and framework for implementation by the private sector. It is increasingly being accepted that internalization of externalities in the energy sector is economically feasible and environmentally desirable. This can tip the balance in favor of dendro-power in many situations and considerably accelerate the implementation of energy from biomass.

Recommendations

- Developing countries and economies in transition should convert the new options for dendro-power into projects, making full use of the modalities for funding and implementation.
- In order to fully exploit the new options, capabilities should be developed with expert inputs from the energy, environment, forestry and financial sectors.
- Initiatives should be taken for the provision of information, training and demonstration for policy makers, professionals (engineers, environmentalists, foresters, economists, and others) and the general public on the positive impacts of biomass energy for economic development, employment generation and environmental management.

Financing

Conclusions

- The renewable energy sector is professionalizing rapidly, resulting in higher success rates for projects.
- As yet, important barriers for obtaining financing for dendropower are: (a) uncertainties in fuel supply caused by competitive use of both the lands that it is on, the long tree harvesting times as well as alternative uses of the biomass once harvested, and (b) the low scrap value of highly specific and technical equipment.
- More financing options besides the World Bank and GEF are becoming available such as the Clean Development Mechanism (CDM) and green banks.

Recommendations

- RWEDP member countries should take advantage of the new mechanisms for financial assistance, at the same time serving their domestic priorities for power sector development and local environment management.
- Governments should assist private sector organizations to actively access financial options.

A full report will be published by the RWEDP in due course. For more information, please contact:

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Fax: (66-2) 280-0760
Tel: (66-2) 280-2760

RERIC on the World Wide Web

http://www.ait.ac.th/clair/centers/reric

Visit our homepage to find out more about our services and your benefits as RERIC member.

[1] For instance, a project in the range of 20MW to 40 MW requires some 120 million m² of fuelwood plantation and some US$ 50-100 million of investment.

BOOK REVIEWS

Green Guide to Cars and Trucks:
Model Year 1998

J. DeCicco and M. Thomas. Published by the American Council for an Energy-Efficient Economy (ACEEE), 1001 Connecticut Avenue, N.W., Suite 801, Washington, D.C. 20036. Fax: 202-429-0193; E-mail: ace3pubs@ix.netcom.com URL: http://aceee.org ISBN 0-918249-33-3. 108p. 1998. US$8.95.

This pathbreaking new guide ranks cars and trucks according to environmental friendliness. Consumers can use it to compare cars, vans, pickups, and sport utility vehicles by their environmental impacts, including air pollution, global warming, and fuel efficiency. Inside the guide are:

- how to buy the cleanest and most efficient vehicle that meet your needs;
- "Green Scores" for all 1998 makes and models, listed by class - compact, midsize, and large cars; vans; pickups; and sport utilities;
- a "Best of '98" list featuring the "greenest" models in each class;
- listings for electric and other alternative fuels' vehicles in addition to gasoline and diesel vehicles;
- tips on keeping your vehicle running cleanly and efficiently; and
- educational and consumer information about the environmental impacts of vehicles covering global warming and health effects of vehicle pollution.

The easy-to-use listings will help consumers find the "greenest" model that meets their needs and fits their budgets.

Solar Energy Houses

Published by James & James (Science Publishers) Ltd., 35-37 William Road, London, NW1 3ER, United Kingdom. Tel: +44 (171) 387 8558; Fax: +44 (171) 387 8998896; Email: orders@jxj.com; URL: http://www.jxj.com/

This manual describes the strategies and technologies studied by the Task members of IEA's Solar Heating and Cooling Programme. Meetings were held between the Task members from fifteen participating countries from across three continents to share ideas and evolve design strategies. Innovative materials, components, systems and technologies were used if they were economical. These included transparent insulation, advanced glazings, thermal storage materials, intelligent control systems, integrated mechanical systems, solar water collectors and photovoltaic systems.

Part I of the book deals with the strategies, while Part II describes the technologies. Practical application of the strategies and technologies are demonstrated, which point up their strength and occasional weakness. The book is a valuable resource for all architects and planners who are designing domestic buildings with low energy usage.

Improving Energy Efficiency in Apartment Buildings

J. DeCicco, et al. Published by the American Council for an Energy-Efficient Economy (ACEEE), 1001 Connecticut Avenue, N.W., Suite 801, Washington, D.C. 20036. Tel: 202-429-0063; Fax: 202-429-0193; E-mail: ace3pubs@ix.netcom.com URL: http://aceee.org ISBN 0-918249-23-6. 300p. 1995. US$31.

This books reviews building characteristics, energy use, and barriers to conservation in existing five-or-more unit multifamily housing, and presents an up-to-date overview of approaches for audit and retrofit, energy-saving technology, conservation programs, evaluation, and financing strategies. Extensive tables and figures providing a statistical portrait of the sector are complemented by a dozen case studies illustrating "what works" for engineering, program planning, and financing apartment building retrofits. Topics covered are:

- techniques for efficiency improvement,
- program experience highlighting the elements of successful approaches to apartment building retrofit,
- innovative methods for financing energy-efficient improvements in apartment buildings, and
- recommendations for federal, state, local, and utility programs.

Global Electricity Company Profiles

D. Kurtz. Published by Financial Times Energy Asia Pacific, 159 Telok Ayer Street, Singapore 068614. Tel: +65 323 6373; Fax: +65 323 4725; E-mail: ftenergy@pearson-pro.com.sg. 485p, 1997.

Across the world, electricity markets are entering an era defined by liberalization, privatization and competition. Electricity utilities are moving into areas as diverse as natural gas and telecommunications. In this time of great change, the activities of the leading electricity companies are shaping the future of the entire industry.

Global Electricity Profiles examines the operations and strategies of 60 of the leading electricity companies in the world. Through its analysis of the key players, the report provides a comprehensive review of the current state of the global electricity industry. *Global Electricity Profiles* devotes an entire chapter to each company. Using electricity sales as its criteria, the report analyses the most successful companies form each region, including the emerging markets of eastern Europe, Asia and Latin America. Each entry includes:

- an overview of key personnel and structure,
- a review of operations by activities, including electricity generation and sales,
- key financial data such as profit and loss accounts,
- performance benchmarking by operational and financial criteria, and
- company strategy and future development.

International Events

INSIDE ASIA

August and September 1998
Small-Hydro Conferences in Vietnam and Brazil
Contact:
HRC, Hangzhou Regional Center for Small Hydro Power
RC, D. Pan
P.O. Box 1206
Hangzhou, China
Fax: +86-571-8062934
Email: hrc@public.hz.zj.cn

30 September - 2 October 1998
Pragati Maidan, New Delhi, India
POWER-GEN Asia'98
Contact:
Times Conferences and Exhibitions Pt. Ltd., Times Center
1 New Industrial Road
Singapore 536196
Tel: 65 284 8844
Fax: 65 286 5754

14-16 October 1998
Shanghai, China
Renewable Energy and Efficiency Asia Pacific '98 (REAP '98)
Contact:
Cassy Kurtzman
Alternative Development Asia Ltd.
1406 Leader Commercial Bldg.
54-56 Hillwood Road
TST, Kowloon
Hong Kong
Tel: +852 2574-9133
Fax: +852 2574-1997
Email: info@adal.com
http://www.adal.com

20-22 October 1998
Shanghai, China
International Conference and Exhibition on Renewable Energy and Energy Conservation for Buildings
Contact:
Rm. 1322, Bldg. 3
1486 Nanjing Rd. (W)
Shanghai 200040
P.R. China
Tel: +86-21-62479796
Fax: +86-21-62049481
Email: wjyao@online.sh.cn

2-6 November 1998
Beijing, China
International Oil and Gas Conference and Exhibition
Contact:
Dan Lipsher
Society of Petroleum Engineers
P.O. Box 833836
Richardson, TX 75083-3836
U.S.A.
Tel: (972) 952-9306
Email: dlipsher@spelink.spe.org

9-11 November 1998
Safat, Kuwait
International Conference on Energy Research and Development
Contact:
Conference Secretariat
ICERD&D
College of Engineering and Petroleum
Kuwait University
P.O. Box 5969
Safat 13060, Kuwait
Tel: 965-484-9413
Fax: 965-484-7131
Email: chakroun@ku01.kuniv.edu.kw

19-21 November 1998
Manama, Bahrain
ENERGEX '98
Contact:
Dr. W.E. Alnaser
University of Bahrain
P.O. Box 32038
Bahrain
Tel: +973-683278; 688396; 682582
Fax: +973-688381; 688307
Email: EA607@lsa.cc.uob.bh

25-27 November 1998
Tsukuba, Japan
Third International Conference on EcoBalance
Contact:
Ms Shoko Tsuda
Ecomaterials Forum, Kotohira Kaikan Bldg., 3F,
1-2-8 Toranomon
Mintao-ku, Tokyo 105,
Japan
Tel: +81 3 3503 4681
Fax: +81 3 3597 0535
Email: mitoh@snet.sntt.or.jp

OUTSIDE ASIA

13-17 September 1998
Houston, TE, U.S.A.
17th Congress of the World Energy Council
Contact:
World Energy Council
Fax: +1 202 331 0418
http://wwwwec98congress.org/17regis.htm

14-17 September 1998
Portoroz, Slovenia
EuroSun 98, ISES-Europe Solar Congress and Exhibition
Contact:
E-NET, Center for Efficient Use of Energy
1000 Ljubjana, Ambrozevtrg 5
Slovenia
Tel: +386-61-1729284
Fax: +386-61-1729283
Email: e-net@siol.net

20-25 September 1998
Florence, Italy
World Renewable Energy Conference WREC '98
Contact:
World Renewable Energy Network
147 Hilmanton
Lower Earley
Reading RG6 4HN, U.K.
Tel: +44 118 961 1364
Fax: +44 118 961 1365

20-25 September 1998
Giarini, Naxos-Taormina, Italy
Fifth Natural Gas Symposium
Contact:
Adolfo Parmaliana
Institute CNR-TAE
Messina, Italy
Fax: 39-90-624427
Email: parmaliana@itsmel.me.cnr.it

4-10 October 1998
Brisbane, Australia
Thirteenth International Coal Preparation Conference
Contact:
Richard E. Hucko
U.S. Department of Energy

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P.O. Box 10940
Pittsburgh, PA 15236-0940
U.S.A.
Tel: (412) 892-6133
Fax: (412) 892-4604

6-8 October 1998
Prague, Czech Republic
EEBW '98, 6th Energy Efficiency Business Week International Conference and Exhibition
Contact:
SEVEN, Slezska 7
120 56 Prague 2
Czech Republic
Tel: +420-2-2424-7552
Fax: +420-2-2424-7597
Email: seven@ecn.cz

5 October - 7 November 1998
Enschede, The Netherlands.
Training Course on Energy Management and Cleaner Production in Small and Medium Scale Industries
Contact:
The Course Administration
Technology and Development Group
VOK/CT 180
University of Twente
P.O. Bow 217
7500 AE Enschede
The Netherlands
Tel : 31 53 489 4377/489 3539
Fax : 31 53 489 3087
Email : j.r.m.borghuis@tdg.utwente.nl

12-14 October 1998
Oostende, Belgium
Materials from Energy and Refuse
Contact:
Rita Peys
Technologisch Instituut vzw
Desguinlei 214
B-2018 Antwerpen
Belgium
Tel: 32-3-216-0996
Fax: 32-3-216-0698
Email: mer@ti.kviv.be

22-25 October 1998
Istanbul, Turkey
ENERGYTECH '98
First Instanbul International Energy Technology Fair
Contact:
CNR International Fair Organizations, Inc., CNR World Trade Center
Ataturk Havalimani Karsisi
34830 Yesilkoy, Istanbul, Turkey
Tel: (+90 212) 663 08 81
Fax: (+90 212) 663 09 73
Email: ifnrg@ibm.net

10-12 November 1998
Nevada, USA
ENVIRO-SOFT 98
Development and Application of Computer Techniques to Environmental Studies
Contact:
Liz Kerr
Conference Secretariat
ENVIROSOFT 98
Wessex Institute of Technology
Ashurst Lodge, Ashurst
Southampton
SO40 7AA, U.K.
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Fax: 44 (0) 1703 292853
Email: liz@wessex.ac.uk

19-21 November 1998
Lyon, France
EPIC '98
The Joint Meeting of the Second European Conference on Energy Performance and Indoor Climate in Buildings and the Third International Conference on IAQ, Ventilation and Energy Conservation in Buildings
Contact:
Prof. G. Guarracino
Tel: 33 4 72 04 70 27
Fax: 33 4 72 04 70 41
http://epic.entpe.fr

10-13 February 1999
Perth, Western Australia
World Renewable Energy Congress 1999
Contact:
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Murdoch WA 6150, Australia
Fax: +61 8 9310 4997
Email:mathew@essun1/murdoch.edu.au
http://wwwphys.murdoch.edu.au/acre

1-5 March 1999
Nice, France
World Energy for the Next Millennium
1999 European Wind Energy Conference and Exhibition
Contact:
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Conference Chairman
Wind Energy and Atmospheric Physics Department
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The Regional Energy Resources Information Center (RERIC) is one of the four specialized information centers of the Center for Library and Information Resources (CLAIR), Asian Institute of Technology (AIT), Bangkok, Thailand. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

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New RERIC Director

Dr. Francis J. Devadason is recently promoted as Director of the Center for Library and Information Resources (CLAIR) at the Asian Institute of Technology (AIT). Before taking up this post, he was the Associate Director of CLAIR. Dr. Devadason had served in several capacities in India and other countries. He was Associate Professor at the Indian Statistical Institute, Documenmtation Research and Training Centre, Bangalore; Scientist and Head of the National Information Centre for Leather and Allied Industries, CSIR Madras; Assistant Librarian, Indian Institute of Management, Bangalore; and Senior Lecturer at the University of Papua New Guinea. Dr. Devadason has about 50 papers to his credit, and has served on the Editorial Board of an international journal published by Pergamon Press and on several national committees and missions. He holds two Bachelor's degrees from the University of Madras, an Associateship in Documentation and Information Science from the Indian Statistical Institute, and a Ph.D. from Karnatak University, India. In addition, to his administrative duties at CLAIR, Dr. Devadason teaches a required course in the Information Management field of the Computer Science and Information Management Program, School of Advanced Technologies at AIT.

Green Paper for a Community Strategy

Energy for the Future: Renewable Sources of Energy

The European Union's current energy situation calls for effective management of all available resources in order to attain the European Community objectives. A well balanced fuel mix, in which all appropriate energy sources play their proper role, is essential to support sustainable economic growth. Renewable sources of energy are currently unevenly and insufficiently exploited in the European Union. Although the potential is significant, renewable sources of energy make a disappointingly small contibution of less than 6% to the Union's overall gross inland energy consumption. European Union energy consumption is predicted to grow steadily in the future. Even a significant increase in the use of renewable energy sources, as pleaded for in this Green Paper, will not be enough to satisfy the expected demand. If, therefore, the Community does not succeed in attaining a significantly higher share of renewable energy in its balance, it will become increasingly difficult to comply with the international commitments concerning environmental protection. Secondly, failure to increase the share of renewable energy sources will have negative effects on other important policy objectives, in particular security of supply, economic and social cohesion, and at least in the medium to long term economic competitiveness.

The present Green Paper constitutes the first phase of a two-step approach to develop a strategy aimed at ensuring a greater use of renewable sources of energy. The establishment of a Strategy for Renewable Energy Sources was foreseen in the Commission's White Paper "An Energy Policy for the European Union" and specifically included in the indicative work program attached to that document. The present Green Paper describes the current situation, the advantages of an increased use for renewables vis-a-vis Community objectives, and sets out the basic elements of a policy strategy aim of promoting renewable energy sources as an integral part of energy policy and a number of other policies and sets the objective of doubling the contribution made by renewable energy sources to the European Union's energy balance by 2010.

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(contd. from p. 1) **Energy for the Future...**

The level of exploitation of renewable energy sources varies significantly between the Member States. These variations are due to different geographical and climatic conditions in the Community as well as differences in the policies which have been put in place in support of renewable sources of energy. Technological development in the field of renewables has, in recent years, been significant and many of the technologies either are, or are becoming, economically viable, in particular in certain regions of the Community and compared to the economies of the other decentralized energy applications. Nevertheless, due to market failures and other obstacles, renewable energy technologies still have difficulties in "taking off" in marketing terms.

Renewable sources of energy should be actively promoted for a number of reasons. Development of renewables goes hand in hand with the objective of protecting the environment and reduce CO_2 emissions from the energy sector. Renewable energy sources are indigenous sources of energy and can therefore contribute to reducing dependency of energy imports. Development of renewable energy sources can actively contribute to employment creation, and development of renewables is an important aspect of regional development with the objective of achieving greater social and economic cohesion between the regions of the Community. Moreover, the expected growth in energy consumption in many third countries, in particular Asia and Africa, to which a large extent can be satisfied using renewable energy, offers hugely interesting business for EU based industries which in many areas are world leaders as regards renewable energy technologies. Finally, the general public favors development of renewables more than any other source of energy mostly for environment reasons.

Under the prevailing economic conditions, a serious obstacle of greater use of certain renewables, has been the cost associated with their exploitation. Although the cost curve for most renewables is dropping rapidly, the use of renewables is in many cases hampered by higher capital cost than those related to conventional fuel cycles. This is particularly due to the fact that fuel and energy prices currently do not reflect the full cost, including the external cost implied for the society for the environmental damage caused by the use of conventional and fossil fuels. Secondly, a significant obstacle is that renewable energy, technologies, as is the case for many other innovative technologies, suffer from lack of confidence from investors, government and users, low levels of knowledge about their technical and economic potential and a general resistance to change and new ideas.

To counteract these obstacles, it is proposed in this Green Paper to implement a policy strategy consisting of four distinct elements.

Firstly a clear ambitious, and yet realistic, increase in the contributions of renewables to the Community energy balance should be aimed for at Community level. If the contribution by renewables can be doubled by 2010 compared to the current level, this would mean achieving a contribution by renewables to the gross inland energy consumption close to 12%. An ambitious objective provides the necessary means for focusing the minds of decision makers at all levels and enables a continuous monitoring of progress with a view to rectifying or adjusting policies.

Secondly it is proposed to strengthen member state co-operation on renewables. To achieve the target, strong policies will have to be implemented at a national level and it is necessary to have a mechanism for co-ordinating efforts at Community level. The Commission's recent proposal for energy policy co-operation around agreed energy policy objectives, one of which is effective promotion of renewables, is an important instrument in this respect.

Thirdly, it suggested that the Community reinforces its policies affecting development of renewable sources of energy. The provisions of the Treaties and the internal market requirements offer substantial opportunities for the promotion of renewable energy sources. Moreover, given the fact that cost currently constitutes the largest barrier to a more widespread use of renewables the policy instruments must address in particular this problem. Internalization of external cost is a key concept in this respect, to which the Commision remains committed. Accompanying measures, including continued and strengthened policies and support for Community RD&D, training actions, awareness building, pilot schemes, etc. must be continued and reinforced.

As policies in other areas than energy, including external affairs, agriculture, regional policy, fiscal policy, etc. also have a major impact on the conditions under which renewables are developed, it is fundamental to the strategy that these policies facilitate the development of renewable energy sources. It is also important the coordination between the decision-makers in the various fields is improved.

The fourth element of the strategy is a proposal for a strengthening assessment and monitoring of the progress towards achieving the objectives for the penetration of renewables.

The aim of this Green Paper, as the first step in a two-step approach, is to stimulate wide consultations and discussion with all interested parties and the Community Institutions. This document sets out a broad framework, but does not make detailed proposals. On the basis of the conclusion that the Commission will draw from the wide debate, a more detailed Community Strategy with an Action Plan will be established.

[Green Paper on Renewable Sources of Energy. http://europa.eu.int/en/record/green/gp9611/ensumen.htm]

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http://www.ait.ac.th/clair/centers/reric

SOLAR ENERGY

Myths and Reality

Solar and other renewable energy supply options have the capability to supply a large proportion of energy requirements. The increased use of renewable energy technologies will reduce pollutants and greenhouse gas emissions as the energy is derived from the natural sources of sun, wind, water and biomass. Renewable energy technologies already exist in a wide range of forms suitable for satisfying energy demands for many end uses. However the implementation of these technologies is hampered by myths and misinterpretations.

Myth Number One:
Solar energy can only heat water.

Reality:

Solar (renewable) energy includes the production of electricity and heat directly from the solar radiation for many applications. It also includes the utilization of indirect forms of solar energy like the power of the wind and water and all forms of energy from biomass (plant and animal material).

Designing a house to use solar energy passively can provide 60% to 100% of heating and cooling requirements. Photovoltaics (solar cells), wind generators and hydropower can supply electricity for any use. Biomass fuels include wood, alcohol, and methane for heating, electricity generation or transportation.

Myth Number Two:
Solar energy cannot be used at night.

Reality:

Solar heat can be stored in thermal mass or thermochemical reactions so it is available on demand at any time.

In a solar efficient designed house, the building elements themselves store the energy in their thermal mass for night-time comfort and for cloudy days.

Other facts about solar energy are: electricity from photovoltaics can be stored in batteries; wind generators run day and night; hydropower, derived from the solar evaporation of the oceans, can be used at any time, with water storage buffering the effect of river flow variations; and solid fuel crops, biogas, (methane) and alcohol fuels can be stored and used when needed.

Myth Number Three:
Solar energy is too expensive.

Reality:

Some solar technologies require no additional costs, e.g., houses designed to make use of natural energy flows employ "design" not "devices" or additional equipment.

Some solar equipment cost less than conventional alternatives to buy and install and also have lower running costs, e.g., solar pool heaters compared with gas heaters; solar clothes lines compared with electric driers; and photovoltaics panels for lighting or power supplies in areas too costly to connect to power from the grid.

Some solar equipment cost more up front but are cheaper overall due to lower running and environmental costs, e.g., water heaters for domestic, commercial and industrial purposes; and wind turbines for electricity generation and pumping.

Also, many costings are distorted to solar's disadvantage, e.g., solar water heaters would be even more attractive if one could get the same loan terms that the utility gets to build a power station. Remember, consumers do not have to pay for the power station when they buy their electric water heater.

Myth Number Four:
Current solar devices are not effective: a breakthrough is needed.

Reality:

While researchers continue to produce further improvement in a wide range of renewable energy technologies, the big breakthrough needed is equality of financing terms with conventional energy, e.g.: Australia leads the way in solar pool heating; there is a wide range of Australian and New Zealand solar water heaters which are among the best in the world; wind generators are operating commercially worldwide; and photovoltaics have steadily improved in performance and cost to where they are now cost effective in many applications.

Myth Number Five:
There is not enough solar energy to maintain our current lifestyle.

Reality:

There is 25 times the yearly energy needs of Australia and New Zealand falling on those land areas on an average day.

The southern coastline of Australia and New Zealand is in the "Roaring Forties", one of the best regimes in the world.

Biomass resources (vegetable matter including waste and specially grown energy crops) could sustainably supply all of Australia and New Zealand's liquid fuels without interfering with food and fiber production from arable land.

Myth Number Six:
To collect enough solar energy requires large arrays of collectors tying up a vast land area.

Reality:

There is sufficient roof space on homes alone to produce the total electricity requirements of Australia and New Zealand using photovoltaic technology.

Wind generators occupy only a small space for the tower with the rest of the land area being available for agricultural uses.

(cont. on p. 5)

Renewable Sources of Energy in Thailand

New and Renewable Energy Policies

The government established policy on New and Renewable Sources of Energy (NRSE) development and promotion for few decades. Under the Seventh National Economic and Social Development Plan (NESDP) (1992-1996) the research and development, production and utilization of NRSE are promoted in the following areas:

- the production of non-conventional energy technologies that are commercially viable and would better the quality of life in rural areas;
- the utilization of non-conventional energy sources such as solar energy, thermal energy and energy from agricultural and industrial residues, e.g., bagasse, rice husk and municipal waste;
- the establishment of private energy plantations for the industrial production of fuelwood and charcoal as energy sources for rural areas; and
- the production and utilization of proven energy technology equipment such as improved fuelwood or charcoal cooking stoves, high efficiency charcoal kilns, biomass gasifiers, etc. (including the dissemination of technical information to ensure equipment quality conforms to commercial standards).

The Ministry of Science, Technology and Environment (MOSTE) is the central government organization which is responsible for considering and allocating budgets to support related NRSE projects. Within MOSTE, the Department of Energy Development and Promotion (DEDP), under the name Bureau of Energy Study Research and Development (BESRD), is responsible for energy research, development and implementation, especially for new and renewable energy technologies.

BESRD is also composed of seven Regional Energy Centers (RECs) through out the country, of which four were established under the Renewable Non-conventional Energy Project which received financial assistance from the United States Agency International Development (USAID), and these were set up to cover a wider area. These centers are essential component in assisting and promoting proven, selected and appropriate rural-oriented energy technologies in the rural area in Thailand.

Renewable Energy Sources

In 1995, Thailand's total primary energy supply was 72.8 mtoe, an increase of 11.9% over the previous year. About 55.2 mtoe came from domestic sources and 44.8 mtoe from imported sources. Conventional energy (coal, oil and natural gas) accounted for 70.1% while renewable energy (wood, paddy husk, bagasse and hydro-electric power) supplied the other 29.9%.

During the period (1986-1995), the contribution of conventional energy to the total primary energy supply increased from 54.8% to 70.1% while the contribution of renewable energy dropped from 42.2% to 29.9%. As conventional energy sources in Thailand are limited, the increased use of conventional energy creates not only a financial burden for the country but also negative impacts on the environment as well as on the security of future energy supply.

An overview of the current situation on renewable energy sources (solar, wind, small-hydro, and biomass) is presented in details.

Solar Energy

Solar Water Heating

The current solar water heating market is immature and limited to the upper-income residential and commercial sector, which is dominated by imports from Australia due to its development only in the last few years. At present, more than 50 000 m² of flat plate collectors from 12 trading firms, both local and foreign, have been installed in hotels, hospitals, apartments, barber shops and private houses.

As markets mature, prices generally decrease and awareness grows. Hot water usage is growing rapidly in the region, as seen by the sales of point-of-use electric water heaters. In addition, as air conditioner markets grow, hot water needs likely to increase. Finally, solar water heaters are most cost-effective when properly integrated into the building construction and tend to be more expensive as a retrofit.

Solar Photovoltaic

According to the data collected up to April 1997, a total capacity 3.4 MW of PV systems had been installed by then. Most PV projects in Thailand are independently conducted by government organizations which depend on their functional responsibilities. Government agencies are also involved in PV activities in Thailand. Those with substantial PV installations are: DEDP, Electricity Generating Authority of Thailand (EGAT), Provincial Electricity Authority (PEA), Telephone Organization of Thailand (TOT), the Public Works Development (PWD), the Ministry of Education (ME), and the Ministry of Public Health.

For the period 1997-2001, the government has set a target to reach a total of 30 MW of PV installations. It is envisaged that future PV applications will be promoted among urban people by appropriate financial incentives. This will shift the PV market from publicly funded applications in rural areas and utility applications to a private/consumer market.

Wind Energy

In Thailand, the average wind velocity is rather low in most of the country's area. Areas that are considered suitable for the application of wind turbines are coastal areas, central plains, Chao Phaya valley, northern inter-mountain basin and Korat plateau.

Wind energy in Thailand is used for water pumping purposes in remote areas and for electricity generation in the islands of the southern region where wind velocity is higher. There are several institutions addressing the development, testing, demonstration and evaluation of wind pumps and wind turbines for water pumping and electricity generation.

Since wind is potential for electricity generation in some coastal areas in Thailand, the future situation could be summarized as follows:

- Several projects are ongoing for developing and testing of wind turbine generators, and
- In some no clear planned utilization of the wind energy resource; exploitation may occur from the year 2000 onwards.

Small Hydro

Viewed strictly in terms of rainfall, there are more regions with high potential for micro-hydropower generation on the Malay Peninsula than on the Indochinese Peninsula (including the Mekong River and Salween River Basins), where medium and large electric power development has been pursued up to this time. Small hydropower plants with installed capacities of 200 kW to 6000 kW have been established by DEDP since 1980. In 1997, 23 projects with a total installed capacity of 128 MW have been completed. Another two projects with a total installed capacity of 2 MW are under construction.

Biomass

Biomass has been the major indigenous energy source in Thailand, accounting for 24% of final energy consumption in 1995. Whereas a major portion of the above is fuelwood and charcoal consumption as cooking fuels, a significant role will be given to electricity production. In this context, the key sectors for which a promising market has been identified are:

1. *Energy from agricultural residues, mainly bagasse and paddy husk.* These are being used as fuels in sugar and rice mills, with annual consumption in 1995 of 16 billion kg and 1.8 billion kg, respectively. The introduction of efficient cogeneration systems could lead to the additional production of approximately 400 MW of power generating capacity for the grid.
2. *Municipal solid waste.* The appraisal of disposal and environmental issues, in conjunction with the predicted increase in the volume of the waste produced, will render this option favorable. Several installations and pilot plants are planned or under construction, while studies indicate significant electricity production potential, particularly in the Bangkok Metropolitan area.
3. *Biogas from agro-industries.* The sources of biogas which could be readily used for the production of energy are animal manure and wastewater from food industries. At present a major part of commercial pig farms use local biogas generation technologies, whereas 19 biogas plants have been installed in the agro-industry (distilleries, breweries and tapioca plants). The forthcoming strict legislation on industrial wastewater treatment as well as the familiarization of the industries with natural gas technologies will further assist the expansion of this technology.

The exploitation of the energy generation potential of biomass has been limited and will have to be further assisted by national policy, especially in terms of pricing. It is worth noticing that in the framework of the *Announcement for the Purchase of Power from Small Power Producers* only 22 small power producers with 229 MW of saleable electricity capacity applied, which is much less than the financial potential of biomass.

[LDK Consultants. 1998. PRESSEA country profile: Thailand. *Promotion of Renewable Energy Sources in South East Asia (PRESSEA).* Oxfordshire, U.K.: ETSU.]

(contd. from p. 3)

Solar Energy: Myths and Reality

Solar supply allows decentralization and the use of small modules which can be accurately matched to the load and which minimize electricity distribution line losses.

Myth Number Seven:
Solar does not yet supply much energy on a national or global scale.

Reality:

Energy statistics tend to be biased; e.g., they include energy used in drying food by oil fired drier, but ignore energy used in drying food in the sun. Even ignoring the bias in the statistics, solar (renewable) energy supplies 20% of the world's energy now - made up of 14.4% biomass and 5.7% hydro. In comparison, nuclear supplies 4.4%.

In California, 'windmills' generate electricity to a peak of 1700 MW, and solar thermal power stations provide over 350 MW of generating capacity. By comparison, the latest power station in Victoria's Latrobe Valley can generate 2000 MW while Darwin's power station is 300 MW, more than enough for that entire city.

Solar supplies all the energy used to grow plants, to evaporate water for rain and to maintain the temperature of the planet, all necessary for human life.

Hydro and geothermal power stations already supply 25% of Australia and New Zealand's electricity requirements.

Myth Number Eight:
More energy is used to manufacture a piece of solar equipment than is saved in its lifetime.

Reality:

A solar water heater will repay its energy "debt" in only 6 to 18 months, depending on the location, and will last well in excess of 15 years.

A photovoltaic module will collect over its operating life four times the energy used in its production.

A wind generator will produce the energy used in its manufacture in one to four years, depending on the wind regime.

[Australian and New Zealand Solar Energy Society (ANZSES). 1995. Myths clouding our most underutilized resource. Solar energy. Maroubra, NSW: ANZSES]

EU-ASEAN Roundtable Discussion on Electricity Interconnection and Deregulation

Following the success of the first EU-ASEAN Roundtable Discussion on Electricity Interconnection and Deregulation, organized by the EU-ASEAN Advisory Panel and the ASEAN-EC Energy Management Training and Research Centre (AEEMTRC) in Singapore in July 1998, ASEAN utilities and senior officials met again in Brussels on 30 October 1998 with their EU counterparts to further EU-ASEAN business relations between the two regions. Both meetings are co-financed by the EU Synergy Program which concentrates on the transfer of energy policy know-how and strategies to Third Countries. In ASEAN in particular, the Synergy Program has supported the activities of the AEEMTRC, and it has contributed to the promotion of business contacts between EU and local energy industries.

The second EU-ASEAN Roundtable Discussion on Electricity Interconnection and Deregulation resulted in recommendations for concrete projects such as the Masterplan for the Interconnection of the ASEAN Power Networks. The Masterplan suggested by the first roundtable discussion in Singapore, is considered by ASEAN Energy ministers as a timely initiative to move forward their ASEAN vision of electricity interconnection.

The Europe-ASEAN dialogue on energy encouraged by the European Commission is a direct implementation of the Europe-Asia Energy Strategy adopted by the Council of Ministers of the EU on May 1997, followed by a resolution of the European Parliament stressing the necessity of a structured approach to co-operate with Asia, including policy dialogue and facilitating the role of the private sector.

The ten year old AEEMTRC will become the ASEAN Center on Energy next January 1999. The Panel, created by the European Commission and the ASEAN energy authorities, is composed of senior energy professionals from the public and private sectors and acts as a major catalyst of energy policy dialogue in fields of mutual interest and business link between the two groupings.

In 2005, Asia will consume 28% of the world's energy. The region's growth rate will command massive capital expenditures in the order of over ECU 77 billion over the 1997-2005 power development period to meet these demands. The ASEAN represents the fourth biggest electricity networks in Asia, behind China, Japan and India with installed capacity of 72 GW. The recent financial difficulties in ASEAN countries allow crucial time for reflection regarding sound investments and strategies for the development of the energy sector. Interconnection of the national networks at a regional level is perceived as a global solution as it will increase the availability and reliability of power, increase competition and market cost-effectiveness, and save investments in generation capacity.

Therefore, regional electricity interconnection remains a major challenge for the Heads of ASEAN Power Utilities/ Authorities (HAPUA) which constitute the regional institutional instrument for strengthening ASEAN energy co-operation on electricity. In March 1998, HAPUA reaffirmed their commitment to ten identified interconnection projects.

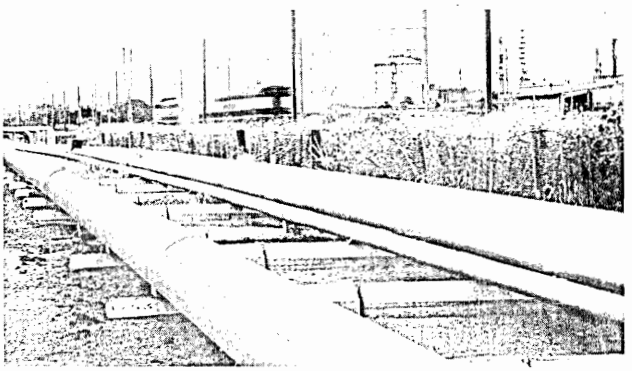
For more information, please contact the EU-ASEAN Advirory Panel, c/o Phillipe Bouix; Tel.: 32 2 513 9319, Fax: 32 2 513 2292; Email: philippe.bouix@ewc.be

Helitherm™ - Solar Heating of Crude Oil Pipelines/Vessels

Solar Systems (SS) Pty Ltd., Australia has headed the Research and Development program for a solar powered heat tracing system for existing or new pipelines. The systems is ideal for crude oil/product flow enhancement applications for above ground installation. The principle of operation lies on the integrated thermal diode which traps the sunlight and keeps the heat in. This passive system requires no power and is safe and reliable for any sunny location.

Among the many benefits which Helitherm™ offers are: increased daytime and night time throughput of pipline (and/or reduction in pump energy consumption for the same throughput; maintenance of pipeline temperature of 10°C to 40°C above ambient during stagnation conditions enabling easy startup; reduced operating pressure in the pumping system thereby enhancing the longevity of oil transportation equipment; and reduced or eliminate the use of steam injection/electrical heat tracing (environment friendly).

Presently, Solar Systems (SS) is planning co-operative demonstration projects worldwide and is interested to hear about the specific requirements of potential customers. Based on the geographical location and process conditions, SS engineers would conduct a feasibility study, custom design, engineer, install and commission Helitherm on turnkey basis. Helitherm technology can also be used for vessels. Please contact John Lasich/Neelabh Kaila for further information at the following address: Solar Systems Pty Ltd, 6 Luton Lane, Hawthorn, Victoria 3122; Tel: 61 3 9819 9544; Fax: 61 3 9819 9063; Email: rosemary@solarsystems.com.au



Solar Systems' Helitherm™: Solar Heating of Pipelines

Wind Energy in China: Institutional Barriers

China has a huge potential to become a dynamic nation in wind energy development, if institutional barriers are reduced. To realize this expectation, vigorous policy measures at the national and regional levels need to be established and readjusted.

Until the late 1980s, China's wind turbine development's main objective was to establish capacity via domestically manufactured small-scale wind turbines. The main aim was to build a decentralized, environmental-friendly energy system and to increase the quality of life for the poor in isolated rural commmunities. As a result, in 1996, there were 150,000 Chinese-made small wind turbines in use. China's small wind turbines have become a mature technology with increasing export. Currently, products are being exported to 22 countries.

The shift of policy emphasis toward large wind turbines started in the early 1990s. Prototypes for wind turbines of 100 kW to 200 kW were tested and demonstrated from 1985 to 1995, but efforts to market them largely failed. This failure can be attributed to high-tech contents of large wind turbines, small investment, and high cost. In 1990, the wind farms' installed capacity was 13 MW; by 1996, this number had increased to 60 MW (16 wind farms with 237 units) and, by 1997, to 160 MW. Another 71 units of 500 kW to 600 kW generators will be installed in 1998. Most of the production units are imported from foreign suppliers.

Exploitable wind resources are estimated at 250 GW. China has set up a plan to develop 1000 MW of wind energy capacity by the year 2000. This objective will require about 10 billion Yuan (US$ 1.2 billion) of investment. Wind energy development in China, however, is restrained by relatively high investment costs. Bank loans for wind energy investment have high interst rates (11.7%) and short terms (less than 5 years to pay back the loan). Taxes for imported equipment are high: import tax (12%) and VAT (17%). VAT for small hydroelectric development is at 6%.

Soft credits provided by foreign governments usually contain 35% grants but this advantage is overtaken by the taxes. In addition, VAT for electricity produced from the wind is set at 17%, the same as for electricity generated by coal-based power plants, which enjoy the advantage of taking depreciation on equipment. No depreciation incentives for wind turbines are available so far.

Current development of wind energy is further handicapped by low prices for wind-generated electricity. There are wide energy-price distortions in the energy market. Wind energy competes unfavorably with other conventional energy sources such as coal, because of the lack of proper energy-price mechanisms that could internalize social and environmental costs of energy production, distribution and consumption.

State-owned companies are the main players in China's wind-energy market. Large foreign companies started their engagement in China in the late 1980s. Lately, foreign companies' involvement in China has intensified, particularly through cooperation with regional governments and the national wind energy companies. Private Chinese companies involved in the wind energy industry are rare. This is related to high risks in investment and long pay-back periods. However, some private enterprises and groups are showing strong interest in investing in wind development, but they are reluctant to take decisive action because of the lack of policy incentives.

China's experience in wind energy development demonstrates that a lack of adequate policy framework constitutes a major barrier to cost-effective wind energy dissemination. This is due in part to an energy policy distorted in favor of conventional, i.e., fossil-fuel-based energy expansion. Many distorted policies are established due to the lack of understanding of wind-energy-related social and environmental benefits. It is important to make more efforts in human resources development and capacity building. The roles of education, training, and media are crucial in fostering such development in the long run. To achieve sustainable development of wind energy, mechanisms for encouraging interest from the private sector and commercialization of domestic products should be improved.

(Sustainable Energy News, September 1998)

Gas-Fired Generation: A Threat to SEA Hydro Power

Recent Asian Development Bank (ADB) and Asia-Pacific Economic Cooperation (APEC) Energy Working Group (EWG) meetings make clear that Southeast Asian hydropower is at a crossroads. It must either sell itself as environmentally benign or be considered as no more commercially and socially viable than nuclear energy.

At stake is a cascade of eight dams on the Lower Mekong, now all but abandoned due to environmental issues, plus many others on Mekong tributaries in the Lao PDR and Myanmar. If the Lao dams are abandoned, the country's development strategy, which relies very heavily on earnings from power exports to Thailand and Vietnam, will be wrecked. Other hydro projects in the region that would be more of less affected by the same situation could include several large projects in Myanmar along the Salween River. Only China's cascade of another eight dams along the Upper Mekong in Yunnan province seem likely to be unaffected. This is because China's demand for power is so vast that all energy sources urgently need to be tapped.

The Asian economic downturn is depressing growth in power demand, but chief threat facing hydro in the region is that the increasing availability of low cost natural gas will make hydro uncompetitive.

As ADB somewhat bleakly observed at the fourth meeting of the Greater Mekong Subregion's (GMS) electric power forum in Hanoi last October 1997, the prospects for hydro power export projects in the region depend largely on the availability of cheap gas for Thailand. The implication is that if low cost gas is available (and it is), even a very modest hydro program becomes non-viable. The threat becomes even more pressing when the present context of deregulation and privatization of power supplies is taken into consideration.

For the foreseeable future, power in Southeast Asia will probably be supplied mainly under what the APEC EWG calls a contract-based system. Although this is a

(cont. next page)

mid-point betwen "natural monopoly" utilities on the one and fully "competitive power provision" on the other, a contract-based system still requires independent power producers (IPPs) to operate within free markets. This being so, IPPs must necessarily favor the primary fuel that offers the best commercial viability.

As pointed out by the World Bank at APEC's EWG workshop on the security of fuel supplies for the power industry, held in Hawaii on 3-4 February 1998, the most commercial fuel is natural gas as shown in Table 1. Overall, in the Bank's ranking, hydro rates little above nuclear and well below gas or oil, although the Bank emphasizes that the local situation is always crucial.

Price is of course a consideration, and gas scores better than all other fuels in this regard, although there is a wide range in financing costs. This reflects the fact that LNG-based gas projects are difficult to finance whereas pipeline ones are easy, as shown in Table 1.

But gas is also far more attractive to IPPs for other reasons: significantly, environmental concerns and security of supply particularly favor gas. A final aspect of the threat is that gas favors "in-house" generation of domestic power demand. It is easy to transport and domestic power generation produces the greatest value added for the consuming country.

Large hydro in Southeast Asia, in stark contrast, is almost entirely predicted on power exports. This is of course fine for the exporting country which in this case reaps the value added, but not for the consuming country which does not. So what should be done by a cash-poor consuming country like Thailand whose power sector is rapidly privatizing?

For all three reasons cited above - price, broad-based desirability and greatest value added - it seems it should abandon regional hydro in favor of low cost gas.

Moreover, this argument applies to any country in a similar situation and could affect power exports from other primary energy sources besides hydro.

The essential antidote must be to rehabilitate hydro's unjustifiably battered environmental reputation. After all, a strong environmental case would also tend to increase hydro's attractiveness with regard to economics and financing.

An excellent start would be to revisit the environmental impact matrix prepared by the International Solar Energy Society (ISES) for the United Nations Conference on Environment and Development in Rio de Janiero back in June 1992.

The matrix compared the environmental impact of 145 energy options across 34 categories of impact within the total energy cycle - raw materials extraction and plant construction, energy production, comsumption and waste disposal.

The 14 options range from energy efficiency (the least impact) through solar and the other renewables, to hydro, gas, oil, coal and nuclear, the five fuels covered by the World Bank in Table 2. Of these five, coal produced the most impact (ISES score 256), then oil (235), and then gas (221). Note the very small spread between the fuels. Thus from an environmental impact perspective across the full fuel cycle, gas is not much better than either oil or coal.

Table 1. Desirability of Fuel Options for the Power Industry.

Option	Technical complexity	Secure supply	Environment concerns	Economics	Finance	Score
Gas	5	4	5	5	1-5	20-24
Oil	5	2	3	3	5	18
Coal	4	3	2	3	3	15
Hydro	3	4	-	2	2	11
Nuclear	3	5	-	1	1	10

1 = least desireable; 5 = most desirable Source: World Bank

Table 2. World Bank and ISES Environmental Ratings for Five Fuel Options.

Option	World Bank	ISES
Gas	5	3
Oil	3	2
Coal	2	1
Hydro	-	5
Nuclear	-	4

Nuclear came next (217), very close to but marginally better than gas. Hydro scored 158, almost 60 points below its nearest rival and nearly 100 points better than coal. As a benchmark, energy efficiency scored 121. Thus hydro, over its full energy cycle, clearly belongs with the renewables rather than with thermal fuels and nuclear, at least from an environmental perspective.

It is interesting to speculate what impact this re-evaluation of environmental concerns among the five fuel options would have on other elements of the World Bank study. For if, as seems likely, a high environmental grade for hydro would improve at least its financing grade and quite probably its economic score, too, then those same grades for gas, oil and coal would have to drop while those for nuclear would have to improve. In short, an entirely new perception of the relative merits of the five options is possible.

The hydro power industry should also consider that even as the ADBs GMS project and ASEAN's interconnection scheme - both hydro export-based - falter under the the twin burdens of environmental criticism and economic downturn both of which favor gas, many interest groups want them to proceed.

The groups include the World Bank, which is quietly urging Mekong riparian countries to push ahead with the GMS, the ADB, APEC, ASEAN and of course the national governments themselves. All groups can see the benefits of what they are trying to achieve. However, at present, under what now seem likely to be highly skewed perceptions, other options appear more economically and socially feasible.

(International Water Power and Dam Construction, August 1998)

NEWS Around the Globe

NEPO, Thailand to Boost NGO Role in Power Policy

The National Energy Policy Office (NEPO), Thailand's energy regulatory body, will weight evidence obtained from a public hearing for non-government bodies to contribute to the formulation of a new power tariff structure.

The event offered a chance for various parties to examine the mass criticisms over alleged overcharging of power tariff by the country's three state power agencies.

The Electricity Generating Authority of Thailand (EGAT) has been in the center of the public and media criticisms for making provisions from its power sales to ensure a pay hike, bonus, and welfare benefits for its 32,000 employees.

Critics said these are "hidden" factors which fuel the rise in power tariff it charges to the public. The utility came under fire recently as its proposed plan to hike the base power tariff by at least 20 satang (US$0.005) per unit, or roughly 12%, within the next months was leaked to the media.

Staging of public hearing included participation from the private and public sectors, including the Federation of Thai Industries, the public, power producers, financial institutes, government, the mass media and the three state power authorities as well as their labor unions, according to NEPO officials.

Opinion and comments obtained from the forum will be contributed to the formulation of a new power tariff which is promised to be transparent, reflecting more on real costs, and acceptable by parties concerned.

Those will also be used as a basis for the study of a new power tariff structure in Thailand which will be conducted by a foreign consulting firm with proven experience in helping the formulation of tariff pricing structure in other countries.

An ideal power tariff formula could be available in the middle of next year upon completion of the final report by the consulting firm which will soon be picked by NEPO.

Formulation of the new power tariff structure is in conjunction with the on-going liberalization of the country's power supply trade and the privatization of power generation industries which was targeted at the turn of new century.

(Power in Asia, 19 October 1998)

New Waste-to-Energy System

Techtrol Ltd. of Manchester, U.K. have specialized for over a decade in the design and manufacture of solid waste burning incinerators for various applications, including clinical, animal and general waste, and have recently achieved ISO 9001 accreditation.

In response to the increasing emphasis on recycling and reuse, Techtrol have introduced a new waste-to-energy system. The new units are suitable for incinerating wood, paper and cardboard waste with the facility to recover energy in the form of hot air, hot water and steam.

All units are purpose built to the customers specific waste criteria and are of steel construction with high temperature refractory lining. A choice of fuels is provided for both the ignition and afterburners, the latter being located within a dedicated secondary chamber to alleviate smoke or odors.

Each unit can be provided with a selection of loading methods ranging from simple manual feed through to sophisticated bulk ram feeders or screw systems for shredded and chipped materials.

The full range offers small units working only several hours per week through to high capacity systems for 24 hours a day operation. Typical uses range from general office wastes through to packaging waste associated with retail and commercial trades and high volume throughput of wood wastes, chippings and production wastes.

(Wastes Management, September 1998)

Report Warns of Energy Shortages

A report by the California Energy Commission (CEC), U.S.A. has warned that rising demand in the state could lead to higher rates during hot summer months and possible blackouts unless new capacity is built. Demand in California has twice outstripped supply this summer when temperatures, and air-conditioning consumption soared.

The report analyses the situation that might develop if aging gas-fired and nuclear power plants are shut down and no new plants are built to replace them. Under worst case conditions, the CEC concludes, shortages could begin as early as 1999.

If this situation was reproduced, big commercial users could find themselves paying higher prices as soon as shortages began. Price changes for residential and small commercial users would come later because their tariffs are frozen until 2002 under the state's deregulation plan.

The commission is considering four applications to construct gas-fired power plants that would together generate 2700 MWe, 6% of peak demand. Plans for a further seven plants with a combined capacity of around 2800 MWe have been announced by developers but their applications have yet to be submitted to the CEC.

(Modern Power Systems, September 1998)

Biomass Update in Australia

The Biomass Taskforce held a one day symposium at the Forestry House Conference Center in Caberra, Australia on 21 October 1997. The symposium brought together 60 participants with interests in biomass and biomass energy. They considered social, environmental, technological development and financial issues in the workshop.

The International Energy Agency (IEA) Bioenergy Program was introduced by the Biomass Taskforce. The IEA Bioenergy is an international colloborative agreement to improve international cooperation and information exchange between national bioenergy programs. IEA Bioenergy aims to realize the use of environmentally-sound and cost-competitive bioenergy on a sustainable basis, to meet a significant proportion of future energy demands.

The Biomass Taskforce is seeking participation from interested organizations for joining the IEA Bioenergy program. Contact with, and gathering of information from the Executive Committee of IEA Bioenergy has been ongoing. In addition, a major study tour and an End-of-Task XII (Biomass Production, Harvesting and Supply) meeting will be attended by a delegation of about 40 international visitors. This meeting was held at the CSIRO Forestry House Conference Center, Canberra, in March 1998. The Biomass Taskforce is providing financial and organizational support for this meeting. The main purpose of holding this meeting in Australia is to facilitate joining IEA Bioenergy. About 20 Australian representatives will be invited to participate in this meeting. A session has been allocated to discuss Australia's participation.

The new set of IEA Bioenergy Tasks for the period 1998-2000 were adopted at the IEA Bioenergy Executive Committee meeting in Rome, Italy on 20-21 November 1997. The tasks include short rotation crops, conventional forestry, combustion (including co-firing), gasification, pyrolysis, techno-economic analysis, MSW thermal conversion, MSW biological conversion, greenhouse gas balance, liquid biofuels and bioethanol.

(Solar Progress, March 1998)

Renewable Energy 2000

Worldwide concerns raised at the Tokyo summit of ministers about carbon dioxide levels in atmosphere have stimulated the launch of Renewable Energy 2000, an exhibition to be held from 1 to 3 July 2000 at the Brighton Metropole, U.K. and organized by Reed Exhibition Companies.

As a result of the summit, renewable energy has become a serious item on the agenda of both the government and the private sector. It is now of concern to hard core business which have begun to stake a claim in a rapidly expanding market. Also, the U.K. government has committed 10 million for research and development into renewable energy sources and agreed to produce 10% of the U.K.'s electricity from renewable energy sources by 2010. In 1997, renewable energy comprised just only 1%.

With this commitment from government and the private sector, the World Energy Council predicts that the market will grow from an estimated ECU 5 billion (£3,500 million), excluding large-scale hydropower and traditional business, to ECU 1700 billion (£1,190 billion) by 2020. The EU estimates that this investment will result in an ECU 17 billion (£11.9 m) annual export business by 2010 and will create 350,000 additional jobs in Europe.

Reed forecasts that the renewable energy sectors represented at the event will include: biomass, biofuels and energy from waste, cogeneration, district heating, general renewable energy services, geothermal, heat recovery, hydropower, solar thermal, sustainable transport, wave and tidal energy and wind power.

(Energy Digest, No. 4, 1998)

Wave Power in Denmark

The Danish government has decided to invest in wave power, hoping to repeat its success in building a profitable export for wind turbines. It has decided to spend 20 million Danish Kroner (about US$3.2 million) as an initial investment in wave power for the first two years (1998-2000) followed by the second amount if the results are favorable.

Denmark's leading wave energy scientist, Kim Nielsen, compared wave power to Denmark's highly succesful investment in wind power, which has resulted in more than half of the world's installed capacity being Danish-made, partly because other countries were slow in appreciating the enormous potential (in energy and commerce). That industry now provides employment for some 12,000 people and generated over US$750 million worth of exports in 1997. The Danes are planning to experiment with seven new concepts, led by the Waveplane, which tests have suggested could generate 1800 MW in the North Sea and 7000 MW off the British and Irish Atlantic Coasts.

Wave energy has at last received practical backing from unexpected quarter - the oil industry. A Scottish company has received an investment of £3 million to develop wave power technology for power to oil fields and grid-connected power. This is a major step forward towards acceptance for the fledgling wave power industry, which has suffered numerous setbacks as it tries to establish itself as an economically viable source of electricity.

(Renewable Energy World, November 1998)

Web Site for Energy Professionals

Professor Exell, who is a Scientific Advisor to RERIC, has established a web site with a section called Solar and Wind Energy containing key references and abstracts of some of his research.

The most recent addition is a full listing of the source code of a computer model for simulating solar radiation in tropical climates. Once the user has entered the mean daily global solar radiation for each month at any location in the tropics the model can create text files of daily or hourly solar radiation on any surface with the same statistical properties as real radiation on the tropics. These data files can then be used in performance predictions of solar energy equipment.

The website has two mirrors: *http://www.crosswinds.net/thailand/~exell/* and *http://www.kmutt.ac.th/~exell/*

BOOK REVIEWS

Investing in Hydropower

Paul Breeze. Published by Financial Times Energy Asia Pacific, 159 Telok Ayer Street, Singapore 068614. Tel: +65 323 6373; Fax: +65 323 4725; E-mail: ftenergy@pearson-pro.com.sg. ISBN 1 85334 910 0. 1997. US$632.

By 2020, over 25% of the global demand for electricity could be fulfilled by hydropower. This will involve a massive increase in global hydropower capacity, with output virtually tripling between 1990 and 2020. However, with many countries struggling to support infrastructure development with state funding, the expansion will have to take place predominantly within the private sector.

Investing in Hydropower gives insight into past, present and future hydropower development around the world. Providing detailed information on resources available and the extent of current activity, it points to areas where potential still exists and opportunities can be exploited.

Covering all aspects of hydroelectric power projects, *Investing in Hydropower* answers important questions such as: Which are the best sites for private sector hydropower development and why? What are the issues involved in the selection and development of a site? What are the technological requirements for electricity generation? What are the economic consideration and economic opportunities for strong electricity in pumped storage hydropower plants? What are the advantages and development potential of small hydropower schemes over larger scale projects? Why have recent projects attracted such bad press? Which key environmental issues need to be addressed? How do you ensure that the project is economically viable? Which problems can be avoided by carrying out feasibility studies? How can the financial, geological and hydrological risks be balance between the key parties? Answers to the questions above can be found in this book's 16 chapters.

Photovoltaics in Buildings
A Design Handbook for Architects and Engineers

Friedrich Sick and Thomas Erge. Published by James and James (Science Publishers) Ltd., 35-37 William Road, London NW1 3ER, United Kingdom Tel: (44) 171 387 8558; Fax: (44) 171 387 8998; E-mail: orders@jxj.com URL: http://www.jxj.com ISBN 1-873936-59-1. 296p. 1996. US$75.

Photovoltaics in Buildings will enable all building designers, engineers and property owners to make the integration of PV into buildings an architecturally appealing and energy efficient option.

Photovoltaics in Buildings provides the feasible means to incorporate energy production in building. This book aims to enable architects and engineers without specialist knowledge to integrate photovoltaic systems into their designs.

The chapters provide details of:

- components,
- architectural integration,
- system design,
- installation and maintenance,
- the relationship of PV with other building elements, and
- how to maximize the overall solar contribution to the building and how to optimize the economics.

The experienced PV designer will find this book of value for the significant, recent achievements and advances which are incorporated in the text.

This handbook is an outcome of the five-year program *Photovoltaics in Buildings*, Task 16 within the Solar Heating and Cooling Program of the International Energy Agency. Architects and solar experts from 13 countries took part.

Power Generation Technologies
Evaluating the Cost of Electricity

Paul Breeze. Published by Financial Times Energy Asia Pacific, 159 Telok Ayer Street, Singapore 068614. Tel: +65 323 6373; Fax: +65 323 4725; E-mail: ftenergy@pearson-pro.com.sg. ISBN 1 84083 038 7. 1998. US$632.

At least 5 million TWh of additional production capacity will be needed to meet global electricity demand by 2015, creating tremendous opportunities in private power generation and capacity development.

Choosing the right power generation technology is critical to the long-term capital cost, efficiency, environmental controls, long-term reliability and fuel costs. For example the capital cost of a gas combined cycle power plant, at US$ 640 per kW, is half the cost of a competitive coal-fired power plant. However, gas can be as much as four times the price of coal, making the coal-fired plant the cheaper option in the long term.

Power Generation Technolgies: evaluating the cost of electricity provides everything that is needed to appraise the different technologies available to power producers. It highlights the principal features and associated risks that affect the long-term profitability of different technologies.

Power Generation Technologies assesses the current potential and likely development of the world's most significant technologies. The report provides straightforward explanations of each technology and key industry data to aid decision making. It uses real life examples of private sector developments around the world to illustrate the practicalities of using different technologies. These infomative case studies include examinations of activity, capacity, output, restrictions, and cost. This comprehensive report is for all interested in the global power generation market.

International Events

INSIDE ASIA

31 May-6 June 1999
Moscow, Russia
Business and Investment for Renewable Energy in Russia
Contact:
The Congress Secretariat
Intersolarcenter, 2, 1st
Veshniakovsky proezd,
Moscow 109456, Russia
Tel: +7 095 171 9670
Fax: +7 095 171 9670

7-11 June 1999
Kuala Lumpur, Malaysia
World Renewable Energy Congress 1999
Contact:
Prof. Mohd. Yusof Hj. Othman
Conference Secretary, Deputy Dean
Department of Physics
University Kebangsaan Malaysia
43600 Bangi, Selangor, Malaysia

4-9 July 1999
Jerusalem, Israel
ISES 1999 Solar World Congress
Contact:
Organizers of the Congresses and
Tour Operators, Ltd.
P.O. Box 50006
Tel Aviv 61500, Israel
Tel: 972 3 514 0000
Fax: 972 3 514 0077
Email: ises99@kenes.com

2-5 November 1999
Guangzhou, China
Environment China 1999
Contact:
Stefanie Niebuhr
Gima Exhibitions and Conferences
Heidenkamsweg 51
20097 Hamburg, Germany
Tel: 49 40 235 24 341
Fax: 49 40 235 24 403

8-12 November 1999
Bangkok, Thailand
Civil and Environmental Engineering Conference: New Frontiers and Challenges
Contact:
Dr. A.S. Balasubramaniam
School of Civil Engineering
Asian Institute of Technology
P.O. Box 4, Khlong Luang
Pathumthani 12120, Thailand
Tel: 662-524-5519
Fax: 662-516-2126
Email: bala@ait.ac.th

OUTSIDE ASIA

1-5 March 1999
Nice, France
World Energy for the Next Millennium
1999 European Wind Energy Conference and Exhibition
Contact:
Dr. Erik L. Peterson
Conference Chairman
Wind Energy and Atmospheric Physics
Department, Riso National Laboratory
P.O. Box 49,
DK-4000 Roskilde, Denmark
Tel: +45 4677 5000
Fax: +45 4677 5970
Email: erik.lundtang@risoe.dk

2-5 March 1999
Leipzig, Germany
Terratec Leipzig - International Trade Fair for Environmental Technology and Energy
Contact:
Nicholas Bloxam
The Leipzig Fair Agency in Great Britain
P.O. Box 43, 1 Elstree Way
Borehamwood, Herts WD6 1NH
United Kingdom
Tel: 0181 953 1688
Fax: 0181 953 9456
Email: ifa@jenoptik-uk.com

24-26 March 1999
Montreal, Canada
Americana 1999
Pan-American Environmental Technology Trade Show and Conference
Contact:
Americana 99
911 Jean-Talon Street East Suite 220,
Montreal, Quebec, Canada H2R 1V5
Tel: +1 514 270 7110
Fax: +1 514 270 7154
Email: info@americana.org

11-14 April 1999
Maui, Hawaii
Renewable and Advanced Energy Systems for the 21st Century
Contact:
Dr. Stanley Kleis
Department of Mechanical Engineering
University of Houston, Texas, U.S.A.
Tel: 1 713 743 4536
Fax: 1 713 743 4503
Email: kleis@uh.edu

The Regional Energy Resources Information Center (RERIC) is one of the four specialized information centers of the Center for Library and Information Resources (CLAIR), Asian Institute of Technology (AIT), Bangkok, Thailand. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

The *RERIC News* is published quarterly by RERIC and distributed to RERIC members as part of RERIC annual membership package along with the *International Energy Journal.*

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How much do you know about Wood Energy?

Providing information on wood energy is among the stated objectives of the Regional Wood Energy Development Programme (RWEDP).

RWEDP has been in existence since 1985, funded by the Dutch government. The current phase of activities (1994 to 1999) is the third phase. In the previous phases, RWEDP has helped key personnel of energy and forest departments, NGOs, and research institutions to initiate and strengthen their own activities on wood energy related issues. In the current phase the focus is on strengthening efforts in policy analysis, energy strategy formulation and wood energy resource assessment, while also addressing the need to improve the efficiency of wood and biomass energy utilization in household, rural and small industrial sectors. To this end, RWEDP provides training activities, expert consultations, study projects, briefings, advice, information, and others, jointly with its member countries. At present RWEDP has 16 member countries, namely, Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Laos, Malaysia, Maldives, Myanmar, Nepal, Pakistan, the Philippines, Sri Lanka, Thailand, and Vietnam.

The major thrust of RWEDP is to help develop the capability of member countries to generate and assess wood energy related data and use this information for the development and implementation of wood energy policies and strategies. Information generation and dissemination is considered one of the main strategies used by RWEDP to achieve its objectives.

(contd. on p. 2)

Renewable Energy Technologies in Asia:
A Regional Research and Dissemination Program

The Energy Program of the School of Environment, Resources and Development of the Asian Institute of Technology is conducting a regional research and dissemination program on Renewable Energy Technologies (RETs) in Asia.

The overall objective of this research program is to promote the diffusion of selected mature and near mature renewable energy technologies (RETs) in a number of selected Asian countries through the adaption of the technologies to the local conditions. The project will involve a wide range of activities to be carried out at AIT in photo-voltaics, solar drying, briquetting and improved gasification as well as institutional stoves. For regional support, the project will also involve activities to be carried out at certain target countries and selected RETs by the National Research Institutes (NRIs) as follows:

> ***The mid-1990s appear to be a better time to promote RETs because of the realization of the gross environmental problems associated with the use of fossil fuels.***

- **Bangladesh** : Pilot project on briquetting of biomass fuel - manufacturing and marketing; R and D on the fabrication and adaptation of appropriate accessories used in small PV systems for rural electrification, and marketing and maintenance strategy for the systems.
- **Cambodia**: Demonstration and promotion of PV; solar drying systems and assessment of the renewable energy resources of Cambodia.
- **Lao P.D.R.**: Demonstration and promotion of PV systems.
- **Nepal**: Study on PV solar home systems and solar dryer adaptation.
- **Philippines**: Development of hybrid solar-biomass system for ceramic drying applications.
- **Vietnam**: Briquetting of agricultural residues and rural electrification using PV . In addition, a study of government policies and fiscal incentives for the promotion of RETs in each of the target countries will be carried out.

(contd. on p. 2)

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(contd. from p. 1) # How much do you know about Wood Energy?

Information on wood energy issues and activities in Asia and worldwide is available on the Internet at the RWEDP's website: *http://www.rwedp.org*. Through organizing workshops, seminars, training and carrying out research projects, RWEDP collects information from each member country.

RWEDP Wood Energy Database

A wood energy database has been developed by RWEDP. The database is designed to present wood energy related data selected by RWEDP from various sources, in a systematic and comprehensive way. The sources for data are not only regional and international organizations but also country statistical reports, individual researches and papers presented during workshops or other activities. Data are organized into four main categories: wood energy resources; fuel flow; consumption; and others. The latter includes demography, economy, income and environment, etc. Under each category, sub-categories and even finer divisions make data searching faster and more precise. Although the database focuses on wood energy in RWEDP countries, it also contains data related to non-member countries.

Database on Household Energy Organizations

A database is available which documents and assesses the activities of national and regional organizations and institutions as well as individuals active in the field of household energy projects and programs. The information has been compiled by RWEDP in close cooperation with the Asia Regional Cookstove Program (ARECOP), based in Yogyakarta, Indonesia. The latter organization maintains the database.

Efforts are being made to keep the information up to date. Therefore, organizations and institutions in the field are invited to keep RWEDP and/or ARECOP informed about their activities. Those interested to learn more about household energy related activities such as cook stove programs in their respective countries, can contact either RWEDP or ARECOP.

Database on Major Woodfuel Using Industries in the Region

RWEDP is in process of setting up a computerized database system on major woodfuel using industries in the region. The system will contain all sorts of information with regard to wood and other biomass energy. Part of the information concerns major fuelwood using industries in the region, i.e., wood processing industries, small-scale building materials industries (bricks, tiles, limes), etc. The database has been compiled by desk studies, complemented with information from field visits and other sources of information. The database has not yet been published but is available upon request. It should be noted that much of the information is based on national statistics. Although the latter are reliable with regard to the large-scale industrial sector, the same is often not true for the rural based small-scale industries. Particularly as in the latter woodfuels play an important role. For that reason, the available information may not always be up to date. Readers are invited to supply information to RWEDP in order that others can also be kept informed about the present status of major wood fuel using industries in the region.

RWEDP Publications

There are two major kinds of publication from RWEDP: field documents (FDs), and reports and miscellaneous documents (RMs). FDs contain the results of studies and research. RMs document the meetings, workshops and training courses organized or sponsored by RWEDP.

During the past four years, about 23 publications have been published by RWEDP. In principle, all documents should be available to persons and institutions interested in the subject of wood energy. This policy of free distribution has been widely appreciated.

RWEDP's newsletter, *Wood Energy News*, which is published on a regular basis, addresses a wide variety of wood energy issues, such as woodfuel resources, woodfuel flows, wood energy planning and policies and wood energy technologies.

For more information, please contact:

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(contd. from p. 1) # RETs in Asia...

The expected output of the regional support are as follows: a set of RETs adapted to suit the local conditions of the selected countries; transfer of RETs to selected countries; and development/strengthening of the capability of the NRIs in the field of RETs.

Attempts to introduce RETs were undertaken in most developing countries after the energy crisis in 1973. Most of these attempts were later abandoned because of a variety of reasons, e.g., the crash of oil prices in 1986, teething problems encountered in developing new technologies, lack of trained manpower, lack of coordination among various agencies involved (government agencies, R&D institutions, entrepreneurs and users), lack of consistent government policies, etc. The mid-1990s appear to be a much better time to promote RETs because of the realization of the gross environmental problems associated with use of fossil fuels and possibility of joint implementation of renewable energy projects in the near future.

This regional research and dissemination program on RETs in Asia is sponsored by the Swedish International Development Cooperation Agency (Sida). For more information, please contact: Prof. S.C. Bhattacharya, Coordinator, Energy Program, SERD, AIT. E-mail: bhatta@ait.ac.th.

Recent Developments in Power Line Communication Technology

The use of electricity distribution networks for communications and data transfer has been an ambition of power companies for many years. The first technology patent on the subject of sending signals down power lines dates back to 1899. However, until recently, the prospect of high-speed, two-way communication network has been a dream of utilities. That dream is now being turned into reality. Although the two-way power line carrier is still a relatively new technology, it is already showing great promise. Some of the developments are briefly introduced below.

Nor.Web (U.K.)

In 1992/1993, Norweb, a U.K. power distribution company, achieved a breakthrough in the operation of power line communication (PLC) systems, and implemented the world's first telephony and data trial from an operational power distribution network for 25 domestic customers. After 18 months, the trial was operating these services at over 99% reliability. Nortel and United Utilities formed a joint venture, Nor.Web, to develop and market the digital power line (DPL) technology.

West End Networks (Canada)

West End Networks (WEN) was invited to participate in the Norweb PLC test in 1995. At the time, WEN was trialing a product to provide high speed interactive communications over cable TV networks employing fiber and coaxial cables. The base protocol for the WEN technology was seen as being particularly suitable for the PLC environment. The WEN systems aims to provide individual customers with potential bandwidth of up to 2 Mbits/s.

BEWAG (Germany)

Bewag, in collaboration with the University of Paderbom, has implemented trials of PLT products designed to provide service over the local power network and onto the in-building wiring. This will provide a capability to utilize each power socket as a communications port. The system is designed around a Code Division Multiple Access protocol as used in some mobile telephony networks. The Bewag product is in the design and test stage.

Intelogis (U.S.A.)

Intelogis is developing a product to allow data communications over the local power distribution network and onto the in-building wiring. The passport product is a device connected to a computer or printer port. The device is then plugged directly into the electricity mains, converting the data and transmitting it at about 5.6 MHz. This system allows in-building mains to be used as a communications local area network, although the application is not designed for use over external public power distribution cables.

Siemens (Germany)

Siemens has developed a system for energy meter data management called SEMMS. SEMMS can be implemented by power supply measurement or for applications where optimization of processes and cost accounting are important. The system is based on flexible communication, and has standard protocols for telephone, low voltage grid, radio, broad-band cable, standard field bus, and mobile data-recording.

ABB (Sweden/Switzerland)

ABB has developed its Panorama system for distribution and demand side management based on power line communication for data transfer. The medium voltage distribution line carrier is completed through improved grid coupling. The Local Area Network (LAN) counterpart brings the communication over the power line down to the household level, providing two-way communication for load management, meter reading and other services.

IBM (U.S.A.)

IBM has developed an Intelligent Distribution Automation and Management (DAM) system, based on a modular structure with interfaces between different individual components in the system. The system is mainly intended for remote metering, distribution automation and customer services.

A new concept is communication on all three phases in the low voltage grid to secure the data transfer. This enhances the safety of data communication. The main system components are: the Multi Functional Node (MFN), the interface on the customer side; the Concentrator and Communication Node (CCN), which manages multiple MFNs; and the Operation and Management System (OMS) that manages the total network.

RWE (Germany)

RWE is working on pilot tests to determine the technical and economic feasibility of using the low voltage grid for both telephony and data transmission. RWE regards PLC as a strategic asset, which will be especially valuble in a deregulated energy market, as it represents value-added service. RWE is promoting an 'Open Powerline Platform' to be achieved by close Europe-wide cooperation between utilities, suppliers and developers.

Electricite de France (France)

EdF carried out studies starting in 1994, which showed strong customer interest in services such as demand side and energy management. The studies showed that although interest in energy management services by residential customers is high, their actual knowledge of their own load and cost profiles is very limited. EdF is attempting to introduce a service to improve customer knowledge in this area.

ECN, KEMA (Netherlands)

KEMA is studying the standardization and integration of PLC protocols with software applications technologies. ECN, the national energy research foundation of the Netherlands, is developing tools to support energy customer policy.

[Recent developments in power line communication technology. *Modern Power Systems* (November 1998)]

Sugar Cane: A Sustainable Energy Resource

In May 1998, the Stockholm Environment Institute (SEI), Sweden and the Zambian Department of Energy (DOE), Zambia initiated a joint project on the development of sugar cane resources in the Luena region of Luapula Province in Northern Zambia. The project team will evaluate the techno-economic options for uses of the sugar cane resources in Luena and assess the potential social and environmental impacts. The team will then identify the alternatives that are consistent with a sustainable development strategy for the region. The Swedish International Development Cooperation Agency (Sida) is supporting the project within the broader context of regional economic development in Luena. The project also fits well with the Zambian National Energy Policy adopted in 1994, which emphasized development of indigenous and renewable resources.

Sugar Cane Resources

One of the most promising agricultural sources of biomass in the developing world is the sugar cane plant, along with its associated products and by-products. The plant has the special feature of providing its own energy source for cane processing in the form of the fibrous outer residue of the cane stalks, known as bagasse. Surplus electricity generated at the sugar mill using bagasse is sold to the electricity grid in some countries. Bagasse can also be used to make industrial products such as particleboard and newsprint.

From Molasses to Ethanol

Another important by-product of sugar production is molasses, which can be used to make many different products, such as animal feeds, ethanol, and fertilizers. Sugar cane can also be sent to a distillery to ferment the cane juice directly into ethanol, as is common in Brazil. The production of ethanol for blending with gasoline could be an attractive option in Zambia, whose transport sector is powered solely by imported oil. The use of ethanol would save foreign currency, reduce carbon dioxide emmissions, and stimulate development of a new domestic industry.

> ***The sugar cane plant is a valuable biomass resource that can be used to make ethanol, electricity, and a variety of other industrial and agricultural products.***

Other cane-based resources could contribute to rural development in Zambia and neighboring countries, while at the same time offering greater flexibility to sugar producers. Modern bagasse-fired cogeneration units could enhance rural electrification efforts and contribute to regional exports, furthering the objectives of the Southern African Power Pool, an SADC initiative to promote regional trade in electricity. New regional markets could also be developed for cane-based agricultural products such as fertilizers and animal feed, and industrial products such as particleboard and newsprint. A diversified portfolio of cane-based products would lower investment risks for sugar producers, who face fluctuating sugar prices and increasing competition from other sweeteners.

Next Steps

The project has now moved into the analytical phase, using data gathered on the Luena region. The joint SEI-Zambian project team will develop and compare different scenarios for production, sale, and consumption of sugar, ethanol, electricity generation, and related products and services. For each scenario, the following key elements will be identified and evaluated: technical feasibility, market potential, investment costs and financial parameters, regional and national economic impacts, social and cultural implications and environmental impacts.

The project team has adopted an analytical framework to integrate technical, economic, social, and environmental aspects in order to characterize the preferred strategies for developing the sugar cane resource from a societal perspective. The project is scheduled to be completed in June 1999.

The project aims to increase understanding of the potential role for sugarcane resources in supporting economic development in Zambia and elsewhere. The Zambian government is expected to use the results of the study comparing the costs and benefits of energy sector investment options. The Luena region itself will benefit through increased knowledge of the economic resource base and the opportunities for investment and development. The project will also be of general interest to policymakers and researchers working on biomass and other renewable energy projects.

[Johnson, F.X. and Morales, M. 1998. Sugar cane resources - a sustainable energy option. *Renewable Energy for Development* 11(2): 1 and 17.]

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Wind Energy: A True Option for Developing Countries

For developing countries, wind turbines offer an attractive source of power generation. Compared with fossil-fuelled thermal power stations, they are non-polluting and, in many cases, economically efficient. The high prime costs involved in wind energy projects are soon recouped thanks to the low external costs once in operation. Also, funds are available from a number of sources for such investments. In 1988, a wind energy program named TERNA was initiated under German Technical Cooperation and cooperation has since been extended to numerous developing countries in Africa, Asia and Latin America.

Wind energy has macro-economic advantages in developing countries, mainly because of lower external costs for wind turbines.

For industrialized countries, the prime costs of standard wind turbines are now lower than those of conventional power stations. Compared with thermal facilities, grid connected systems are now economically viable. For developing countries, however, the costs of wind energy projects tend to be higher at first. Mainly, this is because of producers' higher expenditure on installation and after sales service.

Where wind conditions are favorable, the higher investment costs are recouped solely due to the higher energy harvest. In general, wind energy has macroeconomic advantages in developing countries, mainly because of lower external costs for wind turbines in operation.

The more this source of renewable energy is used, the greater the macroeconomic benefits. A considerable contribution can be made to reducing dependence on energy imports. Also, the wider use of wind turbines improves the overall supply situation by introducing diversity into the energy sector. Local production of components, if possible, will stimulate the domestic markets. A final point is, of course, that non-polluting power generation will save real costs in the long term.

Yet despite all this, even the most favorable wind energy resources have been untapped until now. The main reason is a lack of know-how concerning the methods of site selection as well as technical aspects of wind power. Yet such know-how is essential for designing wind projects and planning wind farms. Thus, wind energy today does not feature on the national energy plans of most developing countries.

Specialist know-how and experience are needed to determine the wind resources of a country and to identify the best sites. Without such work, neither technical nor economic analysis is possible. Yet these are vital basis for discussions with donors.

To disseminate such knowledge, the German Ministry for Economic Cooperation and Development (BMZ) started a wind energy program in 1988: TERNA (Technical Expertise for Renewable Energy Application) provides technical consultancy and help for potential operators of wind farms in developing countries, whether large utilities or private independent power operators (IPP). Partners are trained to analyze wind energy projects and to plan successful measures. Ultimately, this is aimed at improving energy supplies to the population.

The Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) coordinates the program. In view of their supra-regional character, the BMZ provides these projects with funding over and above the aid available under bilateral cooperation with a partner country. This means that TERNA can offer additional money to partner countries for wind energy.

Supra-Regional Wind Energy Program

At the begining, the program demonstrated the feasibility of decentralized wind energy systems for rural electrification. Measurements were carried out in several countries. Since 1994, the program has new features aiming at grid connected wind farms of at least 3 MW. The focus is now no longer on building small turbines and isolated wind/diesel systems or on promoting research and development countries that provide the necessary conditions for large systems to operate in an economically efficient way.

TERNA: Projects on Three Continents

Brazil

Starting in 1989, the regional utility COELCE and GTZ carried out wind monitoring along the coastline of the state of Ceara. The measurements showed mean annual wind velocities of between 8 m/s and 9 m/s, which meant the area offered considerable potential. Therefore, two sites were identified for feasibility studies. At the end of 1996, COELCE built its first demonstration wind farm with an installed capacity of 1.2 MW at Mucuripe, Fortaleza. Funds came from the German government's ELDORADO program. At second site, in Paracuru, COELCE is now planning a 30 MW wind farm. The Japanese development bank, the Overseas Development Cooperation Fund (OECF), will finance the project.

Even the most favorable wind energy resources have been untapped until now because of lack of know-how concerning the methods of site selection and technical aspects of wind energy.

Bolivia

The regional utility Cooperativa Rural de Electrificacion (CRE) carried out wind monitoring together with GTZ to identify suitable sites. This was followed by a planning phase to identify how best to use the existing potential. Now, CRE intends to install a 22 MW wind park and has requested financing from the Danish Department of International Development Cooperation (DANIDA).

Morocco

Wind monitoring revealed mean annual velocities of 11.5 m/s in the region of Tetouan

(contd. on p. 6)

Renewable Energy: Education and Training

An International Senior Executive Seminar on Renewable Energy: Education and Training, sponsored by the Swedish International Development Cooperation Agency (Sida) and UNESCO, and organized by International Solar Energy Society (ISES) Committee on Education, World Solar Commission and the Asian Institute of Technology, was held on 25 and 26 February 1999 at AIT, Bangkok, Thailand. The seminar brought together senior executives from 16 Asian countries and a number of international experts from Asia, Australia and Europe.

Accelerated adoption of renewable energy technologies in the developing countries would require widespread dissemination of information about the latest developments in the field of renewable energy, as well as information about significant global renewable energy initiatives/programs being undertaken. Also, it would be necessary to take urgent steps to introduce/strengthen renewable energy education in these countries at different levels. This would be vital to promote awareness and develop manpower needed to support increased use of renewable energy. An important target group that needs to be informed and involved for this purpose would be senior executives associated with policy making. The participants of the seminar included nominees from the Ministries of Education, Energy, Industries, universities, UN organizations, donor agencies and NGOs.

The seminar was organized to include presentations by invited international experts on the state-of-the-art of renewable energy technologies, gender and energy issues, and on-going global and national renewable energy programs. These presentations were followed by group discussions on the four themes, namely: (a) education of decision-makers, (b) public awareness and school education, (c) university level education, and (d) maintenance and repairs manual. The results of the group discussions were in form of recommendations regarding regional renewable energy education and training project proposals. It was expected that the seminar would promote renewable energy education at different levels and facilitate accelerated adoption of renewable energy technologies in the participating countries.

Seminar presentations by invited international experts were on the following topics:

- Renewable Energy: Promotion and Education in the early 21st Century
- World Solar Program 1996-2005
- Women and Energy
- State-of-the-art of Wind Energy Technologies
- State-of-the-art of Solar Thermal Technologies
- State-of-the-art of Photovoltaics Technologies
- State-of-the-art of Biomass Energy Technologies
- Renewable Energy Education in the U.K.

Expected Outputs: (a) awareness among senior executives about the importance of promoting renewable energy, (b) recommendations regarding renewable energy education curriculum at different levels, (c) awareness of new opportunities for renewable energy promotion, and (d) identification of regional renewable energy education and training projects.

(contd. from p. 5)

Wind Energy: A True Option...

near Tanger, making it one of the best sites in the world. The utility Office Nationale d' Electricite (ONE) has since signed a contract with the German Kreditanstalt fur Wiederaufbau (KfW) for the financing of a 3 MW demonstration wind farm. Additionally, ONE issued an international call for tenders to select a private company for planning and operating a 50 MW wind farm. A French-Danish group was awarded the contract. Now, the Centre de Developpement des Energies Renouvelables (CDER) and GTZ are carrying out a new wind monitoring study in the regions Tan-Tan and Tarafaya on the Atlantic coast some 500 km south of Agadir.

Jordan

The Royal Scientific Society (RSS) and GTZ have called for tenders to select a producer of wind turbines. The German government will finance a 1.2 MW wind farm with ELDORADO program funds.

Cape Verde

A 150 kW wind turbine was installed and began operating in January 1996 financed by GTZ. The system is connected to a week isolated grid, to which it can supply a high amount of electricity through fuel-saving wind generation.

Bangladesh

On the initiative of the Bangladesh Atomic Energy Commission (BAEC) and the Rural Electrification Board (REB), site selection took place in March 1996. In cooperation with GTZ, measuring systems were installed and the data collected were analyzed as part of the practical program for REB engineers. However, the mean annual wind velocities of 5 m/s to 6 m/s have proved too low.

Namibia

Measurements have shown that there are good wind resources near the coastal towns of Walvis Bay and Luderitz. Now, the Namibian Energy Ministry, the utility NAMPOWER and GTZ are analyzing the technical and economic feasibility of wind farms at these sites and also the costs for the alternative installation of long-distance transmission lines to South Africa.

[Abramowski, J. and Posorski, R. 1998. Wind energy: a true option for developing countries. Win-win-solutions for economy and environment. *GATE Technology and Development* (4): 44-46.]

NEWS Around the Globe

World's Largest Straw-Fuelled Power Station

Construction of a 36 MW power station fuelled by straw began in September 1998 near Ely, in the east of England. The project is owned by Energy Power Resources of Bristol and should come fully onstream in August 2000, supplying 85 thousand homes. Annual consumption of straw is expected to be 200 million kg, and will come from about 70 farms in the area. FLS Miljo A/S, a subsidiary of Danish conglomerate FLS Industries, has been selected to design, build and operate the Ely Power Station under a 15-year contract.

Equity and subordinated finance for this approximately US$ 102 million project has been provided by EPR and Cinergy Global Ely, Inc., a subsidiary of Cinergy Corporation of U.S.A. Senior Debt finance has been arranged and fully underwritten by Bayerische Hypo- und Vereinsbank AG and De Nationale Investeringsbank NV, London branch. EPR was advised on the transaction by Impax Capital Corporation, a firm with an impressive record in financial advisory and strategic consultancy services to clients in renewable energy and environmental fields.

(Renewable Energy World, November 1998)

Photovoltaics in Japanese Market

Kyocera of Japan is apparently to invest 10 billion Yen (US$ 83 million) to increase the annual production capacity of solar cells to 100 MW level by 2003. The current 36 kW per year capacity will be increased to 60 MW per year by financial year 2000 with the investment of 5 billion Yen (US$ 41.6 million). After financial year 2001, annual average of 2 billion Yen (US$ 16.7 million) will be invested to reach 100 MW per year level in 2003. Kyocera's export this fiscal year is approximately 4 MW in the first half and 3 MW in the second half, respectively.

Sharp will organize the marketing team professional in retrofit market. This is aimed at increasing sales of the PV system in the retrofit market. The sales of the PV system have grown in the new houses, but the demand might drop following the decreased demand for the construction of new houses. The marketing team will be reorganized into Sharp Amenity System, a company in charge of design, construction and sales.

Sanyo Electric will commercialize a 25 mm thin solar module to strengthen the residential PV system business. In addition to the conventional sales in housing, Sanyo will promote through the 4800 home electric appliances stores.

Mitsubishi Electric will reinforce its sales activities in the residential PV system. The company started the operation of the PV system plant in lida works of Nakatsugawa factory in August 1998, which produces the whole system from solar panels to related equipment. The number of stores will more than triple to 600 from 170 with the sales target of 3450 kW, 2.3 times the previous year's 1500 kW. Mitsubishi will also work on improving the efficiency and reducing the cost to achieve 20% market share of 7.5 billion Yen (US$ 62.5 million) in financial year 2000.

Sumitomo SiTiX of Amagasaki, supported by the Agency of Industrial Science and Technology (AIST of MITI) subsidy for technology development of new industry creation for rationalization of energy use, started the production technology development of SOG-silicon materials by zinc reduction method in October 1998, $SiCl_4$ is reduced in desolving zinc to produce SOG-silicon with 7 nine purity.

(Renewable Energy World, January 1999)

Reduced Role for Coal in China

The importance of coal to the Chinese electricity sector will decline during the next century according to the president of China Mining University. Although the move will not take place rapidly, other sources such as natural gas, nuclear power and renewable sources will have become more prevalent by the year 2050.

According to other analysts, the proportion of electricity in China that will be generated from coal is likely to drop to about 65% in 2010, compared with 75% in 1998. Petroleum, natural gas, nuclear and hydro generation will all take a large share of the total.

By 2050, according to the China Mining Universty president, coal will only contribute 50% of the electricity generated in China. This will come about as the country pays more attention to the environmental effects of coal combustion. Cleaner natural gas and renewable resources are likely to be developed as an alternative to coal.

(Modern Power Systems, October 1998)

Natural Gas Powers Town in Czech Republic

In 1996, the city administration of Kaplice, Czech Republic set out to develop an energy plan for the town with the aim of stabilizing heating prices for the residents of housing estates, for public building heating consumers and for other users as well. It was necessary to reduce the concentration of pollutants while keeping the price per GJ low. The district heating facility had been displaying a high incidence of trouble and capacity overload, particularly in the winter. Breakdowns at the heating source were not uncommon. Rectification of the situa-

(contd. on p. 8)

India Produces Energy from Flowers

A team of researchers at the Aireff Research Centre, Thane, Maharashtra, India, has developed a new process to produce biogas utilizing waste flowers. Nearly 400 m^3 of biogas is obtained from 1000 kg of used flowers. Biogas thus obtained has a methane content of 70%.

The anaerobic process involves feeding a slurry of disposed flowers and water into a digester which is of the constantly stirred reactor type. Separate reactors for acidification and methanation are not required. The reduction in the total solids content upon digestion is around 80% to 85%. An advantage of this treatment process is that the sludge can be dewatered and the water used for gardening or it can be treated aerobically before being discharged. The dewatered sludge can be composted and used as a fertilizer/soil conditioner.

(VATIS Update, November/December 1998)

(contd. from p. 7)

Natural Gas Powers Town..

tion required an investment of approximately 45 million CZK in the district heating system.

In 1997, the conversion of the town to natural gas was begun at a cost of approximately 5.5 million CZK. This fuel switching made possible to connect private homes, public buildings and industrial enterprises, including the main district heating plant. The district heating source produces approximately 140 000 GJ annually. At the same time an ecological upgrading of boilers and cleaning of the waste gases was carried out.

In 1998, the conversion of the town to gas continued and extensive reconstruction was carried out on the part of the primary steam pipeline carrying the heaviest load.

In the future it will be necessary to reduce heat loss by rebuilding the remaining section of the steam pipeline. Further measures to increase the effectiveness of the district heating system are planned which will bring greater heating savings.

(News at SEVEn, December 1998)

Thailand Cocycle Scheme Advances

The Independent Power (Thailand) Co., or IPT, marked the advancement of its Baht 11.8 billion (US$ 295 million) combined cycle power scheme with the arrival of the gas turbine at its contruction site on the Thai eastern seaboard.

It is one of the major pieces of equipment destined for the 700 MW combined cycle power complex now under construction as part of the kingdom's independent power producer (IPP) program.

The first gas turbine is being installed in the project site on a plot of land adjacent to the Thai Oil Co's refinery in Sri Racha, Chon Buri, 125 km southeast of Bangkok.

IPT reported that over 70% of the construction work has already been completed. The mechanical completion will be in March 1999 and is scheduled to be commissioned around October 1999. It will be the first among seven IPPs in Thailand to come on line.

The facility comprises of two 230 MW gas turbine generators and one 240 MW steam turbine generator. It will run on indigenous natural gas as fuel. IPT will sell the whole electrical power to the Electricity Generating Authority of Thailand (EGAT) under the IPP program.

The Independent Power (Thailand) is a joint venture of the Thaioil Power Co., Ltd. which is a wholly-owned subsidiary of the Thai Oil, Unocal Asia-Pacific Ventures, Ltd. and Westinghouse Electric S.A.

(Power in Asia, November 1998)

Germany Develops New Solar-Powered Cooling System

In Germany, EG Solar e.V and Zeo-Tech have together developed a new cooling system which is cheap, reliable and easy to maintain. The system consists of a refrigerator powered by solar energy, with a built-in evaporator, one or more zeolite containers and a parabolic concentrating solar collector. A hand-driven vacuum pump is supplied for removing air from the adsorption system.

For refrigeration, a zeolite container - with about 4 kg of zeolite - is connected with the evaporator. Once air is removed, making the system airtight, the cooling process begins within seconds. Temperatures between 0°C to 6°C can be maintained for about 72 hours. When the zeolite is saturated with water, the container is separated from the evaporator and a new desorbed zeolite container is connected. Using the vacuum pump, air is removed to allow the cooling process to continue.

Water from saturated zeolite is removed by placing the container at the solar collector focus, where it is heated to a temperature of 250°C in about 4 hours. The container can be reused after a few hours.

The advantages of this system include:

- the simple design makes maintenance easy and repairs can be performed locally;
- The solar collector can also be used for cooking, baking, sterilization and drinking-water preparation;
- Water and zeolite are both natural substances that are not harmful to either humans or animals;
- Compared to a solar-driven compressor system (powered by electric solar cells) of an equivalent capacity, the investment for this system is lower; and
- As energy can be stored in the zeolite containers, continued operation during bad weather is possible.

For further information, contact:

EG Solar e.V., Neuottinger Str. 64c
D-84503, Altotting, Germany
Tel: 49 (8671) 969 937
Fax: 49 (8671) 969 938

(VATIS Update, November/December 1998)

Calls for More Nuclear Power in Russia

The Russian Atomic Energy Minister has said that nuclear power should provide 30% to 40% of Russia's energy needs. With the nuclear sector currently supplying 12% of demand, this would require a significant increase in the installed nuclear capacity.

The minister also called on the nuclear industry to revive its export program. Western contries have tried to persuade Russia not to export its technology.

There are nine nuclear power plants, and 29 power reactors in Russia as well as a number of research reactors. Three of these nine plants are short of fuel.

Revenue is a problem. Rosenergo-atom, the company which runs the nine power stations, is owed US$ 1.12 billion from organizations to which it has supplied energy. It, in turn, owes US$ 930 million to its suppliers.

Meanwhile the Sosnovy Bor nuclear power plant, near St Petersburg, has shut down its fourth reactor in preparation for a US$ 300 million overhaul to improve safety of the unit and extend its lifetime. The operation will take 18 months, but may stall through lack of funds.

(Modern Power Systems, November 1998)

Small Wind Energy Systems for Battery Charging

Intermediate Technology Development Group, U.K. is undertaking a project to help widen the range of renewable sources of energy to meet the basic electricity needs of rural communities. This project is funded by Department of International Development (DFID) and will be done initially in Peru and Sri Lanka by developing a small wind generator for battery charging. The project will design and test a 100/200 W prototype, ultimately intended for local manufacture. Although small, these could provide sufficient power to trickle charge batteries for use in isolated school or health centers or, in the case of larger capacity system, a small community.

The project is in its early stages. Work carried out in Peru and Sri Lanka to date has concerned resource assessment and market potential. In Peru a study has been undertaken on the available data concerning the wind resource. A revised map has been produced showing average velocities, and regions of high potential have been chosen, both in terms of resource and population density. Two general regions for further research have been identified, one in the north part of Peruvian mountains and the other in the coastal region. An in-depth market study is to be conducted in the most promising areas.

In Sri Lanka, a similar resource assessment has taken place, correcting existing data to conform with international standards where necessary. A map has been prepared showing the specific wind energy output for different parts of the country. A postgraduate at Imperial College has conducted a market survey in two villages, and has concluded that there is a significant market potential for wind turbines among the villagers, with a willingness to pay provided suitable credit agreements can be established. It is estimated that there are 300,000 batteries being used in Sri Lanka for TV/radio sets, although lighting loads at present would require too frequent battery recharging. Further surveys are to be carried out and it is hoped that they will enable areas with significant markets to be identified.

Information gained from technical and market surveys will aid the technical development to be carried out in the U.K., Peru and Sri Lanka. Pilot projects will be established in both countries and designs modified to suit local manufacturing conditions, with the ultimate aim of local entrepreneurs taking up the technology. For further information, contact: Dr. Smail Khennas at e-mail: smailk@itdg.org.uk

(DFID-Energy, November 1998)

New Power and Energy Calibrator Measures with High Accuracy

The ROTEK Model MSB100 is a primary watt and watthour standard that performs at a new level power and energy measurement accuracy. It provides reliable, accurate traceability to N.I.S.T. or other national standards worldwide. Versatile measurement ranges and unparalleled accuracy allow the MSB100 to be the single instrument necessary to calibrate any watt/watthour measurement instrument available today. Ideally suited for use as a primary watt/watt-hour reference meter, the Model MSB100 has four voltage input ranges, from 120 VAC to 640 VAC, and five current input ranges, from 50 mA to 5A, with optional current ranges of 10 A, 50 A, and 200 A. Its accuracy of 0.005% for power and 0.015% for energy is maintained regardless of phase angle, greatly simplifying power measurements at near-zero factor. For more information, contact: Rotek Instrument Corp., 390 Main Street, P.O. Box 504, Waltham, MA 02454-0504, U.S.A. Tel: 781-899-4611; Fax: 781-894-7273; E-mail: sales@rotek.com

Website Simulates Solar Radiation

The most recent addition in the Solar and Wind Energy website is a computer model simulating solar radiation in tropical climates. Once the user has entered the mean daily global solar radiation for each month at any location in the tropics, the model can create text files of daily or hourly solar radiation on any surface with the same statistical properties as real solar radiation in the tropics. These data files can then be used in performance predictions of solar energy equipment. The latest version of the model is written in JavaScript 1.1, so it works on an Internet browser without the need for any software. The website was established by Prof. Exell, RERIC's scientific editor. It also contains key references and abstracts of some of his research. The website has two mirrors:

http://www.crosswinds.net/thailand/~exell/
http://www.kmutt.ac.th/~exell/

ENERGY PUBLICATIONS

LNG in Asia Pacific Promise and Peril in the 21st Century

Al Troner. Published by Financial Times Energy Asia Pacific, 159 Telok Ayer Street, Singapore 068614. Tel: +65 323 6373; Fax: +65 323 4725; E-mail: ftenergy@pearson-pro.com.sg. ISBN 981 306921 X. 1998. US$650.

Between 1995 to 2010, an estimated US$ 825 billion will be required to meet Asia's energy needs. Increased use of coal will be constrained by environmental concerns and the need for alternative energy sources is becoming critical. Liquefied natural gas is seen by many to provide the solution but will require major changes in energy policy to succeed. Compared with other energy sources, LNG is both capital and technology intensive and will require major investment if it is to develop.

With Asia Pacific now set to become a testing ground for the development of the world LNG industry, *LNG in Asia Pacific: Promise and Peril in the 21st Century* provides in-depth analysis of the most important issues in the LNG debate. This is the first report to focus on Asia Pacific while covering the LNG sector from the upstream development of gas to the distribution of regasified LNG.

The report examines: market development from 1964 to the present; the requirements for a successful LNG project; strategies for cost containment; the environmental issues; current LNG suppliers and consumers; contracts, pricing and marketing; the competitive environment; and corporate strategy through case studies of leading players. *LNG in Asia Pacific* assesses the impact, both present and future, of LNG throughout Asia Pacific, as well as the Middle East and Alaska. The report provides an accessible insight into this complex and highly technical subject, with relevant case studies and comprehensive industry data alongside clear and concise market analysis.

The World Directory of Renewable Energy Suppliers and Services 1998

Published by James and James (Science Publishers) Ltd., 35-37 William Road, London NW1 3ER, United Kingdom Tel: (44) 171 387 8558; Fax: (44) 171 387 8998; E-mail: orders@jxj.com URL: http://www.jxj.com ISBN 1-873936-79-6. 488 pp. 1998. US$120.

The World Directory is established as the largest and most comprehensive annual guide to the renewable energy industry. Organized in two parts it is both a yearbook, with a wide range of articles from all sections of the industry, and a directory. It lists alphabetically and classifies by activity companies and organizations throughout the world which are active in the field.

The Directory includes sections on:

- Biomass
- Rational use of energy
- Geothermal
- Hydro wave and tidal
- Energy in buildings
- Energy storage
- Photovoltaics
- Solar thermal
- Wind
- Finance
- Wide range of articles on each of the above.
- An alphabetical and classified listing of nearly 5000 companies and organizations worldwide, with a description of their activities
- Information regularly updated for accuracy

It will be an essential source of information for anybody, whether scientist, engineer, politician, journalist or general reader, who wants to inform themselves about renewable energy.

Combined-Cycle Gas and Steam Turbine Plants Second Edition

Rolf Kehlhofer, Rolf Bachmann, Hendirk Nielson, and Judy Warner. Published by PennWell Publishing Company, P.O. Box 21288, Tulsa, OK 74121, U.S.A. Tel: 1-800-752-9764 or (918) 831-9421 Fax: (918) 831-9555 URL: http://www.energycatalog.com ISBN 0-87814-736-5. 250 pp. 1999. US$89.95.

First published in 1991, this book is the leading reference on technical and economic factors of combined-cycle applications within the utility and cogeneration markets. With combined-cycle applications now leading the trend toward merchant plants and the "peaking" power needed in newly deregulated markets around the world, this long-awaited second edition is more important than ever.

The scope and detail found in the first edition is widen. Included are tips on system layout, details on controls and automation, and operating instructions. Loaded with case studies, reference tables, and more than 150 figures, this text offers solid advice on system layout, controls and automation, and operating and maintenace instructions. The authors provide real-world examples to apply to your own applications.

Contents of this book include: Introduction; The electricity market; Thermodynamic principles of combined-cycle plants; Combined-cycle concepts; Applications of combined-cycles; Components; Control and Automation; Operating and part load behavior; Environmental considerations; Develop- mental trends; Typical combined-cycle plants already built; Conclusion; Appendices; Conversions; Calculation of the operating performance of combined-cycle installations; Definitions of terms and symbols; Bibliography; and Index.

International Events

INSIDE ASIA

19-20 April 1999
Singapore
Electricity Deregulation 1999
Creating an Efficient and Competitive Market
Contact:
IBC Asia Limited
No. 1 Grange Road
#08-02 Orchard Building
Singapore 239693
Tel: (65) 732 1970; 835 5137
Fax: (65) 733 5087; 736 4312
E-mail: rochelle@ibcasia.com.sg

19-21 April 1999
Hangzhou, China
First EU-China Small-Hydro Industry Conference
Accelerating Technical Co-operation and Market Development in Small-Hydro
Contact:
Oliver Paish
IT Power Limited, The Warren
Bramshill Road, Eversley
Hampshire RG27 0PR
United Kingdom
Tel: 44 118 973 0073
Fax: 44118 973 0820
E-mail: ofp@itpower.co.uk
URL: http://www.itpower.co.uk

31 May-6 June 1999
Moscow, Russia
Business and Investment for Renewable Energy in Russia
Contact:
The Congress Secretariat
Intersolarcenter, 2, 1st
Veshniakovsky proezd,
Moscow 109456, Russia
Tel: +7 095 171 9670
Fax: +7 095 171 9670

7-11 June 1999
Kuala Lumpur, Malaysia
World Renewable Energy Congress 1999
Contact:
Prof. Mohd. Yusof Hj. Othman
Conference Secretary, Deputy Dean
Department of Physics
University Kebangsaan Malaysia
43600 Bangi, Selangor, Malaysia

4-9 July 1999
Jerusalem, Israel
ISES 1999 Solar World Congress
Contact:
Organizers of the Congresses and
Tour Operators, Ltd.
P.O. Box 50006
Tel Aviv 61500, Israel
Tel: 972 3 514 0000
Fax: 972 3 514 0077
Email: ises99@kenes.com

August 1999
Mauritius
First International Conference on Renewable Energy Resources
Contact:
Mr. C.V.J. Varma
Central Board of Irrigation and Power
Malcha Marg, Chanakyapuri
New Delhi - 110 021, India
Tel: 91-11-6115984; 6116567
Fax: 91-11-6116347
E-mail: cbip@del1.vsnl.net.in
URL: http://www.cbip.org

5-8 September 1999
Haifa, Israel
Greenhouse Techniques Towards the Third Millennium:
An International Conference and British-Israeli Workshop
Contact:
Institute of Agricultural Engineering
P.O. Box 6, Bet Dagan 50250, Israel
Tel: 972-3-9683303
Fax: 972-3-9604704
URL: http://www.agri.gov.il/events/GreenHouse.html

2-5 November 1999
Guangzhou, China
Environment China 1999
Contact:
Stefanie Niebuhr
Gima Exhibitions and Conferences
Heidenkamsweg 51
20097 Hamburg, Germany
Tel: 49 40 235 24 341
Fax: 49 40 235 24 403

8-12 November 1999
Bangkok, Thailand
Civil and Environmental Engineering Conference: New Frontiers and Challenges
Contact:
Dr. A.S. Balasubramaniam
School of Civil Engineering
Asian Institute of Technology
P.O. Box 4, Khlong Luang
Pathumthani 12120, Thailand
Tel: 662-524-5519
Fax: 662-516-2126
Email: bala@ait.ac.th

OUTSIDE ASIA

1-5 March 1999
Nice, France
Wind Energy for the Next Millennium
1999 European Wind Energy Conference and Exhibition
Contact:
Dr. Erik L. Peterson
Conference Chairman
Wind Energy and Atmospheric Physics
Department, Riso National Laboratory
P.O. Box 49,
DK-4000 Roskilde, Denmark
Tel: +45 4677 5000
Fax: +45 4677 5970
Email: erik.lundtang@risoe.dk

17 May - 19 June 1999
Enschede, The Netherlands
Rural Electrification
Contact:
The Course Administration
Technology and Development Group
University of Twente
P.O. Box 217
7500 AE Enschede
The Netherlands
Tel: 31-53-4894377/3539
Fax: 31-53-4893087
E-mail: M.vanderMeer@TDG.UTWENTE.NL

2-5 March 1999
Leipzig, Germany
Terratec Leipzig - International Trade Fair for Environmental Technology and Energy
Contact:
Nicholas Bloxam
The Leipzig Fair Agency in Great Britain
P.O. Box 43, 1 Elstree Way

Borehamwood, Herts WD6 1NH
United Kingdom
Tel: 0181 953 1688
Fax: 0181 953 9456
Email: ifa@jenoptik-uk.com

24-26 March 1999
Montreal, Canada
Americana 1999
Pan-American Environmental Technology Trade Show and Conference
Contact:
Americana 99
911 Jean-Talon Street East Suite 220,
Montreal, Quebec, Canada H2R 1V5
Tel: +1 514 270 7110
Fax: +1 514 270 7154
Email: info@americana.org

11-14 April 1999
Maui, Hawaii
Renewable and Advanced Energy Systems for the 21st Century
Contact:
Dr. Stanley Kleis
Department of Mechanical Engineering
University of Houston, Texas, U.S.A.
Tel: 1 713 743 4536
Fax: 1 713 743 4503
Email: kleis@uh.edu
URL: http://www.mengr.tamu.edu/ASME/Maui.htm

1-3 June 1999
Frankfurt, Germany
POWER-GEN EUROPE 1999
Contact:
Penn Well Europe, Kaap
Hoorndreef 30, 3563 AT
Utrecht, The Netherlands
Tel: 31 30 2650963
Fax: 31 30 2650928
Email: info@pennwell-europe.co

11-14 August 1999
Edmonton, Canada
North Sun '99
Eighth International Conference on Solar Energy in High Latitudes
Contact:
The Solar Energy Society of Canada, Inc. (SESCI)
116 Lisgar Street, Suite 702
Ottawa, Ontario, Canada K2P 0C2
Tel: 1 613 234 4151
Fax: 1 613 234 2988
E-mail: NorthSun.99@cyberus.ca

25 September - 3 October 1999
Brisbane, Australia
PLEA 1999
The Sixteenth International Conference on Passive and Low Energy Architecture
Contact:
Sally Brown, Conference Secretariat
The University of Queensland
Brisbane, Queensland
Australia 4072
Tel: +61 7 3365 6360
Fax: +61 7 3365 7099
Email: sally.brown@mailbox.uq.edu.au

24-28 January 2000
Geneva, Switzerland
World Clean Energy Conference 2000
The Protection of Health, Biosphere and Climate by Clean Energy
Contact:
Secretariat
World Sustainable Energy Coalition
P.O. Box 325
CH 1211 Geneva 17, Switzerland
Fax: +00411-463-0252;
Email: icecag@zik.ch

19-22 June 2000
Copenhagen, Denmark
EUROSUN 2000
Contact:
ISES-Europe
Mollegade 54-56
6400 Sonderborg
Denmark
Tel: 45 73 42 31 00
Fax: 45 73 42 31 01
Email: torben.esb@esbensen.dk

1-7 July 2000
Brighton, U.K.
World Renewable Energy Congress VI
Contact:
Prof. A.A.M. Sayigh,
Congress Chairman
147 Hilmanton, Lower Earley
Reading RG6 4HN, U.K.
Tel: (0118) 9611364
Fax: (0118) 9611365
Email: asayigh@netcomuk.co.uk
URL: http://www.WRENUK.CO.UK

17-22 September 2000
Mexico City, Mexico
Millennium Solar Forum 2000
Contact:
Millennium Solar Forum 2000, c/o
Centro de Investigacion en Energia
UNAM, Apartado Postal #34
Temixco 62580
Morelos, Mexico
Tel: 52 73 250052
Fax: 52 73 250018
Email: ises2000@mazatl.cie.unam.mx
URL: http://www.cie.unam.mx/~ises2000

The Regional Energy Resources Information Center (RERIC) is one of the four specialized information centers of the Center for Library and Information Resources (CLAIR), Asian Institute of Technology (AIT), Bangkok, Thailand. The Center provides information services on renewable energy (biomass energy, small-scale hydropower, solar energy and wind energy), energy conservation and energy planning.

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URL: http://www.ait.ac.th/clair/centers/reric

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