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CENTRALLY-FUNDED ENERGY ACTIVITIES OF THE U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

Introduction

Since the mid-1970's most of the developing countries have faced two types of energy problems. One set of problems involves the lack of equipment and/or fuels to produce energy needed in rural areas for economic development and for improvements in the quality of life. These energy needs have existed for centuries. A new set of energy problems arose from the rapid increases in the prices of imported petroleum fuels in the mid-1970's. These old and new energy problems are highly interrelated and very complex. They are among the most important and difficult problems faced by the developing countries.

In vast rural areas economic and social development is limited by the lack of electric power or other sources of mechanical power. About two million villages in developing countries have no electric service. The lack of power for pumping water restricts agricultural production and the development of community water supply and sanitation systems. Post-harvest food losses are very large due to the lack of refrigeration and cold storage facilities. Educational and medical facilities are limited by the lack of lighting, power, and refrigeration.

The oil price increases of the 1970's intensified these rural power problems while also creating serious national economic problems in most developing countries. Some of the rural power needs had been supplied by small engines and engine-generator sets fueled with gasoline or diesel fuel; however, high fuel prices have restricted the use of existing units and limited the economic feasibility of new units. In the many countries which also use petroleum fuels for most of their centralized electric power generation, the oil price increases required sharp increases in power rates or high governmental subsidies.

In the typical oil-importing developing country the much larger oil import bills

have absorbed a large percentage of the country's earnings from exports, increased its foreign debt, and limited the funds available for economic development programs.

Many developing countries have sought assistance with some of these energy problems from the U.S. Agency for International Development. This presentation describes energy activities which have been carried out between 1978 and 1983 under AID Projects administered by the Office of Energy in the AID Bureau for Science and Technology. These centrally-funded Projects provide technical assistance, training, and other services which support and supplement the energy-related objectives and projects which have been established by USAID missions in most developing countries.

Types of Energy Assistance

The economic problems arising from the oil price increases have forced the government of almost every developing country to greatly expand its institutional structure, personnel, and procedures for energy policy planning and decision-making. Since 1975 most governments have established a Ministry of Energy or some other new energy policy and coordinating body. These agencies are engaged in the development of national energy plans and assessments and the examination of the technical and economic feasibility of many types of energy projects. One of the Projects administered by the Office of Energy provides training in energy planning and management in the U.S. for participants from developing countries; another of these Projects provides advisors and consultants to several USAID Missions and governments on the development of national energy plans and assessments.

Every oil-importing developing country wants to reduce its dependence on oil imports and to increase its utilization of domestic energy resources, including both conventional and renewable sources of

energy. Some of these countries may have significant oil, gas, or coal resources. However, most of them have lacked personnel with the training needed to conduct programs for the development of these resources or to negotiate mutually satisfactory agreements with private firms for the exploration and development of these resources. One Office of Energy Projects provides advisors and consultants on the development of conventional energy resources to the governments of several countries. Another Project provides U.S. training in conventional energy technology and economics for participants from developing countries.

Oil-importing and oil-producing countries share a desire to reduce their domestic consumption of petroleum fuels, to the extent this can be done without sacrificing economic development and productivity. Oil-importing countries want to decrease oil import bills; oil-producing countries want to maintain their income from oil exports. There is growing interest among developing countries in techniques for increasing efficiency in the use of energy in industry, transportation, buildings, and other sectors. One of the Office of Energy Projects has funded two training courses in the U.S. on energy conservation in industry and utilities. Another Project has sponsored energy use studies and a conservation workshop and is developing an expanded multi-country program of energy conservation services.

As another means of reducing dependence on imported fuels, virtually every developing country wants to expand its use of renewable energy resources. However, most countries have lacked personnel with extensive experience with renewable energy systems; they need assistance in choosing appropriate systems and developing effective projects and programs. Three Office of Energy Projects focus on bioenergy systems and technology, small decentralized hydropower, and solar photovoltaic technology. One Project provides a comprehensive training course in alternative energy technologies. Another provides information to individuals and institutions in developing countries on low-cost energy technology, especially

wood-burning cookstoves and water-pumping windmills. A sixth Project funds consultants to Missions and governments on solar thermal, wind, geothermal, and other renewable energy systems. Several of these Projects provide funding and/or technical assistance for in-country demonstrations of renewable energy systems.

Types of Program Services

Five types of program services are provided by the Office of Energy Projects. These include educational and training activities, information services and materials, consulting and advisory services, technology demonstrations, and research.

a. Educational and Training Activities

Eight of the Projects have provided some type of training or other educational opportunities for personnel of energy agencies in developing countries. Three Projects provide training programs at U.S. institutions. These programs include the Energy Management Training Program operated by the Brookhaven National Laboratory and the State University of New York at Stony Brook; the program of Training in Alternative Energy Technologies at the University of Florida; and the Conventional Energy Training Program administered by the Washington Office of the Institute of International Education. The latter program includes special courses for participants from developing countries on petroleum technology, electric power systems, and industrial energy conservation as well as other types of group and individual training.

Shorter international workshops have been sponsored by the Office of Energy and its contractors under five other Projects. These include workshops on energy survey methodologies, energy planning, energy conservation, natural gas utilization, small decentralized hydropower, bioenergy systems, charcoal production, water-pumping windmills, and wood-burning cookstoves. In addition, both formal training sessions and on-the-job training have been provided by many of the advisors and consultants sent to developing countries under Office of Energy Projects.

b. Information Services and Materials

The publication of various types of printed materials on energy projects and technologies in developing countries has been sponsored or assisted by several of the Office of Energy Projects. Under the Project on small decentralized hydropower the National Rural Electric Cooperative Association has published the proceedings of four regional workshops, case studies on small hydro programs in Nepal and Pakistan, and various manuals and equipment directories. The Project on Bioenergy Systems and Technology has sponsored the preparation and publication of a series of bioenergy systems reports, a bioenergy handbook, and a guide to species for fuelwood plantations. Publications on water-pumping windmills, wood-burning cookstoves, and other renewable energy systems have been published by Volunteers in Technical Assistance (VITA) under the Project on Low-Cost Energy Technology.

Written and audiovisual materials on energy conservation techniques will be prepared and disseminated under the new Energy Conservation Services Program with funding from the Project on Energy Policy Development and Conservation.

VITA also operates an inquiry service which responds to requests for information on low-cost energy technologies from individuals and institutions in developing countries.

c. Advisory and Consulting Services

Several of the Projects provide short-term consultants or longer-term resident advisers to assist USAID missions and governments of developing countries with energy programs and projects. The previous and present Projects on energy policy development have provided advisers and/or consultants on energy planning to Morocco, Sudan, Liberia, Togo, Guyana, Tunisia, Costa Rica, and Malawi. Contractors funded by the Project on

Conventional Energy Technical Assistance have assisted with coal development in Pakistan, Costa Rica, and Indonesia, natural gas development in Morocco and Bangladesh, petroleum refining in Kenya, and electric power problems in Sudan.

Under the Small Decentralized Hydropower Project, NRECA has sent teams to 20 countries to survey potential small hydro sites and/or assist with the development of small hydro projects. Project staff from the Bioenergy Systems and Technology Project have participated in surveys of bioenergy potentials in 12 countries; staff and contractors have assisted with the planning of specific bioenergy projects in eight countries. Consultants on solar energy, wind energy, geothermal energy, and other technologies have been provided to Missions and governments through the Project on Energy Technical Service Support.

d. Technology Demonstrations

The Photovoltaic Technology Project has funded the installation of 19 solar-powered refrigerators in rural clinics in 18 developing countries, as well as larger photovoltaic power systems in five rural health facilities in four countries. A wood gasifier system which will provide 140 kW of electric power is being installed in a rural community in Costa Rica under the Bioenergy Systems and Technology Project. Technical assistance has been provided for the construction of improved wood-burning cookstoves and water-pumping windmills in a number of countries under the Project on Low-Cost Energy Technology.

e. Research

A new program of grants for research on selected aspects of energy policy and economics in developing countries is being initiated under the Project on Energy Policy Development and Conservation. Cooperative research on bioenergy systems among institutions in developing countries will be assisted by the Bioenergy Project.

ENERGY POLICY DEVELOPMENT AND CONSERVATION

(PROJECT 936-5728)

Energy Policy Development

In recent years most developing countries have established a Ministry of Energy or other energy agency to manage energy resources and develop national energy plans and policies. Some of these agencies have asked for U.S. assistance with (a) the analysis of national energy problems, (b) training personnel and the development of processes for effective energy policy making, and (c) developing programs and policies which might be implemented to expand domestic energy resources and reduce energy imports.

From 1979 through 1981 energy planning assistance was provided to several countries under an Office of Energy Project on Energy Policy and Planning (Project 936-5703). Beginning in 1982 such activities as well as conservation-oriented activities have been carried out under the Project on Energy Policy Development and Conservation.

Energy planning assistance in Morocco, Sudan, and Liberia is outlined below. In each of these cases the Project has provided a resident advisor or team which provides continuing advice and assistance to the host agency, coordinates the work of short-term consultants, and provides in-service and formalized training to the agency's planning personnel. The Office of Energy's experience with these projects indicates that such a continuous presence in the country is usually necessary to make a significant contribution to the host agency's planning capabilities.

In addition, intermittent assistance has been provided to Tunisia, Togo, Guyana, Costa Rica, and Malawi. Reconnaissance teams have examined energy planning assistance needs in Honduras and Haiti, and long-term assistance will begin soon in Haiti.

a. Morocco

AID signed its first agreement on energy planning assistance to the Government of Morocco in 1980. The first phase of this assistance was provided under the previous Project; the second phase has been funded under the current Project. Both phases have been carried out by a team provided by Energy and Environmental Engineering, Inc. and Development Sciences, Inc.

The project aims to strengthen the institutional capability of Morocco's Ministry of Energy and Mines in the areas of energy planning, analysis, and decision-making. The project provided on-the-job training for Ministry officials on project evaluation, demand analysis, data collection, estimation methods, energy scenario and strategy development, and comparative investment analysis. Inter-disciplinary teams from the U.S. contractors and a team of ten Ministry officials worked together in four intensive month-long work sessions in 1981 and 1982. Six Ministry officials involved in this project have attended the Energy Management Training Program in the U.S.

The development of an adequate information base for energy planning has also been a high priority. The project staff participated in the development of energy use surveys in the industrial, transport, and household sectors. Information was assembled for the analysis of more than 40 projects which had been proposed to enhance the indigenous energy supply or reduce energy demand.

A third objective was to develop a method for the comparative analysis of energy investment projects and for the evaluation of energy scenarios and strategies. A computer-assisted analytical tool has been developed for this purpose. Two of the intensive work sessions described above concentrated on training the Ministry

team on the use of this model which is called "En Vest".

Planning assistance in Morocco is being jointly funded by the Project and the USAID mission in Morocco in the current year; all such activities will be funded by the Mission after September 1984 under a follow-on project.

b. Sudan

Energy planning assistance to Sudan began early in 1981, shortly after the formation of the National Energy Administration (NEA). Assistance was begun under the Energy Policy and Planning Project, and has been continued under the current project. The activities in Sudan funded by both Projects have been carried out by International Science and Technology Institute, the prime contractor, and Energy/Development International, a sub-contractor.

Since most of the NEA staff consisted of recent university graduates without substantial experience in the energy sector, a high priority has been given to training including both formal training sessions and on-the-job training. This in-country training has supplemented the training in the U.S. provided for a large number of staff members of NEA and other Sudanese energy agencies through the Office of Energy projects on Energy Management Training, Conventional Energy Training, and Training in Alternative Energy Technology.

Resident energy advisors and short-term contract consultants have participated actively in the preparation of a National Energy Assessment in 1982 and a draft of a National Energy Plan in 1983. The project staff also prepared special reports on petroleum supply and distribution, petroleum exports, the use of kerosene as a domestic fuel, conservation of motor fuel, long-range electric power issues, and reliability improvement in the electric power sector. The latter report contributed to the USAID Mission's decision to assist Sudan to rehabilitate the 300-mile Blue Nile power grid; this assistance is being provided in part through the Office of

Energy Project on Conventional Energy Technical Assistance. The planning assistance in Sudan has included the development of an energy library and information system, including the provision of microcomputer hardware and software.

In fiscal 1984 all responsibility for funding energy planning assistance to Sudan will be transferred to the USAID mission in Sudan. Two Requests for Proposals have been issued for a program of long-term planning and management assistance to the National Energy Administration, the General Petroleum Corporation, and the National Electric Corporation.

c. Liberia

The Project has provided short-term technical assistance to Liberia's National Energy Committee; the contractor for these services is the Oak Ridge National Laboratory (ORNL). One result of this assistance in the initial year was the preparation of a national energy assessment. AID's Africa Bureau plans to provide funding for a longer-term resident energy adviser to the Liberian government, and the Office of Energy will fund short-term consultants.

As a part of this energy assistance effort, ORNL raised various issues regarding the viability of the government-owned refinery at Monrovia and less costly options for providing products for the domestic market in Liberia. Consequently, the government asked AID to provide refinery specialists and petroleum procurement specialists to examine these issues. A study by a team provided by Arthur D. Little, Inc. and funded by this Project led to a decision by the government to close the facility. The decision should save from \$15 to \$20 million per year.

d. Workshops and Conferences

An International Workshop on Energy Survey Methodologies was sponsored by AID in January 1980 under the Energy Policy and Planning Project. The workshop, held at Jekyll Island, Georgia, was organized by the Board on Science and Technology for

Development of the National Academy of Sciences. The Workshop was attended by 65 persons, including 15 participants from 12 developing countries.

A Conference on Energy Analysis, Planning, and Policy Development in Developing Countries was organized and funded by the Office of Energy under the Energy Policy Development and Conservation Project in the late winter of 1983. The agenda covered the need for better information on energy demand and supply, the shortage of trained manpower and effective institutions in the energy sector, the use of computer-based forecasts and models in energy planning, the impacts of energy pricing policies on energy consumption, the need for new capital for energy projects, and the risks associated with new energy technologies. The conference was attended by 40 officials of 25 developing countries and 50 representatives of U.S. governmental agencies and non-governmental institutions. A book on energy planning, based in part on the conference papers and discussions, will be published in early 1984.

e. Research

The Office of Energy initiated a program of grants for research on selected energy policy topics in 1983 under the Energy Policy Development and Conservation Project. About fifty research proposals were received in response to an announcement indicating a number of general topics. Eight proposals were recommended for funding by a peer panel assembled for AID by the National Science Foundation. These proposals cover studies on the following topics: (1) the transition from traditional to commercial fuels in two Indian cities; (2) the interaction and linkages between energy policy alternatives, overall development strategies, and macro-economic policies; (3) the experience with U.S. - Indian joint ventures for the transfer of energy technologies to India; (4) the effect of changing world energy prices on the rate of economic growth in selected developing countries; (5) policy issues related to the role of electrified irrigation pumping within rural electrification

programs; (6) development of a framework for fuelwood policy analysis; (7) impacts of rural energy costs and availabilities in Kenya, and (8) energy supply and demand in an intermediate-sized city in Kenya.

Energy Conservation

Activities designed to increase efficiency in the use of energy have been carried out in Tunisia, Sri Lanka, West Africa, and Latin America under the earlier and current Projects. A major new multi-country conservation services program has recently been established. (Two courses on energy conservation techniques for engineers and managers from industries and utilities have been held in the U.S. under the separate Conventional Energy Training Project).

The Tunisian government asked AID for help in 1980 with the analysis of energy consumption patterns and conservation opportunities in the industrial, transportation, and agricultural sectors. These sectoral energy use studies were conducted by teams provided by Energy/Development International, Ferguson-Bryan Associates, Oak Ridge National Laboratory, and Resource Management Associates. Each study examined opportunities for energy conservation and for the substitution of indigenous resources including renewables for imported petroleum.

The study of the industrial sector in Tunisia included detailed energy audits of seven energy-intensive industrial facilities, a pilot survey of energy consumption in 50 plants, and the development of an energy survey methodology for inclusion in the annual census of industry. The team also conducted two training cycles on energy conservation techniques for engineers from 20 factories. The transportation study collected data on driving behavior and fuel economy of vehicles and identified opportunities for conservation through changes in fuel pricing, driver education, vehicle inspection and maintenance, and traffic management. The agricultural sector team designed an energy survey

module for inclusion in the Ministry of Agriculture's annual census of Tunisian farms. A detailed study was made of hard wheat farming, which promotes self-sufficiency in food supplies, and tomato farming, which enhances export earnings. These sectoral studies are expected to provide a basis for major policy decisions in Tunisia as well as models for energy data collection in other developing countries.

The Project has funded preliminary assistance to the government of Sri Lanka with the organization of an energy conservation program. These services, provided by Energy/Development International, included assessing conservation potentials and designing a training program on conservation techniques for engineers.

Funding was provided by the Project for a Workshop on Energy Efficiency and Conservation in Lome, Togo, in April 1983. The workshop was organized by the Institute of Energy Research of the State University of New York at Stony Brook, which also operates the Office of Energy's Energy Management Training Program. Twenty-five participants from 14 West African countries attended the workshop, which was co-sponsored by the Economic Community of West African States (ECOWAS). The Project also contributed to a similar workshop in Lima, Peru, in July 1983 which was co-sponsored by the

International Energy Agency and the Latin American Energy Organization (OLADE).

A comprehensive Energy Conservation Services Program (ECSP) is being established with funding from the Energy Policy Development and Conservation Project. Hagler-Bailly and Company and Reliance Energy Services have been selected as contractor and sub-contractor, respectively, for the operation of this new Office of Energy program.

ECSP activities will include (a) design and implementation of energy conservation surveys, (b) economic and policy analysis of energy demand and conservation potentials, (c) performance of on-site energy audits of major energy-using facilities, (d) classroom and on-site practical training of engineers and managers, (e) preparation and dissemination of written and audiovisual materials on energy conservation techniques, (f) fielding of technical teams to provide consulting services to developing countries on energy conservation programs, and (g) advisory services to help AID-assisted countries obtain financing for investments to improve energy efficiency. Field activities in ten to fifteen countries are planned, beginning with ongoing training, auditing, and retrofit feasibility studies in Sri Lanka and assistance to the USAID Mission in the Philippines in designing an industrial energy conservation project.

ENERGY MANAGEMENT TRAINING

(PROJECT 93E-1160)

Introduction

By 1978, after several years of very rapid oil price increases, there had been a rapid escalation of energy planning and management activities in most developing countries. These included intensified planning within national oil companies and electric power agencies, the planning and management of new projects for the utilization of domestic energy resources, and the development of national energy assessments and plans. Most of these countries lacked properly trained personnel for these new energy planning and management activities. The Energy Management Training Program (EMTP) was established by the AID Office of Energy in 1978 to meet some of these needs.

The Program

EMTP has provided a series of intensive courses on energy planning and management. The program is a cooperative effort of the National Center for the Analysis of Energy Systems of the Brookhaven National Laboratory and the Institute for Technology Policy in Development (formerly Institute for Energy Research) at the State University of New York at Stony Brook. Most of the lectures are given by EMTP staff, Brookhaven staff, or faculty members of SUNY Stony Brook. However, experts from other institutions have made significant contributions to each of the EMTP courses.

One EMTP session was scheduled each year in 1978, 1979, and 1980. Since 1981 there has been both a spring and fall session each year. The eighth EMTP session was held in the Fall of 1983.

Prior to 1983 most of the sessions lasted eight weeks. The 1983 sessions were reduced to six weeks and a two-track system was initiated. At present about half of the session consists of lectures to the

entire group. These include sessions on energy planning, energy assessments, pricing, financial accounting, micro-economic project evaluation, energy conservation, energy organizations and institutions, conversion systems, traditional fuels, refinery assessments, health and environmental impacts, investment planning, renewable sources of energy, and case studies of energy planning in several countries.

For about a third of the sessions the group is divided into two sub-groups. A "macro-track" group, consisting of those from agencies concerned with general energy planning, follows a schedule emphasizing macro-economic aspects of energy planning and management. A "micro-track" group, made up of those from agencies involved with specific types of energy resources, spends more time on fossil resource assessment, electric sector analysis, industrial energy conservation, and renewable energy sources. The remaining time, the equivalent of more than one week, is used for tutorial sessions, computer laboratory exercises, and other individualized sessions.

The Participants

Each EMTP course has been presented to a group of between 25 and 35 participants. The Program is primarily directed to those in middle and upper levels of management in energy planning institutions, oil companies, electric utilities, and other energy institutions. Most participants are nominated for the program by their agencies; nominations are submitted to the EMTP staff through the USAID Missions in the nominees' countries. International travel is normally paid by the participant's agency or by the USAID Mission in his or her country; training costs and the participant's living expenses in the U.S. are funded by the AID Office of Energy through the EMTP contract.

A total of 253 persons from sixty countries had participated in the seven EMTP sessions up to the middle of 1983. Approximately 60% of the participants came from governmental energy agencies. These include ministries of energy, other national energy policy agencies, electric power agencies, and national petroleum agencies. About 30% of the EMTP participants came from other governmental economic agencies including planning commissions and ministries of natural resources, trade, and commerce. The remaining 10% were from research institutions, universities, and other institutions involved with energy problems.

The largest regional representation was from Asia; there were 92 participants from 14 Asian countries. Six of the eight countries which have sent ten or more participants to the EMTP sessions are Asian countries. Indonesia has sent 14 participants, more than any other country world-wide. Following his return from the 1980 EMTP session, Ketut Kontra was named director of the planning department of the Indonesian National Electric Utility (PIN). Dr. A. J. Surjadi, a 1981 participant, is now Director of Energy Resources Development in the Ministry of Energy's power directorate. Other Asian countries with more than ten participants are Thailand (13), India (11), and Bangladesh (10). Kriengkorn Bejrputra, participant in the 1980 session, heads the regulatory division of Thailand's National Energy Administration. Antonio Anciano, who attended the 1979 session, is now manager of the planning service in the Ministry of Energy in the Philippines.

Seventeen African countries sent 72 participants. The largest representation from single African countries was from Sudan, which sent 14 participants, and from Tanzania, which sent 11. Seven of the Sudanese participants were from the National Energy Administration, which is developing a national energy plan for Sudan with the assistance of a U.S.

contractor provided by AID under the Office of Energy's project on Energy Policy Development and Conservation. Other African countries with five or more participants included Nigeria (8), Kenya (7), Zambia (6), and Liberia (5). Patrick Nyoike, who was in the first EMTP program in 1978, is now head of planning for the Ministry of Energy in Kenya; five members of EMTP groups participate in the Ministry's planning activities. Miedi-Himie Neufville, a 1981 participant, heads the Department of Hydrocarbons in the Ministry of Mines and Natural Resources in Liberia; his department has coordinated the development of a national energy assessment with the help of a contractor provided by the AID Energy Policy Development and Conservation Project. George J. Chivunga, a member of the 1979 EMTP group, is participating in the development of a national energy plan for Zambia in the National Commission for Development Planning.

Fifty-four participants came to EMTP sessions from 18 Western Hemisphere countries. The largest representation in this region was from Jamaica (8), the Dominican Republic (5), and Brazil (5). Gumersindo Estevez, a member of the 1980 group, is in charge of energy audits carried out by the National Commission on Energy Policy of the Dominican Republic under a USAID-funded industrial energy conservation program. Jose Coronado, a member of the 1979 group, heads the renewable energy unit of Panama's electric utility (IHRE), which is engaged in a large USAID-supported renewable energy program.

Six Near Eastern and North African countries sent 26 participants. Egypt sent eight and Morocco sent seven participants. Six of the Moroccan participants are members of a Ministry of Energy team engaged with American contractors in a comprehensive energy planning program in Morocco; the American assistance is funded under the Office of Energy's Energy Policy Development and Conservation Project.

CONVENTIONAL ENERGY TECHNICAL ASSISTANCE

(PROJECT 936-5724)

Introduction

The primary purpose of this Project is to assist governments of developing countries with the identification, evaluation, and development of indigenous conventional energy resources.

Since its inception in 1980, the Project has provided technical assistance for coal development and utilization in Pakistan and Costa Rica, for natural gas development in Morocco and Bangladesh, for petroleum refining in Kenya, and for the rehabilitation of the major electric power grid in the Sudan. The Project has also contributed to the funding of hydrocarbon resources surveys in areas offshore of several island nations of the Southwest Pacific.

In addition to providing specific technical advice and services, most of these activities have a significant educational element. They are designed in part to increase the capacity and sophistication of the developing country agencies in dealing with the complexities of the development and utilization of conventional energy resources. In most cases this educational element has been provided by close working relationships between American contractors supplied by the Project and counterpart officials in the agencies receiving assistance. Training workshops have been included in some of the in-country activities. Several regional workshops on conventional energy development are planned for 1984.

Natural Gas

In Morocco the Project is providing help to ONAREP, the Moroccan government's oil and gas agency, on an exploration and development program for natural gas. The AID assistance is coordinated with the World Bank, which has provided two loans to Morocco to finance exploratory drilling for natural gas. Bechtel National Inc. is prime contractor; some technical services are

provided by a sub-contractor, the Woodward-Clyde Company. A team of from three to five experts has worked with ONAREP officials since 1982. The team provides advisory technical assistance in the fields of geological and geophysical analysis, drilling decisions, drilling rates, production testing, reservoir analysis, market studies, and supply studies.

In Bangladesh, large natural gas fields have already been discovered and there is substantial gas production. Total natural gas resources may be large enough for Bangladesh to become an exporter of liquified natural gas. However, Bangladesh needs help with the appraisal of this energy resource and with the development of plans for the balanced growth of the natural gas sector. This assistance is provided under the Conventional Energy Technical Assistance Project. The U.S. Geological Survey has conducted a preliminary assessment of the natural gas potential in Bangladesh. Bechtel National Inc. is the primary contractor; specialist assistance is provided by Dresser Petroleum Engineering Services.

The Project will organize a regional workshop on natural gas utilization to be held in Bangkok in February 1984.

Coal

A comprehensive feasibility study for a 300 MW coal-fired power plant at Lakhra in Pakistan was jointly financed by the Conventional Energy Technical Assistance Project and two Pakistan government agencies: the Water and Power Development Authority and the Pakistan Minerals Development Corporation. The study was conducted by Stone and Webster Engineering Corporation; inputs regarding coal availability and the geological aspects of the study were provided by the U.S. Geological Survey and by the results of a prior drilling program. The feasibility study provided a favorable assessment of the

Lakhra plant, and it is now a keystone project in the Government of Pakistan's 5-year plan for the current period. The Lakhra project may also open up opportunities for major private sector roles in coal mining in Pakistan.

A coal development study is being implemented under the Conventional Energy Technical Assistance Project in Costa Rica. Significant coal deposits have been discovered at Volio near the border with Panama, but the extent of the coal resource is not known. A team from the U.S. Geological Survey is assisting Costa Rican officials with the development of a reconnaissance and exploration program and with the assessment of the quantity and quality of the coal deposits. A corporate contractor will analyze the potential for the use of coal for industrial production and power generation in the Volio area.

The project has supplied funds for the continuation of work, started with host government funding in 1980, aimed at the development of Indonesia's coal resources. The work is concentrating on delineating the infrastructure needs for coal transportation.

Work is currently under way to identify coal development activities in the Philippines and in Malawi.

Petroleum

The oil refinery at Mombassa in Kenya is jointly owned by the government of Kenya and four major oil companies. Due to the changing world oil situation, a basic review became necessary of the future status of the refinery and its role in manufacturing products efficiently to meet local demand. At the end of 1981 the government of Kenya requested assistance from AID with the complex decisions to be negotiated with the

oil companies. A management consulting firm with extensive experience in the petroleum sector, Arthur D. Little, Inc., has provided a study team to assist the government of Kenya with the refinery issues. The primary function of the ADL team has been to increase the capacity of Kenya's Ministry of Energy to participate effectively in equitable negotiations with the oil companies concerning the refinery. The value of the ADL contribution to the preparation for the negotiations has also been recognized by the participating oil companies.

Project funds have provided partial support for hydrocarbon resource surveys by a U.S. Geological Survey ship in offshore areas near several island nations of the South Pacific. The survey cruises have been jointly supported with the governments of Australia, New Zealand, and a group of South Pacific nations. Future survey cruises are being planned with similar support.

Electric Power

In Sudan the 300 mile power grid which brings electric power to Khartoum from hydro plants on the Blue Nile has deteriorated to a very low level of reliability. Standby generators consume large quantities of petroleum fuels. The government sought AID help with the rehabilitation of the Blue Nile grid; this assistance was provided under the Conventional Energy Technical Assistance Project. A team from Bechtel National studied conditions on the grid and identified the new equipment which should be installed as well as the transportation and communication facilities needed for the job. The rehabilitation project is now in the procurement stage, and Bechtel is assisting with the procurement process under Mission funding; the work is scheduled for completion in mid 1984.

TRAINING IN CONVENTIONAL ENERGY

(PROJECT 936-9997)

Introduction

A number of developing countries have substantial petroleum, gas, or coal resources which remain undeveloped; in many, the extent of such conventional energy resources remains unknown due to the lack of systematic exploration. The greatest barrier to the identification and development of conventional energy resources may be the lack of trained technical and management personnel. Developing countries also lack properly trained personnel for the electric power sector and for programs to increase efficiency in the use of fossil fuels and electricity.

The Conventional Energy Training Program (CETP) was established in 1981 to meet some of these needs for trained personnel in the conventional energy sectors. The Program, which is administered by a staff in the Washington office of the Institute of International Education, includes both Masters-level academic study and several types of non-academic training.

The academic phase of the CETP has involved grants for two-year Masters degree programs to approximately thirty-five students a year; about seventy participants are at U.S. universities under the program at any one time. The first group of participants completed their degree programs and returned home during the summer of 1983. The most frequent requests are for programs in energy planning and management, geosciences, mechanical engineering, electrical engineering, and petroleum engineering.

About 60% of all nominations are for non-academic training. Most of those selected for non-academic training participate in group programs. In the initial year 36 CETP participants joined other international and American students in seven non-academic short courses

organized by other institutions. However, in the Program's second year the emphasis shifted to special courses organized to meet the special needs of groups of CETP participants. Three such courses - in petroleum, geology, engineering and economics, in electric power operations, and in energy conservation - were scheduled in the summer and fall of 1983 and more of these special courses are planned for 1984.

Two of the special programs provide an individual internship for each participant following the group phase of the program. In addition, during the Program's first two years 24 persons have been provided training in individualized internships with U.S. energy companies.

Petroleum Sector

Eighty-five percent of the applications for academic study and sixty-five percent of the requests for non-academic training have been in the petroleum sector. Master's degree programs have been requested in geology, geophysics, petroleum engineering, petroleum processing and refining, petroleum economics, and chemical engineering. There have also been many requests for non-academic training in petroleum exploration, seismic interpretation, drilling, cementation, petroleum equipment, petroleum management, petroleum law, refinery operations, petroleum chemistry, petroleum transport, and pipeline operations. Such training requests were pending in mid-1983 from Burma, Thailand, Bangladesh, Nepal, Egypt, Tunisia, Morocco, Tanzania, Liberia, Sudan, Kenya, and the Dominican Republic.

In the summer of 1983 CETP sponsored a special 15-week program on fundamentals of petroleum engineering, geophysics, geology, and economics. The program was developed by International Petroleum Consulting Services, Inc. of Washington, D.C. especially for CETP and was attended by 25 junior engineers, geologists,

and geophysicists of national oil companies. The course included petroleum geology, sedimentology, structural geology, seismic exploration and interpretation, logging, reservoir engineering, drilling, well simulation and testing, oilfield development and operations, production engineering, enhanced oil recovery, and the economic analysis of petroleum ventures. Following the group program each participant had a two-week period of on-the-job training in a selected phase of the U.S. petroleum industry.

The CETP staff also receives many requests for academic study and non-academic training on petroleum economics and management. Each year between 5 and 15 CETP participants attend the Arthur D. Little Inc. 16-week course in Petroleum Management. One participant reported that his participation in the course resulted in his assignment as coordinator for several project feasibility studies and to the development of a training program for personnel of his agency based on the ADL course. Another wrote that the ADL course contributed to adjustments in his country's refinery output which increased the production of middle distillates by 2% and resulted in a foreign exchange saving of about one million dollars a year. The CETP staff is planning a special course in 1984 for CETP participants on the economics of the petroleum industry, including the negotiation and management of contracts with private exploration companies.

Electric Power Sector

In the fall of 1983 the CETP is sponsoring a special Power Systems Training Course for 14 CETP participants which has been organized by the Bureau of Power of Tennessee Valley Authority. The course is designed for power production personnel with at least five years experience in electric utilities. The program includes six weeks of classroom lectures and field trips covering power system planning, operations, environmental controls, fossil fuel plants, hydro plants, and transmission systems. Following the group program, each participant has a two-to four-month

internship in an appropriate unit in the TVA power system.

CETP participants have also attended various other non-academic short courses in the electric power sector, including a National Rural Electric Cooperative Association electric generating course, a University of Missouri/NRECA rural electrification course, a Denver Research Institute hydropower course, a Westinghouse power systems program, and a Army Corps of Engineers course on power dam safety.

The CETP staff has also arranged several individual internships in the power sector. The Ceylon Electricity Board of Sri Lanka has not previously burned coal but is planning for future coal-based power generation. A ten-month CETP internship with Pennsylvania Power and Light Company gave two CEB staff members broad familiarity with coal purchasing and handling and with the operational problems associated with coal-based power generation. Other requests for training related to coal have been received from Tunisia, Costa Rica, and India and have been met by Ashland Coal, Geo-chemical Testing, Inc., the U.S. Geological Survey, Stone and Webster, and the Coal Research Center at Southern Illinois University.

Energy Conservation

Training is also provided by the CETP Program on techniques for increasing efficiency in the use of energy from conventional sources. A special course for CETP participants on Industrial Energy Conservation was held at the University of Tennessee in the summer of 1982. The eight-week program was attended by 30 participants from both electric utilities and large energy-using enterprises. Afterwards one attendee was assigned responsibility for developing an energy management program at the steam power station which consumes 15% of his country's total imports of fuel oil. Another participant remained in Tennessee to spend two months at a TVA steam plant; his study of combustion processes resulted in savings of nearly one million kilograms of coal per day at his

generating plant, as well as large savings in fuel oil.

A new two-month practical energy conservation workshop for engineers and supervisors of electric utilities and industrial plants was conducted by TVA in Chattanooga in the summer of 1983. This

special program was organized by the TVA Bureau of Power for 28 CETP participants. It consisted of classroom lectures, laboratory work, and field training. The participants learned to plan energy conservation programs, conduct energy audits, operate test equipment, and select energy-efficient equipment.

TRAINING IN ALTERNATIVE ENERGY TECHNOLOGY

(PROJECT 936-5716)

Introduction

Most developing countries are anxious to explore fully the potentials for using renewable sources of energy to expand domestic energy supplies, provide energy needed for development, and reduce energy imports. However, the utilization of most of these renewable energy sources requires the use of technologies which have not yet been widely used, even in industrialized countries. The Training in Alternative Energy Technologies (TAET) Program was established at the University of Florida in 1979 to provide participants from developing countries with a broad familiarity with renewable energy technologies.

The Program

The TAET Program has provided a 15-week course on renewable energy technologies to two groups of participants per year since the spring of 1980. About thirty participants attended each session. The eighth TAET session began in August 1983.

The program has been designed to provide a comprehensive introduction to alternative energy technologies. The solar components of the program include solar hot water systems, solar heating, solar-powered refrigeration and air conditioning, photovoltaic power systems, solar thermal electric power, and other solar thermal applications. Bioenergy components include combustion systems, thermal gasification, the production of biogas via anaerobic digestion, and alcohol fuels. The TAET sessions also cover hydropower, wind energy systems, and geothermal energy.

Classroom instruction is provided by members of the TAET staff, various members of the faculty of the University of Florida, and lecturers from other institutions. The Program draws on the extensive experience of University of

Florida personnel with solar technologies and the faculty's more recent but growing experience with bioenergy and other renewable energy technologies.

A primary goal of the program is to help participants make informed choices among renewable energy options for various types of applications. Over the four years since its inception, the Program has evolved from a primarily technical focus in the initial sessions to a greater emphasis on non-technical factors influencing the utilization of renewable energy systems. These include economic, financial, social, cultural, and environmental considerations which may influence the choice of systems and/or the effectiveness of the systems.

The course begins with a two-week overview program which serves as both an introductory session for the participants in the full course and as a self-contained orientation program on alternative energy technologies for executives, managers, and planners who are only available for a short period. Most TAET participants have remained for the full 15 weeks. The complete program is made up of classroom lectures, seminars, laboratory work, field trips, and periods of work on individualized research projects.

The schedule includes several field trips to energy facilities in Florida and a one-week field trip to renewable energy facilities in the Western U.S. Solar installations visited by the Spring 1983 group included a number of buildings heated and/or cooled with solar energy, a solar water heating system at a brewery, two plants manufacturing solar collectors, a large photovoltaic system, a solar thermal electric power plant, and the Florida Solar Energy Center. Other renewable energy facilities visited by the group included a fuel alcohol plant, a charcoal plant, a conventional hydroelectric plant, a pumped storage hydro plant, a geothermal power

station, a wind energy farm, a large wind turbine project, and energy exhibits at Disney World's EPCOT Center.

In the second half of the course period, substantial blocks of time are scheduled for the research component of the program. A participant may choose an individual project or a cooperative project with other participants. Some projects require "hands-on" experimentation and construction, while others involve primarily library research and analytical work. Eleven projects were carried out during the Spring 1983 session. Seven dealt with solar technologies including projects on solar collectors, solar ovens, photovoltaics, solar radiation measurement, solar data base systems, and a laboratory-scale ammonia-water solar refrigeration unit. The latter unit was built by five participants from Egypt, Sudan, Senegal, and Thailand; it used solar heat to make about two pounds of ice in a three to four hour period. The group's coordinator, Mohamed Sobhi Abd El Salam, hoped to build such units to preserve food in villages and drugs in rural clinics upon his return to the Renewable Energy Projects Authority in Egypt. Other projects conducted by the Spring 1983 group focused on biogas, an improved charcoal stove, the production of charcoal from crop residues, a wind turbine, and a hydraulic turbine.

The Participants

A total of 223 persons from 49 countries participated in the first seven TAET sessions. Information on the current activities of some of these participants is provided below.

a. Asia

Nine Asian countries sent 82 participants to the first seven sessions. Five of the eight countries which have sent more than 10 participants were Asian countries.

Only one country had more participants than Thailand, which sent 17. Both the National Energy Administration and the Electricity Generating Authority (EGAT) sent four participants; universities and

research centers were also well represented. Two TAET participants, Chaya Jivacate, Chief of EGAT's Special Energy Division, and Krissanapong Kirtikara of King Mongkut's Institute of Technology, are leading a working group established by the National Research Council of Thailand to advise the government on solar photovoltaic applications in Thailand.

The fifteen participants from the Philippines include four from the government's Energy Research and Development Center. Cortecpcion B. Inductivo of the Center's program management department monitors and evaluates solar and wind projects and helped plan a USAID-supported assessment of the potential for biomass fuels in the Philippines. Leonora Dicioco of the National Engineering Center has prepared seminars on biomass energy system for engineering teachers. Rachel Polestico of Xavier University's extension service designs and installs biogas digesters in rural villages. Luis C. Baja and Eugene O. Refuerzo are on the staff of the Gasifier and Equipment Manufacturing Corporation (GEMCOR), the largest manufacturer of biomass gasifiers in any developing country.

Seven of the 12 participants from Bangladesh were from the Institute of Fuel Research and Development of the Bangladesh Council for Scientific and Industrial Research. A solar cooker developed by the Institute's Afiya Mahtab, a TAET participant, is now being manufactured commercially in Bangladesh.

The sixteen Indian participants represent a wide range of institutions. J.R. Meena uses his TAET experience as senior scientific officer of the Government of India's Commission for Additional Sources of Energy. Geethaguruu Veeraswamy of the Shri A M M Murugappa Chettiar Research Centre has designed a water-pumping windmill and published a "do-it-yourself" handbook in three languages on a conical solar still. Professor S.K. Sharma of Panjab University used the information he gained in the TAET course to present graduate and undergraduate courses on alternative energy

technologies. C.R. Das participates in the UNESCO-supported international biogas information program at the Tata Energy Research Institute.

b. Africa

Sixty-five participants came from 17 African countries. Sudan sent 24 participants, more than any other country worldwide, including 15 staff members of the Ministry of Energy and Mining's National Energy Administration. Several of these NEA officials are participating in a USAID-supported Renewable Energy Project in Sudan. Dr. Kamal Abdalla and Dr. Ahmed Elhag, TAET participants who are faculty members of the University of Khartoum's mechanical engineering department, are supervising research on solar refrigeration, solar water pumping, and small-scale hydropower.

Two participants, Charles Ntakirutinka and Prosper Mpawenayo, have served as director of a center for renewable energy at the National University of Rwanda. B.L. Lartey of the Food Research Institute in Ghana coordinates research in Ghana on solar heating and cooling and solar crop drying for the Commonwealth Science Council.

Jacob S. Sandikie and Emile Rhinlander, TAET participants who are with the Liberian Ministry of Lands and Mines, played central roles in the development of a national energy assessment; the study was prepared with the assistance of a contractor, Oak Ridge National Laboratories, funded by AID under the Energy Policy Development and Conservation Project.

c. Latin America and the Caribbean

Fifty-three participants came from 17 Western Hemisphere countries. The Dominican Republic sent the largest number

of participants (11) of any country in the region, including five staff members of the National Commission on Energy Policy. One of these, Gil Canario, heads the Commission's Conservation Division and is conducting an industrial energy conservation program financed by USAID in the Dominican Republic. The goal of the program is to achieve energy savings of 40% in the industrial sector.

Jerome Singh of the Caribbean Development Bank's energy unit coordinates Bank-funded solar projects ranging from simple domestic food dryers to photovoltaic power systems. At Dominica's Ministry of Communications and Works, Petronald Green coordinates OAS-funded renewable energy projects. Dwight Butterfield supervises the extensive biogas research and demonstration program at Jamaica's Scientific Research Council. Ukarran Bhimsen of Guyana's Institute of Applied Science and Technology has assisted with the installation of a photovoltaic power system in a rural area in Guyana under the Office of Energy's Photovoltaic Technology Project.

d. Near East

Five Near Eastern and North African countries sent 24 participants. Thirteen of these came from Egypt, including five each from the Qattaro Hydro and Renewable Energy Projects Authority and the National Research Center. The Center conducts extensive solar research, and a major biogas research and demonstration program is funded by AID through the U.S. National Academy of Sciences. Four Jordanian participants came from the staff of the Royal Scientific Society; a fifth Jordanian, Rashad Aburas, is responsible for energy conservation at the power stations of the Jordan Electricity Authority. Four participants from Morocco are participating in the development of a USAID-assisted Renewable Energy Center in Morocco.

PHOTOVOLTAIC TECHNOLOGY

(PROJECT 936-5710)

Introduction

In many developing country locations remote from an electric power grid, a small amount of electric power is needed for a high-priority purpose such as refrigerating vaccines or operating telecommunications facilities. Solar photovoltaic (PV) systems are a reliable and relatively inexpensive source of power in such locations. The price of PV systems per peak Watt has dropped steadily as the production has increased.

The primary objective of AID's Photovoltaic Technology Project is to demonstrate the suitability of photovoltaic power systems for meeting basic electrical needs in rural areas of developing countries. The Project is carried out by the National Aeronautic and Space Administration's Lewis Research Center in Cleveland, Ohio, which also manages the Department of Energy's program for the development of "stand-alone" PV systems.

PV-powered Grain Mill and Water Pump

A photovoltaic-powered grain mill and water pump was installed in a village in Upper Volta by the NASA Lewis Research Center early in 1979; it provided up to 1.8 kW of DC power to a hammer mill and a water pump. In 1981 the system was refurbished and expanded to 3.6 kW and an improved hammer mill was installed. In mid-1982 the system was being used to grind 1.2 metric tons of finely ground flour per week and pump 74 m³ of water per week during the dry season. After four years of operation under NASA supervision, responsibility for the unit has been transferred to the Government of Upper Volta.

PV-Powered Medical Refrigerators

AID and the Department of Energy are sharing the cost of a program under which PV-powered refrigerators are being installed in 28 rural health centers and clinics in developing countries. Contracts for the

fabrication, testing, and evaluation of prototype PV-powered refrigerator/freezer units were awarded to the Solar Power Corporation (SPC) and to Solavolt International (SVI) in 1979. SPC was awarded a contract in January 1982 to install 19 refrigerator systems in 16 countries, including 11 for AID. In 1983 SVI received a contract funded solely by AID to install refrigerators in 8 countries.

The PV units funded by AID are located in seven Latin American and Caribbean countries (Guatemala, Honduras, Haiti, Guyana, Ecuador, Dominican Republic and St. Vincent), five African countries (Ivory Coast, Upper Volta, Liberia, Zaire, and Zimbabwe), three Near Eastern and North African countries (Egypt, Tunisia, and Morocco), and three Asian countries (Indonesia, Thailand, and Bangladesh). Seventeen units had been installed by June 1983; fourteen were operating satisfactorily, and problems with three units were being investigated.

PV-Powered Medical Clinic Systems

Photovoltaic power systems have been installed in five rural health facilities in Guyana, Ecuador, Zimbabwe, and Kenya. The typical unit includes a 1440 Watt photovoltaic array; the power is used for lighting, refrigeration, sterilizers, and 2-way radios. The unit in Ecuador also powers a dental drill, while the system installed in Guyana also energizes a water pump.

PV-Powered Earth Satellite System

A 1500 Watt PV system funded by this Project will enable a university in a remote area in Indonesia to communicate with affiliated institutions via an Indonesia-owned earth satellite. The PV system with back-up generator will power an earth station in an AID-funded demonstration of the use of satellite communications in educational programs in remote areas.

LOW-COST ENERGY TECHNOLOGY

(PROJECT 936-5701)

Introduction

Since its creation in 1959, Volunteers in Technical Assistance (VITA) has focussed on providing technical information needed by individuals and groups in more than 100 developing countries. In 1979 the Office of Energy of AID requested VITA to undertake an expanded program of services to disseminate information on low-cost renewable energy technologies in developing countries. The program, known in VITA as the Renewable Energy Program (REP), has included a by-mail inquiry service, various types of on-site consulting services, a small grants program, and special projects in two sectors: improved wood-burning cookstoves and water-pumping windmills.

Inquiry Service

VITA's original primary function was to direct inquiries from persons in developing countries to appropriate volunteers with specialized experience. Funding from AID for the Renewable Energy Program has enabled VITA to greatly expand its capacity to deal effectively with inquiries concerning low-cost energy technologies. Such requests are handled by two of VITA's inquiry coordinators who specialize in renewable energy. Requests for basic information are filled by xeroxing information from VITA's extensive Documentation Center. Abstracts of 28,000 documents are now available through two microcomputers. Much of the documentary collection has been microfilmed. More complex requests are directed to one or more VITA Volunteers who reply directly to the inquirer; these Volunteers are selected with the aid of computerized data on the experience of each of VITA's 4,400 Volunteers.

In a typical quarter (July to September 1982) VITA answered 194 requests for technical energy information. However, 300 requests were received in a single month after the Voice of America described VITA's inquiry service in a series of

broadcasts on appropriate technology for developing countries.

Small Grants Program

The Renewable Energy Program has provided funds for a limited number of small grants (\$2,000 to \$20,000) to individuals and institutions in developing countries for innovative renewable energy projects. Examples of some of the grants are provided below and in the following sections..

Charlanka, a new charcoal enterprise in Sri Lanka, received a small grant for experiments with a portable metal charcoal kiln. A non-profit organization in the Caribbean was given a grant for the manufacture, testing, and promotion of improved charcoal kilns made from used metal drums.

The National Research Council of Egypt obtained a grant to build a biogas plant in a poultry-raising community; biogas from poultry manure is being used to heat a large chicken house. The Costa Rican Institute of Technology received a grant for a biomass demonstration and dissemination project which includes both biogas and charcoal activities.

A voluntary organization in Haiti received funds for three water wheel systems for rice hulling, water pumping, and electricity generation. A grant to the Ministry of Health in Honduras was used to install five anemometers for testing wind energy potentials in Honduras.

Improved Wood-burning Cookstoves

During the past four years funds provided by the Renewable Energy Program have helped VITA to assume a leading U.S. role in the worldwide effort to develop more efficient wood-burning cookstoves. VITA staff and Volunteers have been engaged in the development of new stove designs, the testing of these and other stoves, and the

promotion of the manufacture and use of the most promising designs.

VITA's largest woodstove project has been in the Sahel region of Africa and is funded by the office of the Sahel in AID's Africa Bureau. The Permanent Interstate Committee for Drought Control (CILSS), based in Ouagadougou, Upper Volta, established a regional team to assist stove-building programs in the Sahel. VITA has provided the technical coordinator for the CILSS Improved Woodstoves Project since 1980. The CLSS/VITA team has published detailed reports on laboratory tests of fired clay stoves, one-pot chimneyless stoves, and massive masonry stoves.

Working with an interchurch group in Somalia, VITA Volunteer Hank Cauley designed two types of stoves using local materials, trained five trainers, and initiated stove programs in five refugee camps; 2,000 stoves have been built as a result of the project which is supported by the USAID mission in Somalia.

A VITA staff technical adviser spend 10 months in Rwanda assisting an energy research center (CEAER) with its woodstove projects and helping with the organization of an international woodstoves seminar of Rwanda in January 1983.

A small grant from VITA under the Renewable Energy Program helped a non-profit organization in Sri Lanka to design a portable fired pottery stove and train extension workers to build it; 1,000 stoves have been constructed.

VITA's field office in Bangkok built an efficient mud/clay stove with a special grate for burning rice husks; the stove is being used in refugee camps in Thailand to reduce the high consumption of charcoal.

Tests of charcoal kilns and improved charcoal stoves are being carried out in Montserrat in the West Indies under a VITA project sponsored jointly by AID, the Government of Montserrat, and the Caribbean Development Bank.

When the Renewable Energy Program began in 1979, a number of organizations had experimented with improved wood stove designs in developing countries. Extravagant claims were made about the increased efficiency of some of the stoves, but reliable data on stove performance in field tests were rare. Very little information was available on the amount of wood saved by using the new stoves. VITA has given priority to developing techniques for the rigorous evaluation of materials and designs, as well as lowering the cost of materials and labor, increasing the durability of materials, increasing stove efficiency, and making the stoves easier to use and maintain.

In recent months VITA has been engaged in a major cooperative effort to improve the effectiveness of field testing of woodstoves. In December 1982 VITA convened a one-week international meeting of stove experts to determine standards for stove testing. The thirteen experts from nine countries agreed on three basic tests: a water boiling test, a controlled cooking test, and a kitchen performance test. The meeting was funded by AID's Office of Policy and Planning Coordination through the Renewable Energy Program and by IBM/Europe and the Government of the Netherlands. VITA has drafted a provisional manual describing these tests which has been distributed to over 200 stove technicians around the world in English, French, and Spanish versions. Data generated by groups using the new tests will be evaluated by a center in the Netherlands.

Water-Pumping Windmills

In Thailand, VITA has developed a wind-powered pumping system which permits farmers to grow one or two extra crops per year. The first rice crop is grown in the rainy season, but a second crop can be grown in the dry season only with irrigation. Wind power was extensively used in Thailand in an earlier era, but the wind units were replaced by pumpsets powered with gasoline or diesel fuel. Now many farmers cannot afford these imported fuels. The Thai government is promoting the renewed use of the wind energy and has

announced a goal of 9,000 new wind pumps in operation in Thailand by 1987.

VITA's Asia Office in Bangkok built a prototype water-pumping windmill with a 6 m diameter rotor. The rotors are mounted on 10.5 m high wooden towers. A unit can pump 60 cubic meters of water per hour with a pumping head of 1.5 m. VITA estimates that, over the life of the unit, the cost of water pumping per cubic meter with one of these units will be lower than with other types of wind pumps or with electric, diesel, or solar pumps. A dissemination program has been initiated in Phattalung province under the enthusiastic sponsorship of the provincial governor. Ten machines were operational in the province by July 1983.

For more than three years a VITA Volunteer has assisted a non-profit organization in India to design and build three low-cost sailing windmills with 16', 24', and 32' rotors. A guide to the construction of the 24' model has been published by VITA. Assistance to this windmill project has included a small grant from funds available under the Renewable Energy Program.

Technical support was provided by VITA for a wind-powered community water system on the Honduran island of Roatan. A windmill manufactured by Dempster Industries of Nebraska was installed early in 1982; it pumps water from about 50' below the surface to a 5,600 gallon storage tank, from which water is piped to households. VITA has also assisted wind-powered pumping projects in several other parts of the Caribbean basin including the Turks and Caicos Islands, St. Vincent, and Antigua.

VITA staff and volunteers have participated in wind projects in several

African countries. A small grant from funds available under the Renewable Energy Program aided the construction of six windmills in Mali to pump water for community gardens. Windmills have been evaluated and repaired in Somalia. A VITA publication describes a number of wind energy projects in Africa.

Extensive experience has been accumulated with the collection and analysis of wind speed data, on which an evaluation of any potential wind energy project must be based. Low-cost anemometer-totalizers have been used in Honduras, Mali, and Bolivia. Non-programmable wind recorders are being used in several communities on Roatan island, Honduras. A programmable recording system, powered by a solar panel, is operating under the VITA renewable energy project for the USAID Mission in Djibouti.

Four computer programs have been developed by VITA for the analysis of wind speed data, the output of water-pumping windmills, the water storage capacity needed with these pumps, and the economics of the various units. VITA offers to do free computer runs with data provided by institutions in developing countries who are assessing the feasibility of windmill projects.

Since 1979 VITA has been working on "variable-stroke" windpumps in which the torque load of the pump is matched to the torque supplied by the windmill. Such units will boost pumping efficiency over a range of wind speeds, increasing water output and allowing smaller storage tanks. In April 1983 VITA convened a meeting, funded in part by the Renewable Energy Program, of 18 experts from five countries, to assess priorities for further experimentation with variable-stroke windpump designs.

SMALL DECENTRALIZED HYDROPOWER

(PROJECT 936-5715)

Introduction

About two million villages in the developing countries lack electric power. The cost of extending the electric grid to many of these villages is prohibitively high, but the capital and operating costs of decentralized diesel generating units are also excessive. As a result, there is great interest in many developing countries in the utilization of small hydropower resources near many of these villages. Moreover, several countries have found that decentralized hydropower can contribute significantly to the power supplies of large electric networks and thereby reduce or postpone the need to expand large central power stations.

The Small Decentralized Hydropower (SDH) Program was established by the AID Office of Energy in 1980 to provide technical assistance to USAID missions and governments of developing countries for the identification of suitable hydropower projects and programs. The SDH Program is operated by the International Programs Division of the National Rural Electric Cooperative Association (NRECA), which represents member-owned electric cooperatives in the U.S.

The objectives of the SDH Program have been expanded and refined since 1980 to include: (a) assisting the governments of developing countries to understand the potential of small hydropower and to establish national hydropower goals, especially in those countries in which hydropower can make a significant contribution to meeting the country's energy needs and reducing energy imports; (b) providing technical advisory services on the planning, engineering, organizational, logistical, and financial aspects of the development of small hydro projects and programs; (c) strengthening the institutional and individual capacities in developing countries to plan and implement small hydro programs through international workshops

and other educational and training activities; (d) establishing an information exchange network with other technical and financial institutions involved with small hydro projects; and (e) encouraging broader roles by private sector organizations in the development of small hydro projects and programs.

Field Surveys and Technical Assistance

Under the SDH Program, teams provided by NRECA and its member organizations had conducted field surveys and/or provided technical assistance to USAID Missions and governments in 20 developing countries by the summer of 1983. Some teams were primarily concerned with the identification of small hydro resources; others studied specific sites and/or provided other technical or institutional services.

Country-wide assessments of small hydro potentials have been conducted by NRECA teams in Panama, Dominican Republic, Honduras, Burundi, Togo, Bangladesh, and Lesotho. Regional assessments were made in western Ghana and in a part of Sudan.

In Panama NRECA assisted the USAID mission and the national electric utility (IRHE) in 1980 with the planning of a micro-hydropower program. Ten kW and fifty kW demonstration units were installed to provide electricity for two technical schools. The USAID mission is funding equipment for four additional sites. In the spring of 1982 NRECA arranged a tour of manufacturing firms in the U.S. for two IRHE engineers seeking equipment bids.

In 1980 a NRECA team assisted with the planning of a program of small hydro units to be funded by a U.S. loan to Peru. Procurement of equipment for the program is now under way.

A NRECA team helped the USAID Mission in the Dominican Republic with the

preparation of a small hydro program in 1981; a program for the construction of three or four micro-hydro demonstration units is being initiated in 1983.

IN 1980 NRECA assisted the USAID Mission in Morocco with the development of a small hydro program, including site identification, site profiles, and preliminary layouts. In 1981 a two-person team participated in further sites surveys and reviewed project plans. Three sites are being funded by USAID. Equipment specifications and civil engineering works are being prepared, and power is scheduled to be on line within two years.

A two-person NRECA team analyzed 25 sites in Thailand in 1981. Thai and American engineering firms are now developing detailed plans for a phased program of six to twelve sites to be funded by USAID. These units will provide experience with different types of equipment under various conditions and will aid the development of a larger hydro program by the Thai government.

NRECA teams have also participated in the detailed analysis of specific sites in Rwanda, Dominica, and Zaire. Potential sites in Rwanda were reviewed in 1981. The principal engineer of the SDH Program returned in June 1983 to assist with the preparations for the rehabilitation of an abandoned former hydropower site. The USAID-assisted project would provide 100 kW.

A number of small hydro plants are already in operation in Burundi, and the government plans numerous new plants under 250 kW. In October 1982 NRECA sent a team to make recommendations on the institutional, staffing, and training needs connected with this small hydropower program.

In August 1982 a NRECA team assisted the USAID mission in Pakistan with the planning of the mini-hydro components of its proposed energy project. It will involve assistance to agencies in the Northwest Frontier Province which are implementing micro- and mini-hydro units.

Workshops

NRECA has organized four regional workshops on small hydropower which have provided information and training to approximately 400 planners, engineers, economists, administrators, and managers of electric systems from 75 countries.

The first workshop was held in Quito, Ecuador, in August 1980. The three-day program was attended by 118 persons from 13 Latin American countries and the U.S. In June 1981 a five-day workshop was held in Bangkok; it was attended by more than 100 persons from 15 East Asian countries.

Two one-week workshops have been scheduled in Africa. The first was in Abidjan, Ivory Coast, in March 1982. It provided an introduction to small hydropower for 72 participants from 22 Central and West African countries. In June 1983 a workshop was held in Mbabane, Swaziland; over 30 participants came from 13 East and Southern African nations.

Data Base and Publications

A sizeable data base has been assembled on small hydro projects around the world including a library collection of 3,000 items, reports by the NRECA field teams, and 1500 slides on small hydro projects in developing countries.

The SDH Program has added significantly to the technical literature on small hydropower in developing countries. Following each of the four regional workshops described above, NRECA has published a volume of proceedings containing all the papers presented at the workshop. The volume from the Quito workshop contained English and Spanish columns in parallel columns; separate English and French versions of the proceedings of the West African workshop have been published. The SDH Program has also published case studies on micro-hydropower projects in Nepal and Pakistan, a directory of U.S. small hydro equipment suppliers, methodological guides for the assessment of potentials and projects, and other special studies.

BIOENERGY SYSTEMS AND TECHNOLOGY

(PROJECT 936-5709)

Introduction

The rapid increase during the past decade in the costs of imported petroleum fuels has created a new interest in developing countries in renewable energy sources including energy from biomass. Trees have been planted in fuelwood and charcoal plantations in many countries. New direct combustion and thermal gasification systems are being used or developed to produce industrial process heat, mechanical power, or electricity from wood or other biomass. A number of developing countries have initiated major programs to utilize bioenergy resources. Such programs involve integrated activities related to natural resources development, rural development, and energy production with benefits in all three areas.

In 1980 the AID Office of Energy established the Bioenergy Systems and Technology (BST) Project to develop activities to stimulate the use of appropriate bioenergy resources in developing countries. The BST Project gives priority to bioenergy programs which will contribute to economic and social development of small islands, remote areas, marginal lands, and arid and semi-arid areas and/or will help rural people advance beyond subsistence agriculture.

Project activities have included advisory and consulting services to USAID missions and governments, technology demonstrations, research, support for a bioenergy user network, and several types of informational and educational activities.

From 1980 to 1982 BST activities were coordinated and administered by a team provided by the Forest Service of the U.S. Department of Agriculture. Beginning in fiscal 1983 staff support for the BST Project has been provided by a team from the Tennessee Valley Authority; the TVA team is based in Rosslyn, Virginia, near the AID Office of Energy.

Field Advisory and Consulting Services

The BST Project helps USAID Missions and governments of developing countries with the identification and planning of bioenergy activities and programs. BST staff have participated in the assessment of bioenergy potentials in Sudan, Kenya, Pakistan, India, Fiji, Philippines, Thailand, Indonesia, Jamaica, Dominican Republic and Costa Rica, and Honduras.

These visits have produced a number of ideas for bioenergy projects which are being considered by USAID Missions and governments, including the following: (1) India: the production of electric power for dairy operations through the thermal gasification of crop residues; (2) South Pacific: the use of gasifier-powered ice machines and other equipment for the processing and marketing of fish caught near small islands; (3) Dominican Republic: the burning of wood from a 15,000 ha plantation to produce 30 MW of electric power in a "dendrothermal" power plant; (4) Sudan: the pumping of irrigation water with gasifier-powered pumpsets using wood from shelterbelts along the irrigation ditches; and (5) Pakistan: the production of electric power at a cattle-breeding station using an engine-generator set fueled with biogas from cattle manure.

The Project also assists with the development and/or evaluation of bioenergy projects and programs. Staff or contract consultants have evaluated the economics of firewood projects in Niger and Sri Lanka, designed management programs for the use of forest resources for energy production in Panama and the Dominican Republic, planned a research program on energy from coffee hulls in Central America, studied the feasibility of the use of rice husks for power generation at rice mills in Guyana, and assisted with the development of renewable energy research institutions in Morocco and Indonesia.

Demonstrations of Bioenergy Systems

Project funds are also used to support in-country demonstrations of the types of bioenergy projects which would be suitable for widespread duplication in a number of developing countries.

The first of these demonstrations involves the use of a wood gasifier for electric power generation in a small community in Costa Rica. The system will use wood residues from local forestry operations to provide 140 kW of electric power to Horquetas, an off-grid community which is not included in rural electrification plans. The project is being carried out in cooperation with Costa Rican agencies including the Ministry of Energy, Ministry of Agriculture, the Forestry Directorate, the Costa Rican Institute of Technology, and the national electric utility (ICE). Over the lifetime of the system the cost of electric power is expected to be only about half that produced with diesel generators. The system is scheduled to be operational by the end of 1984. System performance will be carefully monitored in coordination with a World Bank gasifier monitoring program, and the experience with the project should provide important guidelines for the planning of bioelectrification projects in other developing countries.

Research

The BST staff has participated actively in the development of Agency priorities for research on the utilization of fuelwood and other biomass for energy production. The staff will play an important role in an evolving Agency-wide program to coordinate research activities on fuelwood and the use of biomass in energy conversion systems.

The BST project manager was a member of an AID team which examined fuelwood programs and research in India, Thailand, Philippines, and Indonesia in the spring of 1983. Research needs identified during the trip included studies of (a) improved matching between tree species and plantation sites, (b) more effective

interchange of experience among scientific tree growers, (c) improvements in the seed research and seed supply system, (d) more dynamic concepts for resource management, and (e) expanded experimentation with the thermal gasification of wood and agricultural residues.

Bioenergy Reports

During its initial year the Bioenergy Project commissioned comprehensive reports on the state of the art of each of the major bioenergy technologies. These reports were prepared by selected experts in research institutions and universities in the U.S. and covered direct combustion, small gasification systems, larger gasification systems, pyrolysis technology, alcohol fuels, and biogas. These reports have provided a solid base of technical information for use in other Project activities.

A detailed guide to tree species which are suitable for use in fuelwood plantations in developing countries was prepared for the BST project and has been published by a commercial publisher with some financial assistance from the Project. A handbook on biomass conversion technologies prepared for the Project by the MITRE Corporation will be published by the United Nations Industrial Development Organization (UNIDO).

Since 1982 the Bioenergy Project has sponsored the preparation and distribution of a series of Bioenergy Systems Reports containing digest-type information on bioenergy projects in developing countries and on bioenergy activities elsewhere which may be applicable to developing countries. Seven reports, each 24 pages in length, were published in 1982 and 1983.

Each of the initial four reports in 1982 covered one or more energy technologies including (a) the production of biogas through the anaerobic digestion of biomass, (b) the thermochemical conversion of biomass including thermal gasification, charcoal production, and the use of agricultural residues in thermal systems; (c) alcohol fuels and other liquid fuels from biomass for vehicles, and (d) the production

of wood fuels and the use of such fuels in industry.

Two 1983 reports reviewed the use of bioenergy systems for (a) the production and processing of agricultural products, and (b) the generation of electrical power. Another report examines the use of agricultural residues as fuels in direct combustion and gasification systems and for charcoal production. Reports on new biogas and thermal gasification projects are scheduled for publication in 1984.

Information for the reports is obtained through correspondence with institutions and firms engaged in bioenergy projects around the world as well as from interviews, conference participation, conference documentation, and other published materials. The reports are distributed to USAID missions and are mailed directly to energy and technical agencies in developing countries.

Workshops and Study Tours

In April 1980 the BST Project sponsored a one-month AID Bioenergy Study Tour for 35 participants from 21 countries in connection with the Bio-Energy World Congress in Atlanta. The program for each participant included Washington briefings, a two-day workshop with Project personnel and contractors, participation in the Bioenergy Congress and in one of the three simultaneous one-week post-conference bioenergy tours, and a week of individualized and small group visits to bioenergy facilities. The program was arranged by the Washington Office of the Institute of International Education.

A workshop on charcoal production was sponsored by the Project in Belo Horizonte, Brazil, in March 1982. The workshop program was organized by a large Brazilian charcoal company, Florestal Acesita, which also prepared a comprehensive state-of-the-art review on charcoal production for distribution to the 20 participants from developing countries. This one-week program included visits to

large eucalyptus plantations and to charcoal production units.

Short study tours in the U.S. on charcoal production and biomass gasification and on tree plantations were arranged by a Project contractor for two small groups of Philippine officials in 1982.

The Project was co-sponsor with the Government of the Philippines of a workshop on the planning and development of bioenergy programs in the Philippines in March 1983. The eight-day program included visits to a wood-burning "dendrothermal" electric power plant, a plantation of fast-growing Leucaena trees, a plant manufacturing small biomass gasifiers, and a cooperative using a gasifier-powered irrigation pump. Participants included 27 officials from 17 developing countries.

International workshops will be co-sponsored by the BST Project on biogas technology in Egypt in November 1984 and on thermal gasification systems in Indonesia in the Spring of 1985.

Bioenergy User Network

Support is being provided by the Bioenergy Project for the formation and initial operation of an independent association representing countries which have active bioenergy programs or are actively considering initiating such programs. The primary goal of this Bioenergy User Network (BUN) is to facilitate the sharing of experience with bioenergy programs and technologies among developing countries.

Interest in the creation of the Network developed at the bioenergy workshop cosponsored by the Project in the Philippines in March 1983. An Organizing Committee consisting of representatives from Costa Rica, Indonesia, Philippines, Sudan, and Jamaica was selected at Manila. An organizational plan and program priorities for BUN were formulated at a meeting of this committee in the Washington area in July 1983.

ENERGY TECHNICAL SERVICE SUPPORT

(PROJECT 936-5702)

USAID Missions and governments of developing countries need many kinds of professional and technical help in planning and carrying out energy projects. The services of short-term consultants and experts are provided to Missions and governments under several Office of Energy Projects including the planning, hydropower, and bioenergy Projects. However, the Office receives many requests for assistance which cannot be handled appropriately within the funding and contractual arrangements for these Projects. The Project on Energy Technical Service Support was established in 1978 to provide a means of responding to a much wider variety of requests for short-term professional, scientific, and technical services.

Since 1978 the Project has provided funding for about fifty consulting and technical assignments. Many of these have involved a single consultant, but some have required the services of a team of two or more persons. Most of the assignments funded under this Project have been carried out by personnel of the U.S. Department of Energy (DOE), the National Laboratories associated with DOE, and/or other DOE contractors. In these cases the AID Office of Energy outlines the scope of the work and the allocation of funds, while the individual consultants or team members are chosen by DOE. In addition, the Project has provided funding for some independent consultants and experts who are chosen directly by the AID Office of Energy.

Most of the assignments require travel to one or more developing countries. Virtually all of the assignments require the preparation of an appropriate report, recommendations, and/or other technical presentations. Examples of a few of the assignments funded under this Project are provided in the following paragraphs.

Lawrence Berkeley Laboratories (LBL) personnel conducted a preliminary assessment of the status of energy efficiency programs in the ASEAN countries and presented a proposal for a cooperative program on energy conservation in buildings in the ASEAN area.

LBL also prepared a plan for a demonstration of the use of renewable energy systems for water pumping; the assignment led to a project funded by AID's Asia Bureau under which photovoltaic, solar thermal, wind, and biomass gasification systems will be used for water pumping at a demonstration site in Malaysia.

Solar experts from the Solar Energy Research Institute and a wind specialist from Battelle Pacific Northwest Laboratories advised the USAID Mission and government in Morocco on the establishment of a comprehensive system for measuring solar insolation and wind velocities; a special purpose of the assignment was to examine the possible use of data from weather satellites for the analysis of solar insolation patterns in remote areas.

Transportation experts from the Oak Ridge National Laboratory conducted a survey of energy consumption in the transportation sector in Tunisia and identified opportunities for fuel conservation.

A team from Los Alamos National Laboratory examined potentials for the development of geothermal energy in the Caribbean region.

A staff member of Argonne National Laboratory was assigned temporarily to the USAID Mission in Jamaica where he assisted with the development of energy projects until a permanent Energy Officer could be assigned to the Mission.