

ISN 2162

6980135/41

PL-AAA-145

RENEWABLE ENERGY IN THE REPUBLIC OF CAPE VERDE:
A Pre-Project Study

by

Carol A. Ulinski
February 28, 1979

Submitted to: Special Development Problems Division
Office of Development Resources
Bureau for Africa
Agency for International Development
Contract No. AID/afr-C-1453
Project No. 698-0135

TABLE OF CONTENTS

	Page
I - INTRODUCTION.....	1
II - THE REPUBLIC OF CAPE VERDE--A GENERAL DESCRIPTION.....	2
III - ENERGY IN CAPE VERDE.....	3
IV - NON-CONVENTIONAL ENERGY PROJECT.....	7
V - OTHER PROPOSED ACTIVITIES.....	9
VI - TERMS OF REFERENCE FOR AN AID-FUNDED PROJECT.....	9
VII - RECOMMENDATIONS FOR WIND AND SOLAR TECHNOLOGISTS.....	11
VIII - INFORMATION ON RENEWABLE SOURCES OF ENERGY.....	12

APPENDICES

1. "Winds Over Cape Verde," by Michael Platzer, Secretariat News, October 29, 1976.
2. Edward Jefferies, Mission Report on the Non-Conventional Energy Project, dated February 1978.
3. Cable from Praia, dated February 5, 1979, on Proposed Renewable Energy Project for Cape Verde.
4. List of Organizations and Individuals Contacted Regarding Identification of Solar and Wind Experts.
5. Resumes for R. Alward and S. Blake.
6. S.D.C.'s International Search Service, "NTIS Off-line Citation List of Renewable Sources of Energy." Covers solar cooling (February 2, 1979), solar desalinization (February 8, 1979), methane from organic wastes (February 8, 1979), solar energy for pumping water (February 8, 1979), Windmills (February 15, 1979), Renewable Energy (February 15, 1979), Reforestation (February 15, 1979).

I - INTRODUCTION

In July 1979, information on a UNDP Non-Conventional Energy Project in the Republic of Cape Verde was forwarded to the Africa Bureau's Division of Special Problems, Agency for International Development (AID). Shortly thereafter, Mr. Horacio Soares, Director General of Natural Resources and Conservation (Ministry of Rural Development, Government of Cape Verde), came to Washington, D.C. During a meeting attended by Mr. Soares and AID representatives, it was agreed in principle that the U.S. would provide support to the Government of Cape Verde (GOCV) to further develop alternative sources of energy. To this end, AID would send a small mission to Cape Verde in late 1978 or early 1979 to design a small renewable energy activity.

The proposed project reflects a shared interest between the U.S. and the GOCV. The U.S. Congress has given AID a clear mandate to assist developing countries in meeting their energy needs, with special emphasis on renewable and nonconventional sources. The GOCV places a high priority on identifying energy alternatives which can be substituted for the increasingly expensive petroleum-based energy technologies currently in use.

This report is written at the request of the Division of Special Problems. Its purpose is to:

- o review the current situation in Cape Verde as it relates to energy;
- o propose a scope of work for the design effort;
- o identify solar and wind specialists who would be available to participate on the mission.

For information on the current situation in the Republic of Cape Verde, the author drew heavily upon the Cape Verde Assessment of the Agricultural Sector,¹ prepared for AID in 1978; and Mr. Edward J. Jefferies' report on the U.N.-sponsored Non-Conventional Energy Project.² In the search for solar and wind technologists, a wide range of people in both the public and private sector was contacted.

¹Peter H. Freeman, et al., Cape Verde Assessment of the Agricultural Sector, Report CR-A-219A, submitted to AFR/RA/PSA, Agency for International Development (McLean, Virginia: General Research Corporation, August 1978).

²Edward J. Jefferies, Mission Report: Non-Conventional Energy, Republic of Cape Verde, prepared for the United Nations, February 1978.

II - THE REPUBLIC OF CAPE VERDE--A GENERAL DESCRIPTION³

The Republic of Cape Verde is situated approximately 600 kilometers off the west coast of Senegal. It consists of ten ecologically diverse and dispersed islands with a total land mass of 4,000 square kilometers. Seventy percent of the country's population of 300,000 inhabitants (1976 figures) live in rural areas and make their living by farming and raising livestock. Major exports include: minerals (salt), fish products, bananas, and provision of fresh water for passing ships.

Although agriculture is the backbone of Cape Verde's economy, food accounts for about 50% of the country's total import bill. Other major imports include fossil fuels, wood, and building materials and supplies. The country's balance on current account is negative: in 1976 the value of imports came to \$39.5 million, while exports amounted to \$1.5 million. However, Cape Verde's overall balance of payments is positive, due to substantial public and private transfers and capital flows.⁴

A major constraint to increasing agricultural productivity is water, supplies of which are limited and unreliable. The country has been in the throes of a prolonged drought, which lasted from 1967-1978. During this time, natural springs and shallow wells, usually a major source of water during good years, have dried up. As a result, the total surface area under irrigation has decreased by approximately 25% from 2500 hectares to 1850 hectares, and annual yields for both rainfed and irrigated crops have declined substantially.

When it does rain in Cape Verde, most of the water streams down the steep slopes of the mountains into the sea. It is estimated that about 330 million cubic meters of water are annually lost to runoff. (Freeman, p. 66). And there appear to be limited possibilities for tapping this potential water supply due to a lack of sites for reservoirs.

Until 1970, there were no drilled wells in Cape Verde. Since that time the government, with support from the international community, has embarked upon a program to locate and exploit the country's groundwater resources. The U.S. is supporting a groundwater exploration project in Tarrafal (Santiago Island). The French and the United Nations are supporting similar efforts in other parts of the country. Although very little data are available on

³ The majority of the information from this section has been obtained from the Cape Verde Assessment of the Agricultural Sector.

⁴ Major sources of private transfers are remittances from citizens living abroad; and U.S. social security payments to Cape Verdians who worked in the U.S. and returned to Cape Verde upon retirement.

the location and extent of groundwater supply, it has been estimated that 80-90 million cubic meters can be safely tapped each year. (Freeman, p. 72) This is considerably more than the approximately 29 million cubic meters exploited in 1973 (last year for which figures are available).

The decline in supplies of spring water, and the subsequent shift to groundwater has considerable economic implications for farmers. Spring water is essentially a free commodity to users, the only cost being some form of payment (either in cash or kind) to the ditchkeeper. This is not the case with groundwater. The Ministry of Rural Development, the government organization responsible for exploiting groundwater resources, charges one escudo (or approximately \$0.03) for each cubic meter of water pumped from wells.

Other efforts are underway to increase water supply and the total surface area under irrigation. The U.S. has recently awarded a grant to the GOCV for the purchase and installation of a diesel electric seawater desalination/power generation plant. Upon completion, the plant will have a daily output of 750 m³ of potable water.⁵ The Federal Republic of Germany is supporting an effort to pump spring water 350 meters from sea level of a farm on the slope of Mount Genebra on Fogo Island. A similar effort is being supported by the Netherlands on the Island of Santo Antao.

The exploitation of Cape Verde's water resources will require substantial inputs of energy. The government is seeking alternatives to high-priced fossil fuels, and is placing a high priority on development of local, renewable sources of energy. An experimental effort is currently underway to tap Cape Verde's substantial wind resources for pumping water and generating electricity. This effort, financed by the Swiss Government and implemented by the United Nations, will be discussed in greater detail in a later section of this report.

III - ENERGY IN CAPE VERDE

As elsewhere around the world, Cape Verde is feeling the impact of rising costs for fossil fuels, which comes at a time when demand for energy is also on the upswing. From 1971 to 1976, the quantity of imported fossil fuels doubled. During this same period costs more than quadrupled. Fossil fuels account for a growing share of the country's total import bill: 8.5% in 1976 as compared to 3.5% in 1971. (See Table 1.)

⁵It is estimated that the annual fuel bill for the proposed plant will amount to \$420,480. This assumes that the cost of gas and oil will be \$155/T. See Cape Verde Desalination and Power (Sal), project paper prepared for the Agency for International Development (Atlanta, Georgia: Georgia Institute of Technology, August 1977), I, p. 41.

Table I. Quantity and Value of Imported Fossil Fuels, 1971-1976

	1971	1972	1973	1974	1975	1976
Fossil Fuel--Metric Tons Imported	10,767	13,106	16,936	19,307	22,080	21,505
Cost (\$000)	\$ 638.0	\$ 808.2	\$ 1,144.9	\$ 1,392.5	\$ 2,778.1	\$ 2,668.2
Total Import Bill (\$000)	\$20,400.7	\$24,419.1	\$34,281.8	\$34,826.4	\$39,766.1	\$30,594.3
% of Fossil Fuel Imports to Total Import Bill	2.9%	3.2%	3.2%	3.7%	6.8%	8.5%

Source: Cape Verde Assessment of the Agricultural Sector, p. 29.

Very little data are available on Cape Verde's wind and solar resources. Some observations were made from 1951-1960 in the vicinity of Praia, Santiago. During this time winds blew from the north and northeast about 78% of the time, and were calm about 7%. (See Table II.) It has been estimated that average wind speeds range from 15 km/hour to 40 km/hour or 9.3 mph to 24.8 mph. (Freeman, p. 193)

Table II. Observations of Wind Direction, Praia, 1951-1960

Direction	Number of Observations	Percentage
North	4,672	43
Northeast	3,833	35
East	672	6
Southeast	243	2
South	384	4
Southwest	158	1
West	0	0
Northwest	180	2
Calm	760	7

Source: Cape Verde Assessment of the Agricultural Sector, p. 54.

Data on solar radiation are equally scarce. However, some estimations are available for Mindelo and Praia, based upon reports over a five year period. The average radiation is 544 Langleys per day for Mindelo and 538 Langleys per day for Praia. (Freeman, p. 55)

The Government has identified four priority technologies for development:

- (1) solar/wind driven pumps to replace diesel and hand pumps;
- (2) small desalination units to provide potable water. (According to Mr. Horacio Soares,⁶ the residents of the islands of Maio and Boa Vista travel long distances to obtain good water. Apparently much of the water on these islands is brackish.)

⁶ Mr. Soares is the Director General of Natural Resources and Conservation, Ministry of Rural Development, Government of Cape Verde.

- (3) solar dryers for preserving agricultural produce and fish;
- (4) solar cookers and improved wood burning stoves.

Wood as a Source of Energy

A large percentage of Cape Verde's population relies primarily on firewood to prepare their meals and heat their homes. The local dish, "Chacupa," is a mixture of corn, water, salt, and lard; sometimes fish or beans are added. It now costs about 10 escudos (or about \$0.13) to purchase enough firewood to cook a pot of Chacupa. (Freeman, p. 95)

The uncontrolled exploitation of trees and brush for firewood has led to a steady destruction of Cape Verde's natural vegetation. Children are traveling farther up the mountainsides in search of supplies which are quickly becoming scarce. The current annual rate of consumption for a family of five is about 2.5 cubic meters. Assuming that 60,000 families reside in Cape Verde, the total annual consumption is estimated to be 150,000 cubic meters.

Assuming that firewood will continue to be a major source of energy for domestic needs, a combination of measures is needed to address the firewood shortage: to increase supply through reforestation, and to decrease demand, possibly through introducing wood-conserving stoves.

Cape Verde apparently has the potential to meet a large proportion of its firewood needs. (Freeman, p. 198) Production potential varies considerably within the islands. Low elevation zones yield about one cubic meter per hectare each year, whereas 10-15 cubic meters per hectare can be harvested annually from the cool, moist, highly elevated areas of Santo Antao. Much of the effort will have to take place in the lower yielding, lower elevation zones as few sites exist at the more productive, higher-elevated zones. (See Table III.)

Table III. Potential Fuel Wood Production

	Presently Forested	To Be Planted	Additional Potential	Potential Yearly Production (m ³)
High elevation plantations	1,330	1,350	1,320 ^a	40,000
Low elevation plantations	710	1,425	3,500 ^a	<u>5,635</u>
Total				45,635

Source: Cape Verde Assessment of the Agricultural Sector, p. 198

^aFrom estimates by M. Goncalves.

Another, complementary, solution to the firewood shortage is to increase the burning efficiency of wood through the introduction of improved stoves. In Guatemala, the Choqui Experiment Station has designed and tested a cookstove, made with mud and sand, which purportedly uses only half the fuel required for most wood-burning systems. In India, a smokeless chula has been fabricated with clay, sand and bits of scrap metal. It uses approximately 40% of the firewood needed for an open fire.⁷ Other efforts are underway throughout the world to design better fireboxes. The potential for improved cookstoves in Cape Verde should be explored.

IV - NON-CONVENTIONAL ENERGY PROJECT⁸

The United Nations Office of Technical Cooperation (OTC) is implementing a Non-Conventional Energy Project in the Republic of Cape Verde, utilizing Swiss funds-in-trust. The long-term objective of the project is to assist the Republic of Cape Verde in tapping local, renewable sources of energy, and to test technologies which harness non-conventional energy sources. To achieve this goal, the following activities will be undertaken:

- (1) collection of prevalent literature and information on wind and solar technologies,
- (2) establishment of a system for collecting data for planning, programming and designing projects in support of non-conventional energy,
- (3) development of standard practices for designing and adapting wind/solar energy devices to local conditions and needs,
- (4) establishment of a pilot project in San Felipe (Santiago) for the purpose of testing a variety of wind/solar technologies for water pumping and electricity generation.
- (5) Training of local personnel to develop alternate energy systems which meet local needs.

⁷Volunteers in Technical Assistance, Woodstove Design Manual, draft, 1979.

⁸See Appendix 2 for the mission report of Edward J. Jefferies entitled "Non-Conventional Energy--Republic of Cape Verde," dated February 1978.

The project provides for the purchase, installation and testing of five different systems:

- (1) Electro wind generator (Switzerland)
- (2) American wind turbine electric pump (U.S.)
- (3) Darrieus wind generator (Canada)
- (4) Dempster wind pump (25 of these wind pumps have been donated by the Church World Service)
- (5) SOFRETES solar (thermal) pump (France)

The site for this pilot activity is San Felipe (Santiago), location of a parallel project to increase the area under irrigation through the development of groundwater resources. The various wind/solar systems will pump water from boreholes drilled as part of the Groundwater Resources Project. According to Mr. Fernandopulle, the project manager for both activities, the results of the experimental energy project will provide a basis for determining which system(s), if any, is most appropriate for replacing diesel engines. He also emphasizes the fact that both projects "are intimately connected to innovations in the field of agricultural development and hence the pumping system--although experimental--should nevertheless ensure the water supply on a permanent basis." (Jefferies, Appendix 5, p. 1) Installation and operation of the equipment is the responsibility of Mr. Josef Van Meel, a U.N. volunteer from the Netherlands. Mr. Van Meel arrived in Cape Verde in September 1977.

In a recent discussion with Ms. Susan Habachy, U.N. officer in New York who is responsible for the Non-Conventional Energy Project, it was learned that none of the windmills (with the exception of the Dempster) are in operation. It was also learned that the funds for the project (totalling \$100,000) have been almost completely expended. As a consequence the status of the UNDP project is uncertain, and additional support for maintaining this activity is now being actively sought.

Mr. Fernandopulle has identified additional activities which would provide a logical extension to the activities already underway in San Felipe. These include:

- (1) Observation networks in Achada du Laranjo, Achada Baleia and Tarrafal for wind measurement and incorporation of some permanent observation points in the existing meteorological network.
- (2) Further installation of windpumps in the low-lying islands of Sal, Maio, Boa Vista and in Achada Baleia (Santiago). A small workshop can be envisaged for repairs, maintenance and new experiments.

- (3) Design and eventual installation for solar stills in Sal (Terra Boa) and in S. Vicente (Salamanca).
- (4) Design of more powerful wind generators for water lifting in the Tarrafal project area.⁹

V - OTHER PROPOSED ACTIVITIES

In October 1978 the Club du Sahel published a report entitled Energy in the Development Strategy of the Sahel: Situation--Perspectives--Recommendations. The study was financed by the Ministries of Cooperation of France, the Netherlands, and the Federal Republic of Germany, and by the West African Development Bank. It was presented to the Third Meeting of the Club du Sahel held in Amsterdam in November 1978. The study recommends that a permanent regional center for applied research into wind power be established in Cape Verde. It also encourages donors to support electrification of the islands using wind power.¹⁰

In December 1978 AID learned that the Federal Republic of Germany was planning to provide support to Cape Verde to implement some of the recommendations of the Club du Sahel Energy Study. At this time, the U.S. contacted the Club Secretariat in Paris to obtain more information about Germany's intentions and to convey an interest in coordinating U.S. efforts with those of Germany's. It was subsequently learned that the Germans had not yet defined the nature of their assistance to Cape Verde, but would be pleased to work with the U.S. in Cape Verde and elsewhere.

The possibility of fielding a joint mission with the Germans was considered but was rejected on the grounds that this would further delay the U.S. mission which has already been postponed several times. As an alternative the U.S. has offered to brief the German Ministry of Cooperation on the conclusions and recommendations of the AID mission, either in Dakar or Bonn.

VI - TERMS OF REFERENCE FOR AN AID-FUNDED PROJECT

In July 1978 Mr. Horacio Soares came to Washington, D.C. At this time, he met with officials of AID to discuss the possibility of U.S.-Cape Verde cooperation in the field of renewable energy. It was agreed in principle that AID would field a design team to evaluate the results of the UNDP

⁹ Fernandopulle, "Future Activities in Non-Conventional Energy Sector, Praia," September 1, 1978.

¹⁰ Club du Sahel, CILSS, Energy in the Development Strategy of the Sahel: Situation--Perspectives--Recommendations (Paris, France: Club du Sahel, October 1978), p. 137.

Non-Conventional Energy Project, and provide recommendations on how the U.S. could best support the development of alternative sources of energy in Cape Verde. Both parties agreed that the initial U.S. project would be small-scale (less than \$500,000) and would be viewed as the first phase of a potentially larger project. Mr. Soares felt that this approach would avoid placing additional strains on the government's management capability, as well as providing sufficient leadtime for training Cape Verdian experts to administer a larger project.

An AID team, consisting of a design officer, a wind expert and a solar specialist, will travel to Cape Verde in March 1979 to draft a project identification document (PID). The recommended terms of reference for this team are cited below:

A. Evaluate the UNDP Non-Conventional Energy Project

- (1) What additional support (materials, technical assistance, funding) is required to complete installation and commercial operation of the Elektro and Darrieus wind generators and the American wind turbine?

What have been the major problems to date?

- (2) What has been the experience to date with the installation and operation of the Dempster windpumps?

When and where will the remaining pumps be installed?

- (3) What system has been established for collecting data on the technical and economic aspects of the various wind systems?
- (4) To what extent are wind data already available, or being collected, at other potential sites in the archipelago?
- (5) Are there sufficient numbers of trained personnel in Cape Verde to install and maintain wind systems? What provisions have been made for further developing host country expectations?

B. Evaluate Other Wind Systems in Cape Verde

- (1) Are other donors currently supporting or proposing to support, the installation of wind systems?

What has been the experience to date?

- (2) Has there been any experience with local construction of windmills?

- C. Evaluate the Potential for Introducing Solar Technologies (Dryers, Distillers, Cookers, Hot Water Heaters) and Improved Wood-Burning Stoves)
- D. Analyze the Economics of Renewable Energy Technologies
- E. Evaluate GOCV's Ability to Absorb Additional Assistance, and Capabilities to Implement an Additional Energy Project

The design team will work in close consultation with the appropriate government ministries,¹¹ to identify problems, priorities and potential solutions to the further development of Cape Verde's renewable energy sector. The team will also work closely with Mr. Denis Fernandopulle and Mr. Josef Van Meel. The information gathered by the team will provide the basis for drafting a project proposal, which could contain the following elements:

- o an assessment of national energy resources
- o establishment of a national energy laboratory
- o testing and introduction of a variety of solar energy devices
- o support for expanding the UNDP Non-Conventional Energy Project¹²

The team will also explore the possibility of technical cooperation between Cape Verde and Senegal. Several organizations based in Dakar, including the Institut de Physique Meteorologique of the University of Dakar, and SINAES are active in developing, testing and installing a range of solar and wind technologies. The U.S. sent a project design team to Senegal in November-December 1978 and plans to provide energy-related support to the Government of Senegal.

VII - RECOMMENDATIONS FOR WIND AND SOLAR TECHNOLOGISTS

As noted earlier, a wide range of individuals throughout the U.S. was contacted as part of an effort to identify available solar and wind experts to participate on the design team. (See Appendix 4 for listing of people contacted.) We were looking for people who have experience and knowledge of small-scale, renewable energy systems, with previous work experience in developing countries and fluency in French and/or Portuguese. During our

¹¹ Ministry for Rural Development and the Ministry for International Cooperation.

¹² See Appendix 3 for the scope of work for the AID project as proposed by Horacio Soares.

search we were able to identify only a small number of individuals who met most or all these criteria. Mr. Ron Alward and Mr. Steve Blake would, in my opinion, form a strong complementary team. Bibliographic sketches of these two people are included below:

Ron Alward: Solar Engineer at the National Center for Appropriate Technology, Butte, Montana. From 1976-77, he was responsible for establishing and expanding an appropriate technology workshop facility at the Bu-Ali University in Hamadan, Iran. Previous to this he worked with the Brace Research Institute in Montreal, Canada, concentrating on solar and wind applications. Activities included the design and construction of: windmills for water pumping and generating electricity; greenhouses environmentally adapted for use in desert environments and cold areas of the world; solar distillation units for arid areas; solar cookers for families, community groups and institutions; solar crop dryers; solar water heaters; solar energy storage systems; and solar house heating systems. In addition to Iran, he has held overseas assignments in Haiti, the Caribbean Islands, Senegal and Paraguay. Fluent in Spanish and French.

Steve Blake: A geographer who specialized in site selection for wind systems. He is an expert in constructing, testing, selling and maintaining wind systems. He is the founder of the Appropriate Technology Group--a non-profit education and scientific organization involved with developing wind energy resources in developing countries. He has been a consultant to the World Bank, VITA, the U.S. Department of Energy and the Brace Research Institute, among others. He has traveled in Latin America and speaks Spanish.¹³

Copies of all resumes received have been submitted to the Division of Special Development Problems, as part of a portfolio of U.S. renewable energy experts. Copies were also sent to Mr. Norman Brown, the Energy Advisor to the Asia Bureau of AID.

VIII - INFORMATION ON RENEWABLE SOURCES OF ENERGY

In January 1979 the Government of Cape Verde requested information on the following subjects:

- (1) geothermal energy, specifically research going on in Hawaii;
- (2) production of methane gas from decomposition of organic wastes;
- (3) air conditioning using solar energy.

¹³ See Appendix 5 for detailed resumes of R. Alward and S. Blake.

This request was conveyed to Ms. Nina Vreeland, Office of Development Information and Utilization in the Bureau for Development Support, AID. Information on other energy technologies, such as windmills, solar stills and reforestation, was also requested. A comprehensive computer search was conducted, the results of which will be delivered to the GOCV by the design team.

Volunteers in Technical assistance, a private, non-profit organization which provides technical assistance and information to developing countries, was also contacted. Ms. Sabra Breslin compiled information on a variety of small-scale renewable energy technologies which might be of interest to Cape Verde. These also will be hand-carried to Praia by the design team.

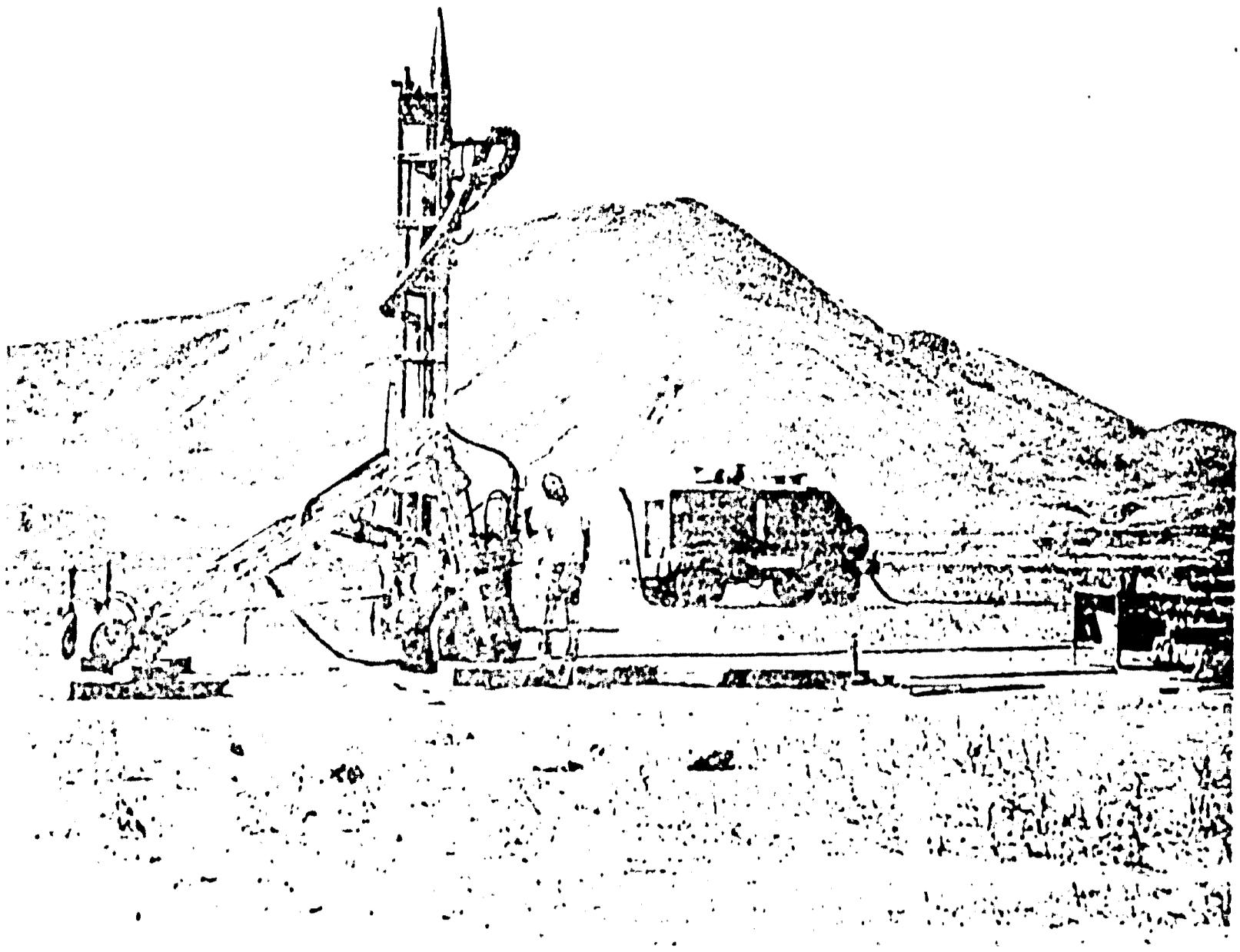


Secretariat

NEWS

United Nations Headquarters, New York

29 October 1976

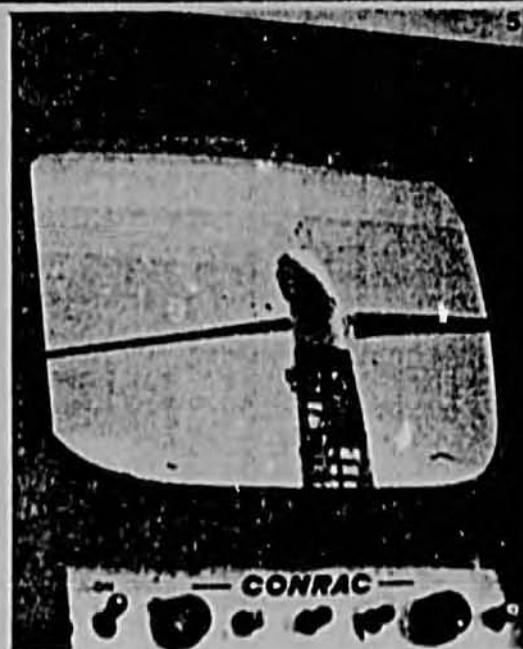
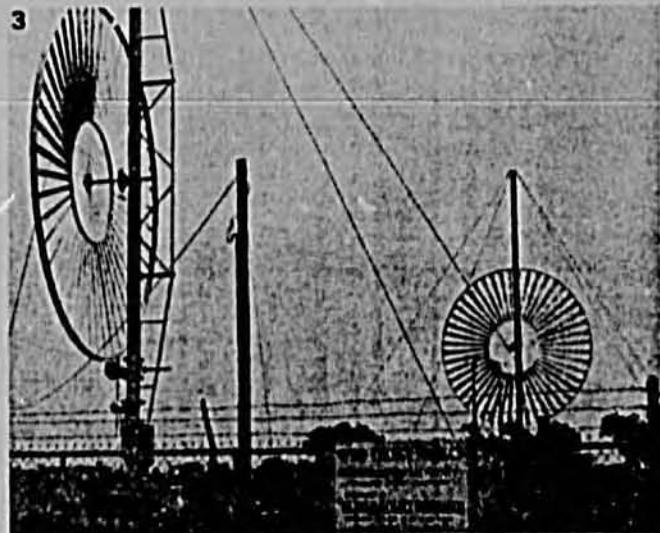


Winds over Cape Verde

by
Michael K. Platzer

This past week, the Secretary-General issued an appeal for international assistance on behalf of the newly independent Republic of Cape Verde which has suffered from the same devastating drought which has afflicted the Sahelian countries for the past eight years. The World Food Programme and UNICEF have already responded with substantial commitments of food and relief supplies. The UN Office of Technical Co-operation and FAO also have important ongoing projects to improve water use and agricultural production. However, the most interesting programme which is attempting to deal with the problems facing this drought-stricken country is a small-scale UN project funded by a Swiss Government Funds-in-Trust contribution.

During the last session of the General Assembly, the Foreign Minister of Cape Verde asked the Office of Technical Co-operation to look into the possibility of establishing a project to tap the abundant wind resources of the archipelago for energy and water pumping. In October last year, I visited the Republic of Cape Verde where, together with the Minister of Economic Co-operation and the UN project manager for groundwater exploitation, we prepared a small-scale demonstration project to harness the solar, wind, and geothermal energy resources of the islands. The UN Centre for Natural Resources, Energy



1. Cape Verdean women and children frequently walk miles with water containers on their heads. 2. Project manager Michael Frenchman inspects a bicycle wheel type wind turbine. 3. One of the sites visited by Mr. Frenchman and his crew. 4. Darrieus type wind turbine being erected on Block Island. 5. All the visits to institutes and projects were video-taped: this was the ERDA NASA 100 kw experimental wind turbine.

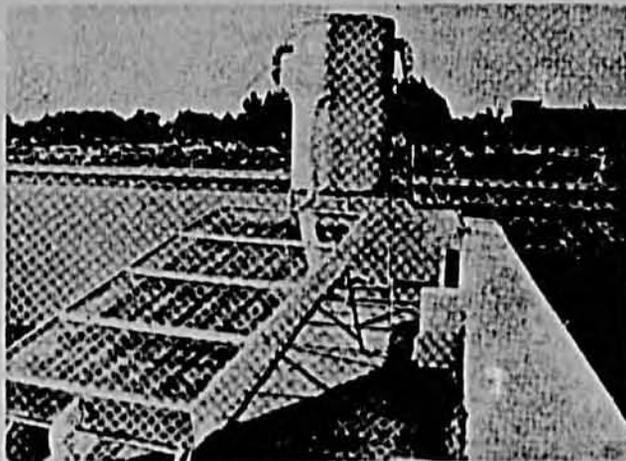
photos: R. E. Charron and Rede Corp.

and Transport, later suggested another project to investigate the use of the surrounding ocean's gradients as well as animal waste for energy production. The Government, in the meantime, allocated 60 acres for a model farm near the capital of Praia, to be run entirely on wind and solar energy. A solar pump has been donated by CIMADE, the French Protestant relief agency. In addition, we have been able to obtain 25 windmill pumps from US Church World Service and these will be placed throughout the islands. The Swiss Government is providing funds for the acquisition of experimental wind and other devices plus the services of a multi-disciplinary systems engineer to manage the programme.

The designated project engineer, Michael Frenchman, had already made a trip to Cape Verde in July 1975 as technical adviser to the American Committee for the Support of Cape Verde, and he had designed a similar project for a desert environmental research applications centre there. Together with Mr. Frenchman, we have written to or visited many of the major institutions and individuals involved in developing appropriate wind and solar devices and arid land management. Simple drip irrigation systems, hydroponic gardening, the erection of windmills and suitable housing techniques for desert environments have been video-taped by Mr. Frenchman and his associates so that they may be shown to Cape Verdean officials who will judge whether they are appropriate to local conditions. We visited the giant NASA 100kw wind turbine as well as community based projects which concentrate on simple, do-it-yourself technology. From the New Alchemy Institute in Cape Cod, the UN has sent the inventor of the "sail-wing" (a windmill pump made of sails) to Asia to build similar windmills constructed completely of indigenous materials. While recently in Tanzania, I came across a project in which windmills are made from corrugated steel barrels. In Niger this summer, I toured Prof. Moumoni's Solar Research Centre which has developed a solar pump and heater and is now concentrating on a solar refrigeration unit.

We hope that the project in Cape Verde will co-operate with all these centres in exchanging experiences with the developing technologies. Already the US Energy Resources Development Agency (ERDA) has expressed interest in the project; close collaboration with Swiss institutions is envisaged as well. Equipment from a variety of sources will be tested for their efficiency and appropriateness to the energy needs of poor African countries. It is estimated, however, that the one vertical axis generator already procured will pay for itself in six months.

The demonstration project, which will supply the electricity and water for a small village, will be a prototype for other villages on the islands. At the same time, the centre hopes to manufacture appropriate wind devices for the developing world. We hope that thoughtful use of the indigenous resources of Cape Verde will not only enable the country to meet the problem of scarce rainfall and lack of conventional energy sources but also serve as a model for other countries.



Solar water heater manufactured in Niger to be acquired by the Cape Verde project.

photo: Halidou Souna

the cover

Michael K. Platzer of the Office of Technical Co-operation, ESA, author of this article, visits the project site, Cape Verde, where a solar pump will be installed.

No thanks

It would seem that the wisdom shown by Chief Seattle in the last century (*Secretariat News*, 30 September) is still alive on this continent. Igloolik is the only community in Canada's North West Territories which has been offered television service by CBC and has turned it down. These are some of the reasons, quoted by *Native Press*, a Canadian paper serving the people of the N.W.T.:

The children are taught English in school all day. If there were TV they would hear English all evening as well and eventually might not learn their own language.

Most community organizations hold meetings in the evenings. In communities where TV has come in, some groups have quickly died out. Igloolik wants to keep the organizations going because they do a lot of good.

Much of the traditional craft work - building sleds and boats, cleaning and sewing skins - is done in the afternoons and evenings. Some people are concerned that these skills would be less used, eventually forgotten, if there were television.

The younger people of the community would spend all evening watching TV and then wouldn't want to get up and go to work in the morning.

Igloolik also worries about the effect of TV on mores - they don't like the emphasis on killing and violence. And they worry about the effect of TV on personal relationships. They say that when you walk into a house where there is TV, nobody looks at you because everybody is watching - guess what?

H. R.

REPORT ON MISSION

CVI/76/X05.

23 to 27 January 1978

NON-CONVENTIONAL ENERGY

REPUBLIC OF CAPE VERDE

EDWARD J. JEFFERIES
February 1978.

CONTENTS

	<u>Page No.</u>
<u>PART I.</u> <u>Organisation and Scope of Mission</u>	1
<u>PART II.</u> <u>Observations in the Field</u>	
A. Control of the Project	2
B. Equipment	2
C. Additional Equipment Recommended	3
D. Work Programme	3
<u>PART III.</u> <u>Future Programmes</u>	6

REPORT ON MISSION
CVI/76/X05
23 to 27 January 1978

NON-CONVENTIONAL ENERGY - REPUBLIC OF CAPE VERDE

EDWARD J. JEFFERIES

Part I

Organisation and Scope of the Mission

This project is being operated by ESA/OTC on a Funds-in-Trust basis, with additional equipment supplied from various sources. In the absence of any field personnel during 1976 and 1977, control of the equipment delivered was undertaken by Mr. Denis Fernandopulle, Project Manager of the parallel Project CVI/75/001, Groundwater Management. In September 1977 Mr. Josef Van Meel, a U.N. Volunteer arrived in Cape Verde under CVI/76/X05 to begin the installation and operation of the equipment.

Information available in OTC and CNRET in New York at that time on the status of the project and on possible future requirements was apparently incomplete. This short mission was arranged in order to clarify the position as regards the proper installation and use of the equipment.

Part II

Observations in the Field

A. Control of the Project

Until September 1977 the field control of the project was exercised by Mr. Fernandopulle, Project Manager of CVI/75/001, since the two projects are closely linked technically and no staff existed in CVI/76/X05. He has received the equipment as it arrived, taken it on inventory and arranged storage. He has also been mainly responsible for drawing up the locations and lay-out of the various elements of the project within the experimental area allocated at San Felipe.

The arrival of Mr. Van Meel created an anomalous situation, with a U.N. Volunteer apparently appointed as Project Manager of CVI/76/X05. In actual fact, Mr. Fernandopulle continues to be the effective Project Manager since he is responsible for the inventory and local funds, while Mr. Van Meel has taken charge of the installation and operation of the specialist equipment.

1 This is intended for the conversion of Wind and Solar Energy into Mechanical and Electrical Energy, most of which will be used to pump water from the boreholes already put in by the parallel Project. The ultimate uses of the water to be produced and the future developments in cattle raising, agriculture, forestry and village development have already been agreed by Mr. Fernandopulle with the Government Department concerned. These sub-projects will be financed by the Government with aid and technical assistance from a variety of sources other than United Nations.

B. Equipment

The equipment already requisitioned or believed to have been requisitioned but which has not yet been received is listed in Attachment No.1. prepared by Mr. Van Meel.

C. Additional Equipment Recommended

Equipment required to supplement what has been requisitioned is referred to in the copy of a cable (attachment No.2) sent to OTC by Mr. Fernandopulle on 20 January requesting purchase in Las Palmas for rapid delivery. The supply of a 110 to 380 volt 3 phase transformer for the "Eloktro" wind generator is most important, to enable this machine to power a borehole pump, whose purchase from Grundfos in Denmark is also requested. Cable is also required to make connections.

It will be highly desirable to supply at least some instrumentation for measuring solar radiation at the site in order to be able to check the performance of the "Sofrates" solar pump and as a basis later for the design of other solar items. This should include at least a "Campbell Stokes" Hours of Sunshine recorder and a Bimetallic Recording Pyranometer to record continuously the global radiation on a horizontal surface. The ex works cost of these two should not exceed US \$ 800.00.

For forward planning of possible windmill installations in other areas and islands, a number of hand-held Indicating Anemometers (e.g. four or six) are needed, to make rapid surveys of the wind regime in a limited area. These are listed in the Edmund Scientific Company's Fall 1977 catalogue at US \$ 27.50. postage paid.

D. Work Programme

There appears to be considerable doubt about the definitive Project Document and its content. Attachment No.3, supplied by Mr. Fernandopulle is a copy of the document which he believes to be the one actually signed by the Government.

The work accomplished to date is described in Mr. Van Meel's Progress Report dated 14 December 1977 (Attachment No.4). This also describes the counterpart organisation and related projects being carried out by other aid organisations.

The locations of the various windmills and their associated boreholes have been agreed by Mr. Fernandopulle with the Ministry of Agriculture and with the Director-General for Natural Resources and Conservation of the Ministry of Rural Development, in relation to the initial agricultural and village development in the area of San Felipe. The Groundwater Management Project has already successfully bored most of the tube wells in question.

The position at the end of January 1978 as regards individual machines is briefly as follows, as stated by Mr. Fernandopulle:-

Demster Windpumps - 25 supplied by Church World Services.

One has been erected at San Felipe (nearly complete)

Five more will be erected at selected boreholes in Santiago Island.

Three are being installed in the island of Maio.

Three are being installed in the island of San Nicola.

Ten are reserved for the island of Boa Vista, for which boreholes have already been put down.

Three are allocated to the island of Sal, of which one is already installed.

Elektro Wind Generator - 5 kW

The tower for this has been erected at San Felipe near a suitable borehole. Completion will await purchase of a transformer, cables and a submersible pump. A control house will be built.

American Wind Turbine

A site for this has tentatively been allocated at San Felipe.

Darrieus Machine

An anemometer has been installed on the proposed hill site for this at San Felipe and hourly wind speed readings are being logged. This will operate a well pump in the valley below the hill. It still remains to purchase a suitable well pump for this and it will be some months before assistance will be required in the erection of the rotor and putting it in operation.

Sofretes Solar (Thermal) Pump

The location for this is in a valley within the proposed irrigated area and the well has been sunk. The foundation for the solar collector panels (about 70 m²) is under construction.

In addition to the development of San Felipe, the Groundwater Management Project is co-operating with a large U.S. AID project in the North of this island (Santiago) near Tarrafal aimed at bringing a very large area under irrigation. This will involve the placing of many tubewells and a system of transfer of water between a number of storage tanks and reservoirs at different levels. The wind regime in that area appears to offer considerable possibilities for the use of wind both for well pumping and for transferring stored water to higher levels. Successful demonstrations by the Non-conventional Energy component of our projects may enable the Tarrafal project to decide whether to substitute windmills for diesel engines in many cases. This Project (CVI/76/X05) is therefore of considerable relevance to the future of irrigated agriculture in the Republic as a whole.

Part. III

Future Programmes

Attachment No.5 shows Mr. Fernandopulle's present ideas on the possible coverage of the work on Non-conventional Energy during the remainder of the present Planning Period (until 1981). The basis of this document seems to be the urgent short-term need to increase the area of agriculture under irrigation, to counter the continued low levels of rainfall. Combining this with a need to economise on imported diesel fuel, then the immediate target for CVI/76/X05 should be the extended testing of the five pumping systems being installed at San Felipe. This will provide a firm basis for recommendations as to which system, if any, will be most appropriate to replace diesel engines in a given locality, terrain and application. At least a year's work in the operation and measurement of performance is required. Only small additional commitments would be needed for this until the end of 1979, provided sufficient suitable counterpart technicians are provided.

In my view, the principle of concentration of the work of both projects on water extraction and use should be accepted for the period to the end of 1979. For this the two projects should be formally combined under one management.

If for 1980 and 1981 the Government wishes to include work on other applications of Non-conventional Energy, this should be planned as a separate project, with a separate manning schedule on both sides, Government and U.N. The list of work which could be included in such a project is virtually open ended. There will be two effective limitations: (a) the capacity of the country to find counterpart staff with appropriate background and interest; and (b) the level of funding, both local and external, which can be attracted. From the U.N. side, I would suggest that the minimum scale on which an effective programme could be mounted would cost US \$150,000 a year, to include only one Expert as Project Manager, with a number of U.N. Volunteers, provision for a few short-term specialist consultants, and a minimum provision for items of equipment which cannot be made locally.

Ordered material, that has not yet arrived.

Non-Conventional energy demonstration project, Cape Verde CVI/76/X05

24 January 1978

Joop Van Mell

1 Darrieus Wind generator

One box is missing:

" DC-AC inversion package " (req. 76-20-21053)

{ 76 - 21010
76 - 21009

2 Measuring equipment from Kahl

1 Sling psychrometer (°C preferred)

1 Psychrometer slide rule (nomograph) for item 1

1 dozen psychrometer wicks for item 1

6 Rain gauges (metric)

8 Min / Max. thermometers in °C

1 Mason hygrometer

1 Aneroid barometer

1 Wind direction indicator

76 - 21006 }
29 - 11 - 1976 }?

Date 9/23/1976

No Req. no indicated. ?

3 Solar equipment from Kalwall

2 Rolls sunlite fibreglass sheet

1 Box Fabral aluminum nails.

6 tubes " tremco " sealant/ caulk

Date: Oct. 4 / 1976

no number ?

4 57 books, no date, no number

5 8 magazines

Date: Oct. 4 / 1976 No number ?

6 11 books

Date Oct. 6/1976 No number ?

7 Parabolic solar cooker

Date Oct. 25/1976

req. n° ~~76-21170~~ 76-21170

cont/...
SHIPMAN JAN 19-77

~~AWS 6-20-20-12~~
AIR HANCO

8 Chemicals from Hach Chemical Co., Iowa USA

Date 29/10/1976 Req. N° 76-22032

~~76-22032~~
~~SHIPMAN~~

9 Gasoline or Diesel electric generator with spare parts.

Date 29/11/1976 Req. N° 76-23075

76-23075A 12 JAN 1977

10 Electric arc welding unit; 30-150 amp.
Including mask, gloves, brush, welding rods

Date 29/11/1976 Req. N° 76-23076.

76-23076A 12 JAN 1977

Welding
rod

UNATIONS

NEW YORK

008 -OPFERHEIM FROM FERNANDEPULLE REF CVI/76/X05 AND YOURTEL
 UDP3454-12 REF LAS PALMAS PURCHASE PLEASE NOTE 3 TRANSFORMER 3 -PHASE
 7.5 KVA INPUT 110V OUTPUT 380V PRICE 257 US DOLLARS. 11 ELECTRIC CABLES
 FIRST REF. C5385/12 NEED 50 METERS OF 3 BY 25 MM² SECOND REF. C5314/5
 NEED 50 METERS OF 4 BY 2.5 MM² THIRD FOR 380 VOLTS 110 METERS OF 4 BY
4 MM² CCC GALVANISED PIPES 45 METERS OF DIAMETER 2.5 INCHES. FOR ABOVE
 ITEMS CONTACT AGENT JUAN CARDENAS GUERRA CALLE ARCO 16 LAS PALMAS RELG; YUBA
 HE WILL FURNISH PROFORMA AND UNDERTAKE INSURANCE AND SHIPMENT DED SHOULD
 ORDER DIRECTLY ONE SUBMERSIBLE PUMP TYPE SP 10-25 FOR 380 VOLTS FROM
 GRUNDFOS BJERRINGBERG DENMARK.

PAQUIN

Prain, 20/1/1978.

I GENERALITES

A. Justification du projet

A present la Republique du Cap Vert est contrainte d'importer la totalite de l'energie qu'elle utilise, a un coüt relativement eleve. C'est pourquoi le Gouvernement desire autant que possible les energies solaire et eolienne dont le potentiel est important. Les premieres donnees recueillies semblent indiquer que le pays dispose de sites favorables a l'utilisation des energies solaire et eolienne dans le cadre plus vaste d'un programme de mise en valeur d'energie non-conventionnelle.

Dans une premiere etape il a ete decide d'etablir a San Filipe (Ile de Santiago) un projet pilote ayant pour objet d'un rechercher et tester les elements de base.

B. Cadre Institutionnel

Au sein du Ministere de l'Agriculture et des Eaux, le Departement de l'Agriculture et le Departement de l'Eau sont tous deux concernes par certains aspects de ce projet. En outre l'organigramme du Ministere fait etat d'un bureau pour l'energie non conventionnelle. Plusieurs ingenieurs et techniciens sont bien au courant de ces matieres et le pays dispose d'une collection d'ouvrages techniques specialises en ce domaine. Le Ministere de l'Agriculture et des Eaux dispose d'un certain nombre de donnees meteorologiques valable et on dispose aussi de donnees sur les coüts de l'energie conventionnelle qui peuvent servir de banc de comparaison dans l'etude de projets de factibilite.

C. Activites consecutives du Gouvernement

Après qu'un travail positif aura été exécuté p sur le site des projets et que des résultats faibles auront été obtenus, l'eau qui pourra être extraite dans la mesure ou elle ne sera pas indispensable aux experimentations, sera mise à la disposition d'usagers éventuels. L'utilisation de cette eau sera décidée par un comité technique établi au sein du Ministère de l'Agriculture et des Eaux avec la participation des personnel

5

On compte qu'à la fin du projet la compétence nécessaire aura été développée au sein du Ministère en vue de poursuivre et étendre les recherches en d'autres zones du Cap Vert, du point de vue de la planification, l'ingénierie, la formation, le fonctionnement, l'entretien et le financement.

D. Autres activités connexes

Le projet d'énergie non conventionnelle derculera en coopération étroite avec le projet de recherches d'eaux souterrains CVI/75/001 financé par le PNUD et exécuté par les Nations Unies dans le but de choisir d'autres sites valables dans le pays et aussi pour recevoir de ce projet à grande échelle le support technique logistique ou autre dont il pourrait avoir besoin.

Le site du projet d'énergie non conventionnelle pourrait être utilisé pour d'autres expériences s'y rattachant telles que l'utilisation de pompes(s) solaire(s), certains projets particuliers d'utilisation de l'eau, ou l'expérimentation agronomiques.

Les résultats du projet seront rendues publics de manière à être considérées dans le cadre de certains projets tels que projets d'électrification, irrigation, et approvisionnement en eau pour usage domestique.

E. Complément attendus d'aide extérieure

Dans le cours de la 2^{ème} année du projet une évaluation des résultats sera faite avec la participation de représentants de l'Agence d'exécution et du Gouvernement. Ceci permettra d'établir les bases pour une assistance future éventuelle pour la continuation et l'expansion des opérations.

Plusieurs organismes d'aide extérieure ont signalé qu'éventuellement ils seraient intéressés à soutenir l'activité du projet si des résultats encourageants sont obtenus.

II. Objectifs du Projet

A. Objectifs a long terme

Le projet vise a:

1) Aider la Republique du Cap Vert à satisfaire ses besoins en energie au moyen de ses ressources propres dans la mesure la plus large possible.

2) Experimenter sur le terrain même une technologie pour l'utilisation d'energie non conventionnelle qui puisse presenter un intérêt pour d'autres pays.

B) Objectifs immediats

1) Rassembler de la documentation et étudier le materiel le mieux adapté à la production d'energie non conventionnelle, solaire et éolienne.

2) D'établir un programme de collecte de donnés orienté vers des buts pratiques en vue de la mise en oeuvre d'energie éolienne et solaire.

3) De mettre au point des normes destinées à la conception et l'adaptation de dispositifs pour la production d'energie solaire ou éolienne, et adaptés aux conditions et besoins locaux.

4) Etablir un projet pilote à San Filipe (Santiago) qui permettra de tester plusieurs pleinement ces technologies, de répondre economiquement a des besoins précis, en particuliers pour la production d'eau et d'électricité pour des besoins domestiques et pour l'agriculture.

5) Former du personnel local de manière à lui permettre de réaliser par ses propres moyens des dispositifs d'energie non conventionnelle capables de repondre aux besoins locaux.

C. Investissement futurs

Si ce projet pilote à petite échelle démontre qu'il est techniquement possible et économiquement rentable d'utiliser l'énergie éolienne et solaire au Cap Vert; il est probable que des capitaux extérieurs, seront disponibles pour l'exécution de projets à grande échelle faisant intervenir les dispositifs mis au point par le projet.

III. Plan de travail

A. Description des activités du projet

1. Arrivée d'un ingénieur consultant pour l'évaluation préliminaire des composants du projet Praia Oct. 76
2. Sélection du coordinateur de projet (Volontaire des Nations Unies) Praia/NY Nov. 76
3. Collecte des informations sur l'utilisation de l'énergie éolienne et de l'équipement approprié NY Nov. 76
4. Finalisation des spécifications de l'équipement NY Nov. 76
5. Commande complète de l'équipement du projet et expédition au Cap Vert NY Dec. 76
6. Préparation des installations du projet S.Filipe Jan. 77
7. Installation et test des systèmes éoliens mécaniques et électriques S.Filipe Avril 77
8. Préparation des réservoirs d'eau et début d'approvisionnement en eau S.Filipe
S.Filipe Juin 77
9. Evaluation et modification du système en conformité avec les besoins Praia Juill.77
10. Planification des activités pour l'utilisation de l'eau et de l'énergie fournis par le projet S.Praia Août 77
11. Début des activités d'utilisation de l'eau et de l'énergie sur place S.Filipe Sept. 77

- 8
12. Début des expérimentations d'énergie solaire S.Filipe Nov'77
 13. Evaluation de la première phase des expérimentations d'utilisation de l'eau et préparation des plans pour la deuxième phase Praia Jan. 78
 14. Début de projets modifiés et élargis S.Filipe Mars 78
 15. Evaluation général du projet; préparation des recommandations pour un développement futur Praia Juil 78
 16. Publication du rapport NY Oct. 78

B. Description des contribution des Nations Unies

1. Personnel

- a) Coordinateur du projet (Volontaire des Nations Unies)
Qualifications : Formation de conception multidisciplinaire en comme ingénierie avec une connaissance et une expérience pratique de l'énergie éolienne et solaire. Habilité pratique dans les domaines électriques et mécaniques. Expérience dans la gestion de projets scientifiques et techniques.

Tâches : Sera responsable des spécification techniques, des équipements du plan de travail, de l'installation, de la supervision, du contrôle, du maintien et de l'opération du projet. Préparera les rapports, travaillera avec les commissions d'évaluation du projet fera des recommandations pour d'autres projets pourant utiliser une composante d'énergie non-conventionnelle, participera à la formation de persennel national.

(Le coût d'affectation du coordinateur du projet est financé par un fonds spécial du Programme des Volontaires des Nations Unies - dépenses prévues : \$EU 8.500 par an,

2. Equiement financé par une contribution de fonds-en-dépôt

DU du Gouvernement Suisse

- Achat et maintenance d'un véhicule	\$	5.000
- Equipement et fourniture de bureau	\$	1.500
- Equipement d'énergies éoliennes et solaire	\$	50.000
- Equipement géophysique	\$	2.000
- Outils et équipement d'appui	\$	4.500
- Frais de transports d'expéditions, administration, divers	\$	37.000

C. Description des contributions du Gouvernement

1. Activités préliminaires

- a. Collecte de toutes informations disponibles sur les ventes et le temp.
- b. Accès à tous les Ministères et institutions compétents en s'assurant de leur coopération, en particulier pour l'obtention des données économiques nécessaires.
- c. Revoir et déterminer le lieu d'implantation du projet
- d. Etudier les possibilités d'intervention dans l'agriculture et des autres domaines qui peuvent être liés au projet et déterminer les besoins en eau, énergie, terrain, matériel et main d'oeuvre.

2. Choix du personnel national

- a. Nomination d'une secrétaire à mi-temps, de personnel technique dans les domaines de l'agriculture, de l'eau et des techniques d'ingénierie.
- b. Désignation du personnel destinée à recevoir une formation technique.
- c. Embauche d'ouvriers (2-3).

3. Bâtiments et équipement

- a. Fournir le matériel, le terrain et la main d'oeuvre nécessaire pour la construction des installations du projet.
- b. Permettre l'utilisation des ateliers du Ministère de l'Agriculture et des Eaux pour la fabrication, la réparation et la maintenance de l'équipement et du véhicule.

4. Autres contributions

- a. Fournir le transport du coordinateur de projet à d'autres îles si nécessaire.
- b. Assister dans les arrangements à effectuer pour le transport du matériel par bateau Capverdiens vers Praia. Fournir ce transport si possible.
- c. Fournir les services postaux, de télécommunications et autres similaires dans le pays.
- d. Fournir une main d'oeuvre spécialisée (par exemple: électricien, machiniste, plombier, etc.) et non-spécialisée pour des besoins immédiats et de courte durée selon les nécessités.

Budget du projet couvrant la
Contribution des Nations Unies

CVI/76/X05
 Energie non-conventionnelle

	<u>Total</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
10. <u>Personnel</u>				
11 Coordinateur	<u>17000</u>	<u>700</u>	<u>8.500</u>	<u>7.800</u>
19 Sous-total	17000	700	8.500	7.800
40. <u>Equipement</u>				
41 Consonable	1.500	1.500		
42 Durable	<u>61.500</u>	<u>61.000</u>		
49 Sous-total	63.000	63.000		
50. <u>Divers</u>				
51 Divers	<u>37.000</u>	<u>37.000</u>		
59 Sous-total	37.000	37.000		
99 Total	117.000	100.700	8.500	7.800

- 1 -

Non-conventional energy project in Cape Verde

N° CVI/76/X05

Progress report after three months of assignment.

14/12/1977

J. van Keel

1 - Introduction

To facilitate the evaluation of the project I will recall the objectives as formulated in the project description (9/11/76):

A Long-range objectives are:

1. To contribute to Cape Verde's ability to satisfy its energy requirements through its own resources to as large an extent as possible.
2. To develop a base of field experience in the application of non-conventional energy technology which may be of interest to other countries.

B Immediate objectives are

1. To collect literature and evaluate available wind, solar, and related non-conventional energy equipment
2. To establish an application oriented data collection program for wind and solar energy planning.
3. To develop standard practices for designing or adapting wind and solar energy devices to local conditions and needs.
4. To establish a pilot project (at San Filipe, Santiago) which will fully test the ability of these technologies to economically meet specified requirements especially in providing water and electricity for domestic and agricultural needs.
5. To train local personnel to independently develop non-conventional energy systems to meet local needs.

From October to November 1976 R. Michael Frenchman visited Cape Verde for an advisory mission. He performed some preliminary wind measurements, ordered material for the project and wrote a report (January 1977).

2 - Project organization

The author is in charge of the pilot project for AChada San Filipe and also has the task to coordinate all projects and proposals on non conventional energy for Cape Verde.

BEST AVAILABLE DOCUMENT

The pilot project has been incorporated into the ministry of rural development. Close cooperation exists with the water department of this ministry with regard to the use of storehouses, workshops, the supply of labour and construction material.

No real counterpart of the same level as the author is working in the project, which hinders the transfer of knowledge in the field of calculating, designing, planning.

For the technical work a mechanic has been added to the project for its total duration of two years. He will learn how the installed machines function, will be able to take care of the maintenance, and will carry out repairs, as far as locally possible.

In the agricultural part of the project a student of agriculture is fulfilling the last half year of practical work of this study. In January of 1978 he will get his diploma of agricultural technician, after that he will stay working in the project.

3 Progress of the demonstration project

The following material has arrived to Cape Verde:

Three wind machines.

"Elektro" wind generator (Switzerland)

"Darriems" wind generator (Canada)

"American wind turbine" electric wind pump (USA)

Tools

Equipment for soil analyses

Car (Toyota pick up)

3 anemometers

The most important material yet to arrive is:

Equipment for water analysis

Welding equipment (gasoline generator)

Literature

No pumps have been ordered for the "Elektro" and the "Darriems" machine. In the isle of Santiago no suited pumps proved to be available. Suited pumps will be ordered as soon as possible, using part of the \$ 21.000, still in the project. Also some measuring equipment, some literature and a small water reservoir will be ordered using the money still left.

Wind measurements in Achada San Filipe

Two anemometers are at this moment in operation at Achada San Filipe. The anemometers of the totalizing type. Every hour a guard reads the numbers, from which hourly average wind speeds are calculated.

Using these anemometers a comparison of wind speeds in a number of locations has been made. On the basis of these measurements two hill tops, having high wind speeds and not far remote ^{from two tubewells,} have been chosen to install the Elektro and the Darriens machine. At this moment long term measurements are carried out to determine the structure of wind in Achada San Filipe in terms of distribution of wind speeds, duration of spells etc.

Installation of the wind machines

Elektro machine

Concrete foundations for the mast and guy wires have been made. Trenches have been diggen for the electric cables and lightning conductors. A shed is under construction that will contain a control panel, with fuses, switches, rectifier etc. A device has been consturcted for balancing the rotor blades.

The manufacturer did not deliver cable clamps for the guy wires. Cable clamps cannot be bought locally. So they are being made now.

The installation of the tower will begin within a few days. The rotor will be installed when the electric pump and cables have arrived.

Darriens machine

Calculations for the foundations of reinforced concret have been made as well as the general design of a building for transformers, batteries, switch panel. The crate containing the installation equipment (exact drawings, earth anchors, electric cables etc) is still in the port. As soon as this crate has left the port, final installation drawings and material requisitions will be made.

American wind trubine

At this moment no tubewell is available in Achada S. Filipe for the third machine. Probably the water situation will permit to make one more tube well for this machine. Sufficient good land for irrigated agriculture is available. The American wind turbine also generates electricity, and is delivered with pump.

Tempter wind pump

Achada San Filipe (a flat open plain) is very well suited for utilizing mechanically coupled wind pumps, in which the wind machine is installed on to, of the well. Luckily a large number of this kind of machine is available. One will be installed in Achada San Filipe.

4 Projects on non conventional energy, not sponsored by UMP

(isle of Santiago)

In Achada Baleia an Aerowatt (French) electric wind pump will be installed in the beginning of next year. The machine has been financed by C I M A D E (France) I C C O (a Netherlands organisation related to C I M A D E) will finance the continuation of the project in Achada Baleia on water supply and agriculture. Some more wind pumps will be installed.

The FAC (French Cooperation organisation) has proposed to offer a 50 Kw Aerowatt machine for providing electricity to a small town.

The FAC also proposed some desalinisation projects for the isles of San Vicens and Eoa Vista. Some installations consist of solar stills and a wind pump. Also some inverse osmose plants powered by a wind generator are proposed.

The WFD (german organisation) is preparing a large development project for the isle of Maico. Pumping by means of wind power will be part of it.

FUTUR ACTIVITIES IN NON-CONVENTIONAL

ENERGY SECTOR

DENIS FERNANDEZ

PROJECT MANAGER C71/75/001

C71/76/X05

Praia, 19/1/1970

Futur activities in Non-Conventional

Energy Sector

Introduction:

At the inception of the Groundwater Project in 1975, it was decided to undertake a certain amount of experiments in the field of the application of solar and wind energies for pumping purposes. With this idea in view 2 pilot areas were selected namely S.Filipe and Achada Baleia. The first pilot project obtained financial support in 1977 through Swiss Funds-in-Trust and as for the second there is now a possibility of financing through I.C.C.O. It must be remembered that these 2 projets are intimately connected to innovations in the field of agricultural developpment and hence the pumping system although experimental should nevertheless ensure the water supply on a permanent basis.

Along with the pumping of water, some experiments were also thought of in the field of desalting using solar stills mainly for water supply of isolated villages.

Activities undertaken.

At the present stage most of the activities are grouped around the installations of San Filipe. In this area the following sites have been chosen for the ongoing installation:

- Tubewell FT 170 - Dempster windmill pump capacity
20 à 25 m³/day
- " FT 176 - Elektromachine Winterthur 6 Kw, 8 m³/H ^{kVA}
- " FT 171 - Darrius Vertical Axis
Rotor 4 Kw, 9 m³/H

Besides these machines on the process of being installed, a Sofrètes Solar Pump (water supply of S. Filipe village) and a American Wind-turbine are also available for the area.

An idea of the groundwater situation has already been obtained after the boring of drill-holes and pump tests. Also a study of the wind field capacity at the test sites was made in order to estimate the performance potentials of the machines.

With regard to hydraulic and agricultural aspects, work has started on the basis of a recent topographic mapping on the scale of 1:5000. Building sites, irrigated tracts (5 ha), reservoirs and water distribution system, wind breaks, catchment reservoirs, and reafforestation zones, have all been planned and implementation is expected to follow soon.

Proposed extension programme

The installations in San Filipe need to be studied and eventually modified. The presence of a UN volunteer attached to the Ground Water project facilitates the tasks already programmed. The knowledge and the experience gained in San Filipe can profitably be transferred to other areas in Cape Verde.

However due to the great variation of the climatic situation within and between the islands a phase of data collection is advisable, covering principally the wind field and solar radiation aspects. Suitable instruments can be incorporated to the existing meteorological network at country level. Further, selected zones may also be considered such as Achada Baleia, ^{and} Tarrafal in Santiago, Upper Rabil in Boa Vista, Terra Boa in Sal, and Baia das Gatas in S.Vicente.

a) Extension of S.Filipe area

The experiments presently undertaken in S.Filipe perimeter can be extended to cover Achada do Laranjo and Achada de S. Jorge on the right bank of Ribeira Laranjo. A tubewell with a drain can be envisaged in the bed of this " ribeira " and pumping can probably be effected using a windgenerator (about 100 m of total manometric head) located on the right bank. Apart from this point, several boreholes will be drilled on

the abovementioned " Achadas ". It is thought that the wind field in this region would be similar to that of S. Filipe. However, an observation network will be setup along with the drilling activities. An equipment programme can be proposed following these results for the period 1979-80.

b) Investigation of Tarrafal area

Although one of the main objectives retained for the experimental phase of non-conventional energy utilisation was pumping ⁱⁿ tubewells, it is now clear that such pumping could be extended to aspects of water lifting for stocking in reservoirs in periods of surplus flow or simply for distribution purposes. This aspect would have a useful application in the Tarrfal Project area where construction of several small tanks and sizable dams are foreseen.

During the period 1978-79 an observation network similar to the one proposed for S.Filipe extension zone can be undertaken. Unlike this latter region situated on a wind-funnel, the Tarrafal Project area is fully exposed to the winds arriving from the sea. The design for more powerfull windgenerators need to be supported by a serious study of the wind system here.

The main pumping station will probably be located in Chao Bom and will concern pumping water stocked in a sizable tank to a stockage - dam situated 60-70 m higher. Since water lifting may not exceed 2 to 3 months, this installation probably can be combined to produce electric power for city lighting in Tarrafal and also for irrigation water distribution systems within the Project area. A long-term observation of wind performance is therefore necessary before arriving at a feasible design for this multi-purpose site.

In the windward area around Achada Carreira, several small tanks have been foreseen for stockage and to facilitate water distribution. Some of these are to be connected by dug-out canals which would be costly. Water lifting machines would be an alternative solution to be investigated.

c) Other areas

In Boa Vista the Upper Rabil valley has 10 boreholes which

will be drilled with 100mm diameter. Since the area is windward...

useful for reservoir design, and plantation of wind-breaks.

In the island of Sal, 2-3 boreholes will probably be equipped with wind pumps in the Terra Boa region but the water is salty. In one of the points, an experimental desalting solar still, could be of great interest for eventual hydroponic agriculture. If successful this method can be extended to S. Vicente island.

About 2 years ago a project for a desalting solar still was proposed for sites in Salamanca and Baia das Gatas in S.Vicente. The first site could be in fact chosen for a solar still using sea water.

Conclusions

In conclusion for the period 1978-79 an extension of the ongoing activities in the field of Non-Conventional Energy utilisation could consider the following points:

- 1) Observation networks for the period 1978-79 in Achada do Laranjo, Achada Baleia and Tarrafal for wind measurement and incorporation of some permanent observation points in the existing meteorological network
- 2) Further installation of windpumps in the low-lying islands Sal, Maio, Boa Vista and in Achada Baleia (Santiago). A small workshop can be envisaged for repairs, maintenance and new experiments for the period 1978-79.
- 3) Design and eventual installation for solar stills in Sal (Terra Boa) and in S.Vicente (Salamanca) for 1979-80.
- 4) Design of more powerful windgenerators for water lifting in the Tarrafal Project area for 1980.

UNCLASSIFIED
Department of State

INCOMING
TELEGRAM

PAGE 01 PRAIA 00036 051553Z
ACTION AID-31

7880

PRAIA 00036 051553Z

RM 272
3/6/79

INFO OCT-01 AF-10 EUR-12 EG-08 DES-03 /071 W
-----061568 051610Z /50/17

P R 050757Z FEB 79
FM AMCONSUL PRAIA
TO SECSTATE WASHDC PRIORITY 0621
INFO AMEMBASSY BISSAU
AMEMBASSY ALGERIA
AMEMBASSY PARIS

UNCLAS PRAIA 0036

C O R R E C T E D C O P Y (FROM PRAIA VICE DAKAR)

AIDAC

E.C. 12055: N/A

SUBJECT: PROPOSED RENEWABLE ENERGY PROJECT FOR CAPE VERDE

REFS: (A) 78 STATE 326739, (B) ULINSKI/SMITH LETTER DATED
JANUARY 24, 1978

1. AID/PRAIA PROGRAM OFFICER CONTACTED HORATIO SOARES,
GOV. MINISTRY OF RURAL DEVELOPMENT, PER JANUARY 23 DIS-
CUSSION WITH BLUMGART, MCALISTER AND ULINSKI, AFR/DR, TO
OBTAIN FURTHER INFO IN PREPARATION OF PROPOSED VISIT BY TEAM
PLANNED FOR MARCH, 1979 TO DEVELOP RENEWABLE ENERGY
AIP PROJECT.

2. ACCORDING TO SOARES, SUGGESTED SCOPE OF WORK WOULD INCLUDE,
BUT NOT LIMITED TO, THE FOLLOWING:

- A) SURVEY OF WIND, SOLAR, WOOD AND BIOGAS ENERGY POTENTIAL,
INITIALLY ON THE ISLAND OF SAO TIAGO, CAPE VERDE.
- B) TO EXPLORE AND DEVELOP THE USE OF WIND ENERGY FOR DIRECT
WATER PUMPING FROM WELLS AND FOR THE PRODUCTION OF ELECTRICITY
FOR VARIOUS PURPOSES.
- C) TO EXPLORE AND DEVELOP THE USE OF SOLAR ENERGY FOR WATER
PUMPING PURPOSES, COOKING, DRYING OF AGRICULTURAL AND FISHING
PRODUCTS, WATER HEATING DESALINIZATION, ETC.
- D) TO EXPLORE AND DEVELOP THE USE OF BIOGAS FOR COOKING,
DISTILLING, HEATING, ETC.
- E) TO IMPROVE THE USE OF WOOD AS A SOURCE OF FUEL, ESPECIALLY ✓
FOR COOKING, IN CAPE VERDE.
- F) TO EVALUATE THE ON-GOING UNDP NON-CONVENTIONAL ENERGY
PROJECT IN SAO FELIPE, AND
- G) TO PREPARE A P.I.D. FOR A RENEWABLE ENERGY A.I.P. PROJECT
FOR CAPE VERDE.

3. THE FOLLOWING ARE RESPONSES TO QUESTIONS RAISED IN REF
(B), PAGE 2, IN ORDER PRESENTED:

- A) SMALL-SCALE REFORESTATION PROJECT NO APPROPRIATE OR
DESIREABLE WITHIN SCOPE OF PROPOSED PROJECT.
- B) DURATION OF TEAM'S VISIT ESTIMATED AT THREE (3) TO FOUR
(4) WEEKS IN MARCH, 1979. TEAM'S WORK WOULD BE CONCENTRATED
ON THE ISLAND OF SAO TIAGO. HOWEVER, IT IS SUGGESTED THAT THE
TEAM BE PREPARED TO VISIT ABOUT TWO (2) OTHER ISLANDS FOR GENERAL
ORIENTATION OF ENERGY RESOURCES AND POTENTIAL, FOR POSSIBLE
FUTURE EXPANSION OF THIS PROJECT. SAO NICOLAU AND SAO VICENTE
WERE SUGGESTED, BUT FIRM DECISION REGARDING ISLANDS TO BE
VISITED WILL BE DETERMINED LATER.
- C) THE MINISTRY OF RURAL DEVELOPMENT HAS PROMISED TO GATHER
INFORMATION WHICH AID/PRAIA WILL SEND ASAP TO AID/W IN
PREPARATION OF TEAM'S VISIT TO CAPE VERDE.
- D) METEOROLOGICAL INFO VERY LIMITED. HOWEVER, MINISTRY OF
RURAL DEVELOPMENT WILL TRY TO OBTAIN AS MUCH INFO AS POSSIBLE
PRIOR TO TEAM'S VISIT.

4. CDD/BISSAU CONCURS PUXTON'S AVAILABILITY TO ASSIST WITH
ECONOMIC ANALYSIS OF PROJECT.

5. HOPE ABOVE FULLY COVERS QUESTIONS CONTAINED REF (B).
PLEASE ADVISE IF ADDITIONAL INFO REQUIRED AS WELL AS
STATUS OF RETAINING SERVICES OF TEAM MEMBERS.
MARKS

INFO
2-5-8
M2
DSE
H/M
118

DOE

UNCLASSIFIED

6

List of Organizations and Individuals Contacted
Regarding Identification of Solar and Wind Experts

Robert Ichord
Office of International Affairs
U.S. Department of Energy
Washington, D.C.
(202) 252-6380

Zephyr Wind Dynamo Company
Brunswick, Maine
(207) 725-6534

Mr. Ben Wolff
American Wind Energy Ass'n
Washington, D.C.
(202) 667-9137

Ms. Cathy Barczys
New Mexico Solar Energy Ass'n
Santa Fe, New Mexico
(505) 983-1006

Ms. Penny Wren
Office of Energy and Conserva-
tion, Governor's Office
Denver, Colorado
(303) 839-2507

Mr. Miguel Des Santiago
Organization of American States
Washington, D.C.
(202) 381-8737

Malcolm Lillywhite, Director
Domestic Technology Group
Denver, Colorado
(303) 988-3054

Tom Graham
Robert Gordon
Donovan, Hamester and Rattien
Washington, D.C.
(202) 342-5400

Lee Johnson
Western Solar Utilization
Network
Portland, Oregon
(503) 234-3361

Elliot Bayly (wind expert)
Whirlwind Power Company
Denver, Colorado
(303) 534-1567

Ron Alward (solar & wind engineer)
National Center for Appropriate
Technology
Butte, Montana
(406) 723-6533

Steve Blake, Director (wind expert)
Appropriate Technology Group
Oskaloosa, Kansas 66066
(913) 597-5603

Eugene Eccli, President
Design Alternatives, Inc.
Washington, D.C.
(202) 223-0830

Marcus Sherman (wind expert)
Wind Energy Services Company
Hyannis Port, Massachusetts
(617) 476-7298

Vaughn Nelson, Director (wind
expert)
Alternative Energy Institute
West Texas State University
(806) 656-3904

Terry Healy
Rockwell International
Colorado
(303) 497-2881

Rolland Fischer (wind expert)
Boulder, Colorado
(303) 419-6407

Denton Morrison (sociologist
specializing in appropriate
technology)
Michigan State University
(517) 355-3396

The following individuals were recommended by Lee Johnson, but lack of time precluded contact with them:

Bob Sherwin (wind electric)
ENERTECH
Vermont
(802) 649-1145

Ty Cashman (built wind pump for
Tassajara Center)
California Office of Appropriate
Technology
(916) 322-9654

Patricia Moodie (methane
digesters)
% Cuerpode Paz
Caoilla 63 S.A.
Quito, Ecuador

Ken Darrow
Volunteers in Asia
Stanford, California
(415) 497-3228

ECOTOPE
Seattle, Washington
(206) 322-3753

Ken Smith (methane)
California Office of
Appropriate Technology
(916) 322-9654

Earl Barnhart (wind
electric)
New Alchemy Institute

Jack Park (wind electric)
(916) 675-2478

Bruce Anderson
Total Environmental Action
(603) 827-3374

Jay Baldwin (built water
pumps for Farallones Insti-
tute)
Co-Evolutionary Quarterly
(415) 332-1716

Michael Evans
Wind Power Digest
(219) 848-4360

Clint Coleman
(414) 363-4408

8
CURRICULUM VITAE

NAME: Ron Alward

DATE OF BIRTH: 9 July, 1941

PLACE OF BIRTH: St. Thomas, Ontario, Canada

NATIONALITY: Canadian

MARITAL STATUS: Married with two children

PERMANENT ADDRESS: 3538 Ste. Famille St.,
Montreal, Quebec, Canada

PRESENT ADDRESS: c/o National Center for Appropriate Technology
P.O. Box 3838
Butte, Montana 59701

LANGUAGES: English, French - spoken, written, reading
Spanish - reading
Creole - spoken

ACADEMIC TRAINING: Bachelor of Engineering Science from the University of Western
Ontario, London, Ontario,
Canada, 1963

Master of Engineering Science from the University of Western
Ontario, 1968

EMPLOYMENT RECORD:

February 1978 to Present - Solar Engineer III, The National
Center for Appropriate Technology, Butte, Montana, USA.

November 1976 to December 1977 - Specialist in Appropriate Tech-
nology, Environmental Sciences Cluster, Bu-Ali Sina University,
Hamadan, Iran.

February 1968 to November 1976- Research Associate, Brace
Research Institute, McGill University, Montreal, Quebec, Canada.

August 1963 to July 1965 - Teaching assignment with Canadian
University Service Overseas, in Ghana.

9

PERTINENT EMPLOYMENT INFORMATION:

During employment with The National Center for Appropriate Technology, work activities include and have included the following:

- coordination of solar energy task group activities.
- providing technical assistance in the following subject areas: solar greenhouses, water heating, space heating and drying processes; wind energy; small scale hydro systems; geo-thermal energy.
- greenhouse thermal monitoring and evaluation.
- preparation of an information package on small scale hydro systems for The U.S. Department of Energy.
- Working with the Historic American Engineering Record and Technical Preservation Services Division of the Heritage Conservation and Recreation Service, U.S. Department of the Interior, on a feasibility study relating to the restoration of historic mill buildings in Claremont, New Hampshire.
- review of D.O.E.'s National Program for Passive Solar Heating.
- monitoring of grants.
- preparation of annotated bibliographies on Wind Energy Conversion and Small Scale Hydro Systems.
- assisting in preparation of NCAT's Year II Work Program.

During employment with Bu-Ali Sina University in Hamadan, Iran, work activities included the following:

- set up and expansion of an Appropriate Technology workshop facility
- design, construction and installation of several solar water heaters, space heaters, agricultural dryers and cookers
- training of staff and students in the design, construction, testing and evaluation of various types of solar systems
- energy survey of rural village area
- assisted in curriculum development at the undergraduate and graduate levels for students in Rural Engineering
- assisted in the preparation of a solar energy handbook published in Farsi (Persian)
- assisted in the evaluation, and the early stages of refurbishing, of an 800 KW hydro-electric system
- assisted in establishing short, medium and long-term university research and fieldwork priorities in the area of renewable energy resources.

10

During employment with Brace Research Institute in Montreal, work activities included the following:

- design of solar heating systems for two existing and three planned solar heated houses in Canada
- design and project field engineer for installation of several solar thermal systems throughout the Caribbean Islands
- research activities related to solar, reverse osmosis and vapour-compression desalination systems
- research activities related to the development and testing of environmentally designed greenhouses for the Quebec climate
- coordinator of project dealing with the installation of gardens and greenhouses on rooftops in downtown Montreal. Project included study of crop productivity, air pollution effects on crops and use of waste building heat for greenhouse climate control
- installation and testing of two electrical and eight water pumping windmills of various designs in Canadian and overseas projects
- author and co-author of several United Nations and Canadian Governmental organization research and field mission reports.

ASSIGNMENTS ABROAD: See employment record above and the following.

- January to July 1969- Haiti- Resident project engineer for construction of a solar distillation system
- 1969 to 1973 - Caribbean Islands - Several short term projects involving design, development and installation of windmills, solar water heaters, solar cookers and small solar stills in rural and urban settings
- 1976- Senegal - U.N.E.P. mission to Senegal to select a site for and estimate the feasibility of setting up a RURAL ENERGY CENTRE utilizing solar, wind and bio-mass energies to supply basic village needs
- 1976- Paraguay - U.N.D.P. mission to Paraguay to assist in the development of renewable energy resources in the remote northwestern Chaco District

OTHER RELATED ACTIVITIES:

- Member and ex-board member of the Solar Energy Society of Canada, Inc.
- Member of the International Solar Energy Society
- Member of the Canadian Government Review Committee for an ARK on Prince Edward Island. The ARK is an experimental bio-shelter system providing a potential ecologically compatible scenario for the conservor society of the future.

PUBLISHED WORKS: See attached list plus the following.

Chapter entitled "The Greenhouse as a Source of Food and Winter Heat" in E. Eccli ed. Low Cost Energy Efficient Shelter for the Owner and Builder, Rodale Press, Inc., Emmaus, Penn., U.S.A., 1976, pp 288 - 303.

Co-editor of A Handbook on Appropriate Technology, Canadian Hunger Foundation, Ottawa, Canada, April 1976, pp 280.

Master's Thesis entitled Solar Powered Intermittent Absorption- Refrigerator, Faculty of Graduate Studies, University of Western Ontario, London, Ontario, Canada, 1968, pp 165

Rural Energy Centre for Africa Using Solar, Wind and Biogas Energies, presented to the Joint Conference of the International Solar Energy Society, American Section, and the Solar Energy Society of Canada, Inc., Winnipeg, Manitoba, 15 to 20 August, 1976, pp 24.

The Integration of Renewable and Nonconventional Sources of Energy into Housing and Community Services in Iran, Proceedings of Seminar on Appropriate Technology for RCD Counties, Tehran, Iran, 3-4 October 1977.

The Introduction of Solar Dryers in Rural Iran, presented at the Renewable Alternatives Conference, Solar Energy Society of Canada, London, Ontario, 20-24 August, 1978.

Setting Up a Solar Workshop in Rural Iran, presented at the Renewable Alternatives Conference, Solar Energy Society of Canada, London, Ontario, 20-24 August, 1978.

- Evaluation of an Experimental Intermittent Absorption Refrigerator Incorporating the Generator with the Flat Plate Collector, published by the proceedings of the Solar Energy Society Annual Meeting, Palo Alto, California, pp. 21-23, October 1968.
- An Optimization Study of Vapour Compression Desalination with a Variable Power Source, Proceedings of the 3rd International Symposium on Fresh Water from the Sea, Vol. 1, 265-274, Dubrovnik, 13-17, September 1970.
- An Analysis of Cost and Production Factors in Operating Solar Stills, Proceedings of the 3rd International Symposium of Fresh Water from the Sea, Vol. 1, 715-725, Dubrovnik, 13-17, September 1970.
- Thermodynamic Analysis of a Double-Effect Basin-Type Still, presented at the ASME Winter Annual Meeting, Washington, D.C., 11 pages, 28 November to 2 December 1971.
- The Effect of a Variable Power Input on the Performance of a Vapour Compression Distillation Unit, Paper presented at the 2nd Conference on Water Desalination, Central Salt and Marine Chemicals Research Institute, Bhavnagar, India, March 2-3, 1972.
- An Investigation of the Contribution of Solar Energy in Heating Greenhouses in Québec, Proceedings of the Conference of the U.S. Section, International Solar Energy Society, Gainesville, Florida, U.S.A., April 1972.
- Le Role de l'Energie Solaire dans le Chauffage des Serres au Québec, Proceedings of the International Congress, "The Sun in the Service of Mankind", Palais de l'UNESCO, Paris, France, 13 pages, 2-6 July 1973.
- The Role of Solar Energy in Heating Greenhouses in Québec, Proceedings of the International Congress "The Sun in the Service of Mankind", Palais de l'UNESCO, Paris, France, 2-6 July 1973.
- Description of a Large Scale Solar Steam Cooker in Haiti, Proceedings of the International Congress, "The Sun in the Service of Mankind", Palais de l'UNESCO, Paris, France, 2-6 July 1973.
- The Integration of Solar Stills into Windmill Cost Drillings for Arid Areas, Proceedings of the International Congress, "The Sun in the Service of Mankind", Palais de l'UNESCO, Paris, France, 2-6 July 1973.
- Unsteady State Operation of a Reverse Osmosis Desalination Unit, Desalination, Vol. 11, No. 3, pages 261-268, December 1972.
- The Effect of a Variable Power Input on the Performance of a Reverse Osmosis Desalination Unit, Proceedings of the 3rd International Symposium on Fresh Water from the Sea, Dubrovnik, Yugoslavia, 1-14 September 1970.

- Review of Windpower Activities at the Brace Research Institute,
Presented to the Symposium on the ENERGY DEVELOPMENT AND UTILIZATION,
University of Sherbrooke, Symposium organized by the Department
of Mechanical Engineering, Faculty of Science under the Sponsorship
of ACRU, 28 May 1974.
- A Review of the Desalination Potential for the Reverse Osmosis Process,
Brace Research Institute Technical Report No. 739, 35 pages,
May 1968.
- The Cost of Supplying Sea Water for Sanitary Purposes in an Isolated
Community, Brace Research Institute Technical Report No. 740, 12 pages,
May 1968.
- The Installation Costs of the Auxiliaries for a Small Desalination Unit in
an Isolated Community, Brace Research Institute Technical Report
No. 746, 9 pages, April 1968.
- The Cost of Collecting Rain Water for Use in Isolated Communities,
Brace Research Institute Technical Report No. 747, 9 pages, May 1968.
- Thermodynamic Analysis of a Double-Effect Rankine Cycle Solar Still, Brace
Research Institute Technical Report No. 750, 10 pages, December 1971.
- An Investigation of the Contribution of Solar Energy in Heating Greenhouses
in Quebec, Brace Research Institute Technical Report No. 773,
77 pages, April 1972.
- Assembly Drawings for the Construction of the Solar Steam Cycle, Brace
Research Institute Technical Report No. 774, January 1973.
- Une Etude sur la Contribution d'Energie Solaire au Chauffage des Bories
au Québec, Brace Research Institute Technical Report No. 776,
20 pages, May 1972.
- Unsteady State Operation of a Reverse Osmosis Desalination Unit, Brace
Research Institute Technical Report No. 778, 8 pages, January 1973.
- Soil Field Tests and Soil Cement Block Fabrication at Source Phillippe,
Haiti, Brace Research Institute Internal Report No. 165, 5 pages,
March 1970.
- Some Notes on the Construction Cost of Auxiliaries for the Haiti Solar
Still, Brace Research Institute Internal Report No. 166, 10 pages,
March 1970.
- Installation of a Solar Distillation Plant on Ile de la Gonave, Haiti,
Brace Research Institute Internal Report No. 167, May 1970.
- Summary Report on the Improvement in Design of Solar Desalination Units for
Wider Application in Arid Regions, Brace Research Institute Internal
Report No. 193, 67 pages, January 1974.
- Structural Policy and Guideline Paper on Appropriate Technology, Prepared
for UNCTAD, Brace Research Institute Internal Report No. 1,103,
21 April 1975.

The Development and Application of Prefabricated Solar Stills for the Production of Fresh Water in Arid Areas, Proceedings of the 4th International Symposium on Fresh Water from the Sea, Heidelberg, Germany, 9-14 September 1973.

Une Cuisinière Solaire au Haiti, Reprint in the March Review of Architecture Concept, 2 pages, March 1973.

Answering the Energy Crisis - Solar Energy, Printed in Montreal Journal, Volume 3, No. 7, pp. 11-13, July 1973.

A Study of Solar Energy Parameters in Plastic-Covered Greenhouses, Solar Energy Society Conference, Cleveland, Ohio, Pages 7, October 3-4 1973.

The Potential of Windpower in Meeting Canadian Energy Needs, Speech given to Canadian Science Writers Association, Yvernon, Québec, 25 January 1974.

Experiences with the Cool House in Montreal, was to be presented to the Integrated Domestic Utility and Energy Systems Workshop, Massachusetts Institute of Technology, Conference cancelled, May 22-24 1974, 12 pages.

The Development and Testing of an Environmentally Optimized Greenhouse for Colder Regions, Proceedings of the International Solar Energy Society, U.S. Section, Colorado State University, Fort Collins, Colorado, August 21-23 1974, also - Solar Energy, Vol. 17, No. 5, pp. 307-312, 1975

A Handbook of Appropriate Technology - A Case Study of its Development, Presented to the Organisation for Economic Cooperation and Development, Study Group on Low Cost Technology and Rural Industrialization, Paris, France, 17-20 September 1974.

Le Développement d'Une Serre Spécialement adaptée à l'Environnement des Régions Froides, Paper presented at the Sixth Annual Meeting and Conference of Agricultural Institute of Canada and Affiliated Societies, Université Laval, Québec, August 4-8, 1974.

Intermediate Technology - Its Practical Application, Cooperation - Canada, (Canadian International Development Agency), No. 15, July/August 1974.

Report of Bruce Research Institute Activities, Paper published in the Solar Energy Society of Canada Conference Proceedings, Ottawa, Canada, 1-2 June 1975.

Solar Energy Greenhouse - Operating Experiences, presented to the International Solar Energy Society, U.S. Section, Los Angeles, California, 28 July to 1 August 1975.

Solar Energy Potential for Canada, Presented to the International Solar Energy Society, U.S. Section, Los Angeles, California, 28 July to 1 August 1975.

Solar Distillation as Appropriate Technology, presented to the International Solar Energy Society, U.S. Section, Los Angeles, California, 28 July to 1 August 1975.

15
RESUME

Steve Blake
Age - 32
Single

Route 1, Box 93-A
Oskaloosa, Kansas 66066 USA
913-597-5603

EDUCATION

Master of Arts in Geography (abt) specializing in site selection for wind systems; Department of Geography-Meteorology, University of Kansas; Lawrence, Kansas; 1974.

Bachelor of Arts in Philosophy; Department of Philosophy, University of Kansas; Lawrence, Kansas; 1968.

Latin American Studies (minor area of study); Latin American Studies Program, University of Kansas; Lawrence, Kansas; 1968.

Philosophy major; Department of Philosophy, Tulane University; New Orleans, Louisiana; 1965-1966.

Graduated from Pembroke-Country Day School; Kansas City, Missouri; 1964.

EMPLOYMENT

1964 - Grain Analyst; Kansas City Board of Trade; Kansas City, Missouri.

1965 - Construction worker; Alaska Railroad; Anchorage, Alaska.

1967 - Foreign car service mechanic; Competition Sports Cars; Lawrence, Kansas

1968 - Millwright; International Brotherhood of Millwrights and Joiners; Lawrence, Kansas.

1969 - Contractor involved in building, concrete fabrication, to trucking, and salvage; self-employed; McLouth, Kansas.
1972

1972 - Wind energy consultant: Sunflower Power Company and to the Appropriate Technology Group; Oskaloosa, Kansas.
1979

PROJECTS

In 1972 I founded Sunflower Power Company (formerly Wind Energy Systems) and the Appropriate Technology Group (ATG).

Sunflower is a sole proprietorship involved in the research and development of wind resources for electrical generation and provides system design, consulting, and hardware distribution services.

The Appropriate Technology Group is (becoming) a non-profit educational and scientific organization involved with developing wind energy resources in developing countries.

The following is a list of projects in which I have been involved through Sunflower and ATG:

<u>Year</u>	<u>Client</u>	<u>Project Description</u>
1978	Luis Wachong	Provided recommendations with regard to reconditioning an existing 60 kw isolated hydroelectric system for parallel generation with the National Electrical System of Costa Rica using a 100 kw induction generator.
1978	Aluminum Company of America (ALCOA)	Designed and constructed a working scale model of ALCOA's preproduction Darrius wind electric system. The model was used by an ALCOA division manager to demonstrate the design to the ALCOA Board of Directors at annual budget meetings.
1978	W. Everett DuPuy	Designed and installed a 2 kw wind electric system in parallel generation with Kansas Power and Light Company's utility network. This system provides part of the electrical requirements to a residence in Junction City, Kansas and uses a synchronous inverter for interfacing.
1978	U.S. Dept. of Energy - Rockwell International	Consulted with regard to a nation-wide demonstration program in which 100-200 residential-size wind machines would be installed. Provided recommendations concerning potential site selection strategies and the problems which could be anticipated with electric utility companies.
1978	World Bank	Presented an overview of the economics of wind energy world-wide as they are affected by the cost of fuel and wind energy potential. Review wind electric and water pumping technologies and the current activities in these areas. Made specific recommendations concerning how the Bank can prepare to implement the use of wind energy on a world-wide basis (see Writings).

- 1978 Volunteers for Inter-National Technical Assistance Presented a seminar to a group of development workers from Honduras and Guatemala on the use of wind energy. VITA is a clearing house for technical information to the international development community and I have assisted them since 1975.
- 1977 Windworks, Inc. Managed the Gemini Synchronous Inverter program.
- 1978 Ted Swansen Designed and installed (with Windworks) a 2 kw wind system at a residence in East Troy, Wisconsin. This system generated in parallel with the Wisconsin Electric Company.
- 1976 to 1979 American Wind Energy Association Elected by the membership to the Board of Directors and appointed as Treasurer by the Board. Responsible for the financial organization of the Association including researching and establishing AWEA as a non-profit trade association. Kept all books and records.
- 1977 Kansas Senate, Energy Committee Presented an overview of wind energy development on a national scale, and the economic potential of using wind energy resources in the State of Kansas.
- 1977 ATG in-house project Organized a series of workshops at which participants learned about and then built a solar domestic hot water heating system.
- 1977 Western Electric Presented an overview of wind energy development at Western's Engineer's Week.
- 1977 U.S. Dept. of Energy - Battelle Northwest Laboratory Facility Performed an investigation into the history of selecting sites for wind machines. Performed an extensive literature review and travelled over 4,000 miles to interview past installers, distributors, users, manufacturers, and researchers of wind systems (see Writings).
- 1976 Robert Nunley Designed and installed the first wind system in Kansas which generated in parallel with the state's electric utility network.
- 1976 Kansas University, Electrical Engineering Department Designed, built, and tested a Savonius rotor wind turbine mounted in an octahedron module tower. This design for developing countries uses 55 gallon oil drums and wood bearings, and provides mechanical power for water pumping.

- 1975 Sunflower in-house project Reconditioned six wind machines for use in demonstration projects. These machines had been recovered from midwestern farmers who had used them prior to rural electrification.
- 1975 Henry Reuss, U.S. Congressman from Wisc. Installed (with Windworks) the first residential-size wind electric system in the United States which generated in parallel with an electrical utility network.
- 1975 Windworks Engineered the Windworks designed Octahedron Module Tower for production.
- 1974 Brace Research Institute of McGill University Constructed, installed, and tested the Windworks designed sail windmill. This machine is designed for use in developing countries. Critiqued the design, and updated the blueprints and construction manual.
Designed, constructed, and tested three Savonius rotors in a program of comparative testing.
Participated in the design and construction of a fully instrumented passive solar dwelling for use by the Cree Indians of northern Quebec.
- 1974 Gates-Lear Jet; Kansas University Prepared a report on the use of wind electrical systems in solar housing designs; seven man research team.
- 1973 Ray Wilber Constructed and tested the Jim Sencenbaugh designed wind electric system which uses an automobile alternator, a 10' rotor, and has a capacity of 750 watts. This machine won Third Place at Kansas University's 25th Annual Engineering Exposition.

WRITINGS

"Wind Driven Water Pumps; Economics, Technology, Current Activities"; a report prepared for the World Bank; December, 1978.

"Geographical Parameters Affecting the Selection of Sites for Wind Energy Conversion Systems"; Master's Thesis, Department of Geography-Meteorology, Kansas University; June, 1974.

"A Framework for Selecting and Evaluating Sites for Small Wind Energy Conversion Systems"; a paper presented at the Sixth American Wind Energy Association Conference; Boulder, Colorado; May, 1977.

"Information and Interviews Concerning a Survey of Historical and Current Site Selection Techniques for Small Wind Energy Conversion Systems"; a report prepared for the American Wind Energy Association under contract No. E(45-1)-1830 with the U.S. Department of Energy, Battelle Northwest Laboratory facility; February, 1977.

"Savonius Rotor Wind Turbines"; Wind Power Digest. Fall, 1975.

"Report on the Sail Windmill Development Program"; Brace Research Institute Report No. L-87; April, 1975.

"Interim Report to Karl Bea Associates"; a site investigation for a 50' diameter wind system proposed by Ultramar Oil Co. of Great Britian for an oil field in Saskatchewan; Brace Research Institute; November, 1974.

"Wind-Solar Energy Investigation, A Feasibility Study of a Wind-Solar Powered Home"; a report prepared by Aerospace Engineering Seminar 802, University of Kansas; May, 1974.

OVERVIEW, RELATED ACTIVITIES

The organizing principal of my work has been to build and nurture spirit. To this end, I have been working since 1972 to develop wind energy resources as wind is a gentle and dispersed energy source with the potential of allowing greater harmony in nature and among men. This work has permitted me to learn and gain experience in design, business, engineering, and politics.

I have travelled extensively in the rural areas of Guyana, Brazil, Colombia, Costa Rica, Nicaragua, Honduras, El Salvador, and British Honduras and speak Spanish.

In 1968 I was the Sports Car Club of America Class F Midwest Regional Champion, and have raced motorcycles.

Since 1975, I have lived in a small house in the country with a hand pump for water and a wood stove for heat.

I enjoy photography, the flute, and good friends.

20

A FRAMEWORK FOR SELECTING AND EVALUATING
SITES FOR SMALL WIND ENERGY CONVERSION SYSTEMS

A paper presented at the
Sixth American Wind Energy
Association Conference, May,
1977 at Boulder, Colorado, USA

by Steve Blake
© Sunflower Power Co., 1977
Route 1, Box 93-A
Oskaloosa, Kansas, USA

I will talk this morning about site selection and evaluation techniques for family-small business size wind energy conversion systems (WECS). I will in turn address one of our many goals in the Wind Energy Industry today, that of projecting long-term wind power potential at optimum sites so as to provide reasonable guarantees of life-cycle WECS performance to users. I will summarize the state-of-the-art in this area and will define a framework for further investigating and understanding the problems we are encountering.

Problem Framework

It is helpful to consider site selection and evaluation within the framework of the central question asked by potential WECS users: "What are the cost-benefits of wind energy; are WECS sound investments?" The answer to this question varies geographically and is typically based upon an understanding of four factors:

- the anticipated amount of electrical demand
- the cost of electricity from competitive sources over the WECS life-cycle
- the costs and projected life-cycle of the WECS being considered
- the wind power potential available to the WECS at a proposed site.

The area available for locating a family-small business size WECS is typically limited in size and its location^{is most} often determined by factors other than maximum wind power potential with current occupancy, land prices and availability, and access to roads, utilities, etc. being primary considerations most often. In such predetermined, small-scale areas, analysing wind flow patterns is simpler as compared with larger-scale areas.

I also find it useful to consider site selection (determining rotor-tower location) and site evaluation (determining wind power potential at the rotor) separately, while in actual field situations these may overlap. I will first consider the site selection guidelines available for our use today, and will then consider site evaluation methods.

Site Selection Legacy

At the UNESCO Wind and Solar Energy Symposium in New Delhi in 1954, E.W. Golding stated: "The selection of wind power sites appears to require skill, acquired by experience."¹ At the United Nations Conference on New Sources of Energy in Rome in 1961, after two decades of site selection research and experience, Golding said: "Hitherto, site selection has been an art rather than a science."² The experience gained since then and since the recent renewed interest in wind power notwithstanding, these statements of Golding's relate the essence of the state-of-the-art in site selection as it is available to us today. These same conclusions are expressed over and over by Ed McCartle, Marcellus Jacobs, Ralph Schupback, and others who pioneered and developed rural wind electric systems in the United States before the advent of Rural Electric Associations.³ Our job then appears to be one of integrating, not differentiating, the art and the science of site selection.

The following is a distillation of site selection guidelines which have evolved through past experiences with WECS in the rural United States. Note that these guidelines, while not the product of a quantitatively based scientific method (anemometers were not used and wind speeds of an area were largely unknown), have evolved through tens of thousands of applications by machinery-wise farmers in a very competitive market situation:

- The tower should be located on the highest terrain near the batteries (load center). This provides a natural height advantage for capturing the smoother, more powerful winds at these greater heights. Low-lying terrain should be avoided.
- The tower should be located on flat terrain rather than on a slope as wind flows parallel to terrain surfaces, not perpendicular to gravity.
- The tower should be sufficiently tall to place the rotor a minimum of 20', and preferably 30', above all trees, buildings, or other obstructions to the wind within a 300-500' radius of the tower to again provide access to the smooth, non-turbulent winds. Note that users were often reluctant to purchase sufficient tower height and that manufacturers would refuse to finance installations which did not meet these requirements.
- Over level to rolling, open farm and ranch country, 45-50' minimum and 65-70' maximum tower heights have been used traditionally.
- Towers should be placed in-line with, not perpendicular to, the ridges of nearby buildings. ⁴

These common sense guidelines evolved primarily through experience in level to rolling farm and ranch country. Note that regional or local conditions may present additional considerations to selecting sites, especially in areas of rugged or mountainous terrain. Examples are areas of turbulence, or backwashes, which can exist on the lee slopes of hills, valleys which channel wind flow, hills which split wind flow, and ridges which compress wind flow. Any of these situations can exhibit highly localized variations in wind power potential.

A number of additional considerations which we have found helpful in our work in the field are:

- The optimum distance from the generator to the load center ^{in part} may be determined by comparing wire cost, power losses and permissible voltage drop.
- Often when selecting a site, the unavoidable disruptive effects of local obstructions such as hills, trees, buildings, etc. may be minimized through understanding the local wind power potential by direction. The tower-rotor may then be located downwind of the obstruction relative to the direction(s) of low wind power potential.
- Selecting optimum rotor height is aided by an understanding of the increase of wind speed with height at the site, or the wind profile. This understanding enables a definitive cost-benefit analysis of tower height vs. WECS output and may be based upon a theoretical understanding of wind profiles (in terms of surface roughness primarily) or may be directly measured.
- The growth of trees and future building projects near the tower-rotor which will disrupt wind flow should be anticipated.

Site Evaluation

Having thus isolated the optimum tower-rotor location(s) in the available area, the next step is to quantitatively evaluate wind power potential. This evaluation

procedure typically involves direct on-site measurements of wind speeds from which wind power potential is projected based upon an established wind speed record from a nearby station and a useful correlation between simultaneous measurements at the site and the station.

("Remote" evaluation procedures, where no on-site wind speeds are recorded and wind power potential is projected based upon a site's relative exposure to the regional wind patterns as determined again through existing records from nearby, established stations, while ideal in concept, are not available to us as broadly applicable, proven techniques today. However, certain remote methods are noteworthy as they apply to specific applications.)

(Automatic Power, the Houston based distributor of Aerowatt in the U.S., remotely projects WECS performance on off-shore oil platforms solely on the basis of extrapolation from established, on-shore wind speed records. This technique has been successful in these critical aids-to-navigation applications in part because the WECS, including battery storage, are typically over-sized by a factor of 2-3 and in part because a water surface is an ideal situation over which to extrapolate a wind pattern.)⁵

(Remote evaluation of a region in which a site is to be located is a useful means to determining a first approximation of WECS feasibility within the region. Regional wind speed records available through the National Climatic Center (NCC), Federal Building, Asheville, NC 28801 and through Jack Reed's Wind Power Climatology of the United States provide the bases for these evaluations.)⁶

(Battelle Laboratories recently issued a Request for Proposals for work to investigate evaluating favorable sites over a larger scale area than is typically available to small WECS. Spin-offs from these investigations may well be applicable to remote evaluation of sites for small WECS. Battelle is also sponsoring the NCC to assemble an index of all wind summaries (over 5000) in the NCC archives. This index which should be available soon will provide a tool for better understanding local wind patterns.)⁷

Our site evaluation research and installation programs in Kansas are designed to provide us with a comprehensive understanding of our region's wind power potential patterns while making the most effective use of the resources available for this aspect of our work. Our goal has been to build an experience base which will enable us to guarantee an installation's performance at a client's site. Building this base requires on-site wind speed measurement prior to a WECS installation, and this measurement equipment remains with the installation subsequently. Hence, we wish to minimize the cost and time demanded by this equipment. These cost-time constraints in turn discount the use of expensive frequency distribution recording equipment or chart recorders and dictate the use of conventional cup anemometers coupled either mechanically or electrically to an odometer type of integrating device which thus provides a record of mean wind speed over time. These cup anemometer-odometer type devices typically sell for around \$100. If a WECS is then installed, an AC kilowatt-hour meter (about \$40 for 110 volt models) is included with the installation which in conjunction with the anemometer-odometer provides us with an ongoing, fixed reference in our region. (The electric utility grid in our area is well developed and WECS interfaced with the grid are used most frequently.)

Since power varies as the cube of the wind velocity, mean wind speeds as recorded by these odometer devices do not accurately reflect the power in the wind. ^{in power calculations.} The question then is what relationship, if any, exists between mean wind speeds and wind power potential? To determine the nature of such a relationship, we analysed wind speed data expressed as both frequency distributions and as annual mean wind speeds for each of

138 wind speed recording stations in the United States over a 10 year period.⁸ First, the ratio of wind power potential as the sum of power in each wind speed interval (P_a) to the wind power potential as calculated solely from the annual mean wind speed (P_i) was determined for each station, a ratio called the cube factor. Next, cube factors for that portion of the wind spectrum available to WECS with 8 mph cut-in speed and an 18 and 25 mph rated speed respectively were determined. For WECS with 8 mph cut-in and 25 mph rated speeds (noted hereafter as 8/25), 92% of all locations in the data set with annual mean wind speeds over 9 mph exhibited cube factors within $\pm .10$ of the curve depicted in Figure 1. For WECS with an 8 mph cut-in and 18 mph rated speed, 96% of these same locations exhibited cube factors within $\pm .10$.

The Electrical Research Association in England investigated similar relationships at over 100 stations in Great Britian (G.B.) in the late 1940's^{early} and 1950's and determined that nearly all stations with mean wind speeds between 19 and 27 mph exhibited cube factors within $\pm .04$ of the curves shown in Figure 2.⁹

These data may also be interpreted in terms of wind power potential in kilowatt-hours/ft²/year vs. mean annual wind speeds as shown in Figure 3 which aids in analysing the performance of specific WECS. Or as the Electrical Research Association prefers, as kw-hrs/kilowatt of rated capacity/year which holds if the co-efficient of performance of the system at rated output is the same as the co-efficient of performance of the system over the total operating range of wind speeds in which power is produced (Figure 4).

It is also interesting to note the relationship between increasing annual mean wind speeds and the subsequent increase in wind power potential available to WECS with various cut-in and rated speed limits as shown in the following table:

As mean annual wind speed increases from (mph)	Wind power potential increases proportionally as the exponent (e)				
	US8/18	US8/25	GB10/20	GB14/25	GB17/30
8 to 9	1.94	2.52	2.30	3.76	4.87
9 to 10	1.90	2.44	1.86	4.49	3.43
10 to 11	1.90	2.34	1.95	2.29	3.46
11 to 12	1.66	2.24	1.92	2.39	2.56
12 to 13	1.55	2.10	1.78	2.31	3.28
13 to 14	1.50	1.97	1.69	1.96	2.16

(based on ERA and Sunflower studies)

From this analysis of United States wind speed records, we concluded that a definite relationship does exist between mean annual wind speed records and wind power potential available to WECS with the noted cut-in and rated wind speeds and further that this relationship is useful in evaluating on-site wind power potential based on mean wind speed measurements. However, to further sort out the geographic variables which affect this relationship, we are currently analysing all available wind speed records for Kansas to further define the exact nature of these relationships in our area.

If on-site mean wind speed recordings provide useful indications of wind power potential, the next question encountered is how to project long-term (10-20 year) potential. Discounting long-term, on-site measurements, we attempt to establish if a useful correlation exists between on-site mean wind speeds and simultaneously measured windspeeds at a nearby station with an established record. If such a correlation exists, the record of the nearby station then provides the basis for projecting long-term, on-site potential.

Putnam found in New England that a comparison of 90 days of data from a potential WECS site and simultaneously recorded data from a nearby established station on a simple wind speed ratio basis provided sufficient basis for projecting long-term site wind speeds within an accuracy of roughly $\pm .10$ for stations separated by as much as 50 miles and 200 feet of elevation.¹⁰ Claude Duchon at the University of Oklahoma, in investigations similar to Putnam's over a 50 mile separation distance near Oklahoma City has determined similar correlation exists with a probable error of less than $\pm .10$.¹¹

Note that in attempting to establish the correlation between on-site measurements and simultaneous measurements at nearby established stations that records from many established stations are typically visual observations for one minute each hour. This will pose difficulty to establishing correlations with continuously recording odometer type devices. To bypass this difficulty, we are placing our own wind-run anemometer at nearby stations to provide as reliable a basis as possible for determining these correlations.

The Direction

We are using this framework and these guidelines as our starting point for understanding our regional wind patterns. Once we have built our experience base, we hope to find patterns of terrain, surface roughness, exposure, etc. such that "remote" evaluations begin to more and more provide reasonable projections. This will then have brought us full cycle from the art of the pre-REA dealers through the present scientific understandings to a well-tuned procedure based upon both.

References

- 1) The Wind and Solar Energy, Proceedings of the New Dehli Symposium, UNESCO, 1954, p.91.
- 2) Proceedings of the U.N. Conference on New Sources of Energy, Volume 7, Wind Power, Rome, 21-31 August, 1961, p. 7.
- 3) Blake, Steve, "Information and Interviews Concerning a Survey of Historical and Current Site Selection Techniques for Small Wind Energy Conversion Systems", Dec., 1976, prepared for the U.S. Energy Research and Development Administration, Battelle MWL facility under contract No. E(45-1)-1830 with the American Wind Energy Association.
- 4) Information taken from owners manuals of the Jacobs Wind Electric Co., The Allied Co., the Winpower Corp., and the Wincharger Corp. all manufacturers of small WECS from the early 1930's to the late 1950's in the United States.
- 5) Ibid., Blake.
- 6) Reed's work is No: SAND74-0348 and is available from: National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22151, \$7.60 paper, \$2.25 microfiche.
- 7) Contact: Battelle, Box 999, Richland, WA 99352; RFP B-29105-A-E, "Estimation of Wind Characteristics at Potential Wind Energy Conversion Sites", Feb. 1977.

- 8) Data from: Climatography of the United States Series 82; Decennial Census of the United States Climate -- Summary of Hourly Observations, 1951-1960 (Table B) as listed in the Climatic Atlas of the United States, U.S. Department of Commerce, June, 1968, p. 78.
- 9) Tagg, J.R., "Wind Data Related to the Generation of Electricity by Wind Power", Electrical Research Association Tech. Report C/T115, Cleeve Rd., Leatherhead, Surrey, England, 1957, p. 32.
- 10) Putnam, P.C., Power from the Wind, Van Nostrand, New York, 1948, pp. 74-76.
- 11) Ibid., Blake, pp. 24-25.

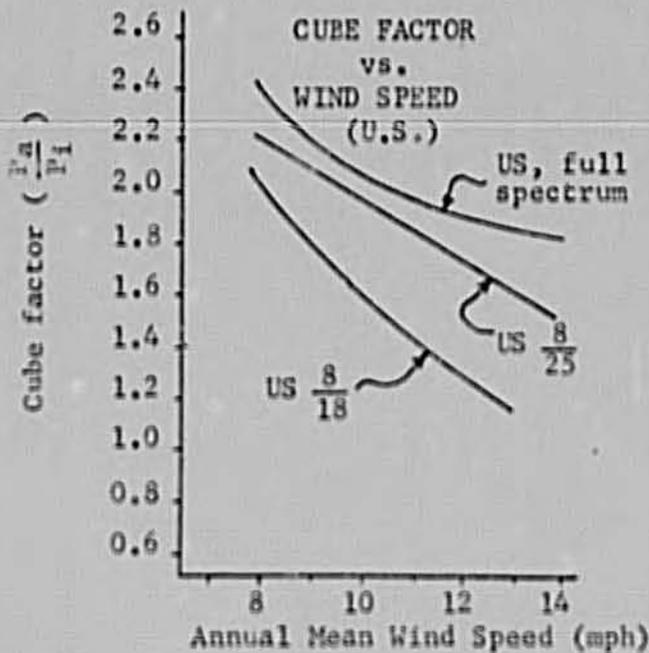


Figure 1

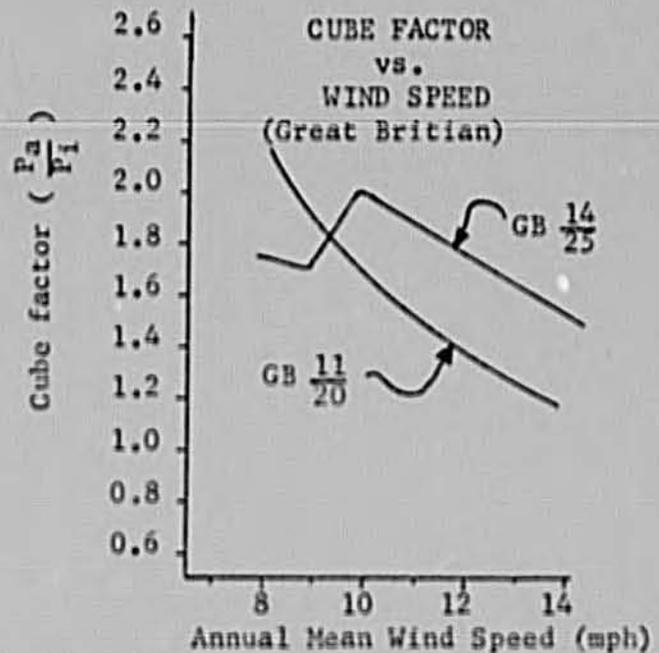


Figure 2

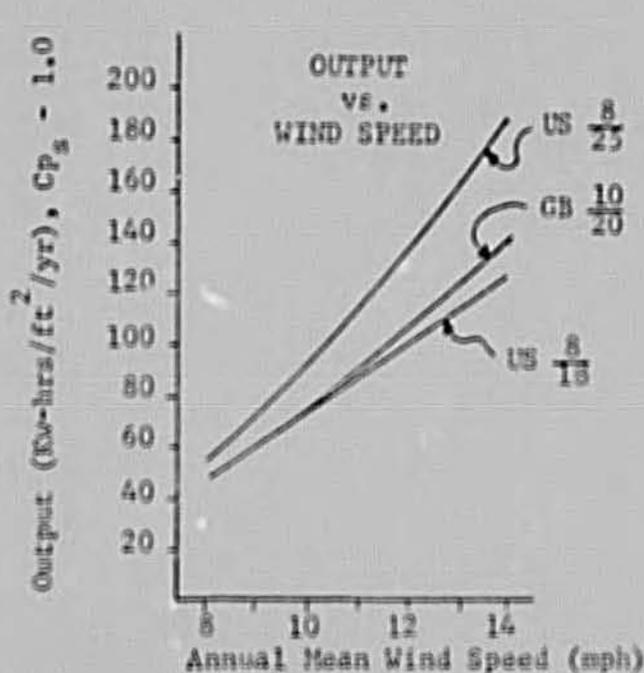


Figure 3

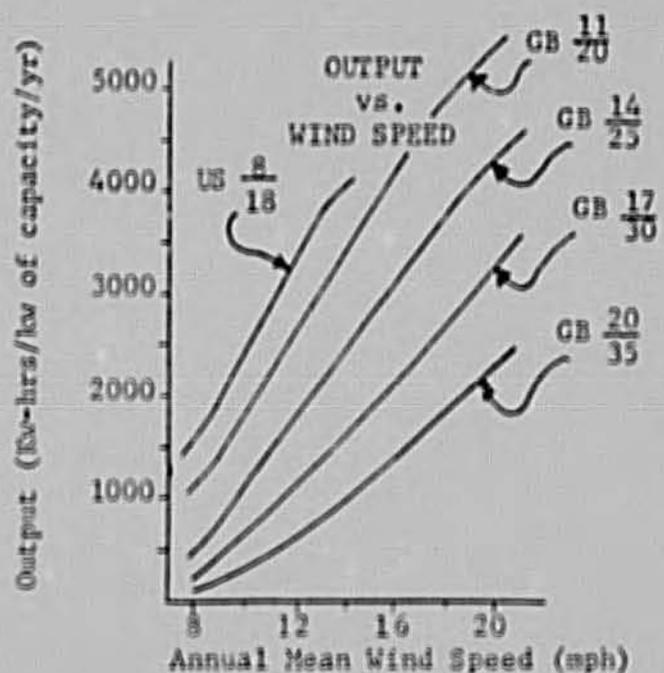


Figure 4

Appropriate Technology

Savonius Rotor Wind Turbines

Copyright by Appropriate Technology Group, 1976.

The Savonius rotor (S-rotor) was invented by Captain Sigurd Savonius, a Finn, in 1921. Since that time, no less than fourteen research groups have investigated and evaluated S-rotors of various sizes and configurations both in free wind and in wind tunnels.

This article distills the experiences and findings reported by these groups and our own experiences and findings. It considers important design parameters, advantages and disadvantages of the design, certain techniques and materials for simple rotor construction, and rotor outputs when coupled with water pumps and electrical generators.

The author, Steve Blake, has had extensive experience with the construction and testing of the Savonius Rotor design. His report here is based on his work with the S-rotor at Brace Research Institute and at the University of Kansas. The following article summarizes over two years work by Mr. Blake and is a review of essentially all that is known about the rotor. Steve is now working with The Appropriate Technology Group, a non-profit organization involved in the transfer of information and the implementation of appropriate technologies. He can be reached by writing to Route 1, Box 93-A, Oskaloosa, Kansas 66066.

Savonius rotor wind turbines have been used to power water pumps, electrical generators, ventilation systems, and sailing boats. (The rotor is also a capable low-head water turbine in flows greater than 5 mph. They have been used in tide/wave powered pumps, are currently used as current flow sensing instruments, and have been proposed for ocean current and river electrical generating stations.)

Advantages of the rotor are that it is omnidirectional and can take advantage of winds from all directions without having to orient. The rotor can simply provide rotating shaft power at ground level. And the rotor design lends itself to simple construction techniques using hand tools and hardware store materials.

The disadvantages of the rotor design are that the solidity ratio of the wings (area of wings/area of wind intercepted) is high at 1.00. Solidity ratios of .05-.15 are common in horizontal axis machines. This translates poorly in terms of material use, weight, and cost. And because the rotor is fully exposed to high winds, the rotor and tower must be capable of withstanding full

high wind forces. Many wind machines have high wind governing mechanisms which allow them to spill high winds.

Rpm limiting spoiler flaps actuated by centrifugal force at a predetermined s-rotor rpm have been used. These limit centrifugal forces on the rotor but do not diminish wind forces on the rotor and tower. Many rotors have destroyed themselves from centrifugal forces and vibration at high wind speeds.

Construction Techniques And Materials

Our involvement with the s-rotor has been concerned primarily with its use as a water pumper which can be built at the village level using locally available skills and materials in newly industrializing areas of the world. And in these applications, sail windmills should also be considered in attempting to determine the best tool for the job.

We use 55 gallon (US) drums for the wings as these are available in many areas. The drums are split in half lengthwise and the exposed edges folded back $\frac{1}{2}$ " for safety and added strength. To brace against centrifugal forces, opposing wing edges are stayed with wire to one another. End discs have been made of milled lumber, plywood, or flattened oil drums. In the simplest of designs, end discs are not used and the rotor works at lower efficiency. 1.25" x 1.5" i.d. galvanized plumbing pipe is used for the center shaft when using one or two drums.

Reducers are fitted to the ends of the center shaft to accept a .75" galvanized pipe. This pipe has an outside diameter of roughly 1 1/16" which fits a Palfur RCJ 1 1/16" flange mounted steel roller bearing. The concentric, self-locking nature of this bearing allows for some free play between the bearing and the pipe.

We are investigating hardwood bearings for situations where the cost and/or availability of steel roller bearings is a problem. A polyethylene washer between the lower bearing halves reduces friction between the surfaces. A gravity fed, drip oiling system further reduces friction here.

The rotor pictured at Kansas University was built using hand tools and does not require welding or machine work. Power tools facilitate construction but are not required. This prototype uses either wood or steel roller bearings for comparisons. The octahedron module tower was built to facilitate truck bed testing. A guyed wood A frame tower of milled lumber or poles works well and is less costly. Materials for this rotor with steel roller bearings cost \$75 (\$140 for the tower), and it takes 10-25 man hours to assemble (25-50 hours for the tower).

Output

We have worked with a diaphragm pump (Brace design) with a two drum rotor which will deliver about 300 US gallons of water per hour in a 12 mph wind at a head of approximately 10 feet. We are currently working with a much simpler centrifugal pump developed by the International Rice Research Institute (IRRI) which has a greater output capacity and can be built entirely from stock 1" or 1.25" i.d. plumbing pipe and connections. These are both suction pumps and are restricted to lifts of roughly 20' or less.

The maximum amount of electrical power available from a two drum rotor in a 12 mph wind is 25 watts or 18 kilowatt-hours over a month's time. This is rotor output only and does not include the losses in the necessary gear step-ups or generator/alternator inefficiencies which together may well decrease this amount of power available by over one-half.

Various rotor shapes have been tested and a semi-circular shape yielded the highest comparative efficiencies (the power produced by the rotor/the power available to the rotor from the wind).

Rotor efficiencies varied between .10 and .37 with .20-.25 being measured most consistently. Efficiency increased at higher wind speeds (higher Reynolds numbers) and increasing the rotor's weight decreased efficiency. The highest efficiency measured with an oil drum design was .15.

Highest efficiencies resulted from a gap ratio (g/d) of approximately 1:10. Rotors may be built without central shafts. However, this weakens the rotor's structure and requires that materials be added elsewhere.

For a given wing diameter, rotor efficiency increased as the g/d ratio got larger (as g got larger) but the power produced by the rotor decreased because the total amount of rotor area exposed to the wind decreased by widening the gap.

The end discs are required to contain the wind stream and to prevent wind from spilling over the rotor ends. An end disc diameter of 1.20-1.30 the diameter of the wing span (D) yielded highest efficiencies.

There were conflicting results regarding the efficiencies of two and three wing rotors. In those cases where the efficiencies of three wing rotors was slightly better, it is doubtful that the extra materials and complicated construction technique are justified.

Rotors with one set of two wings will not start in certain orientations to the wind. This is corrected by symmetrically offsetting an alternate set(s) of wings about the central shaft (see photo).

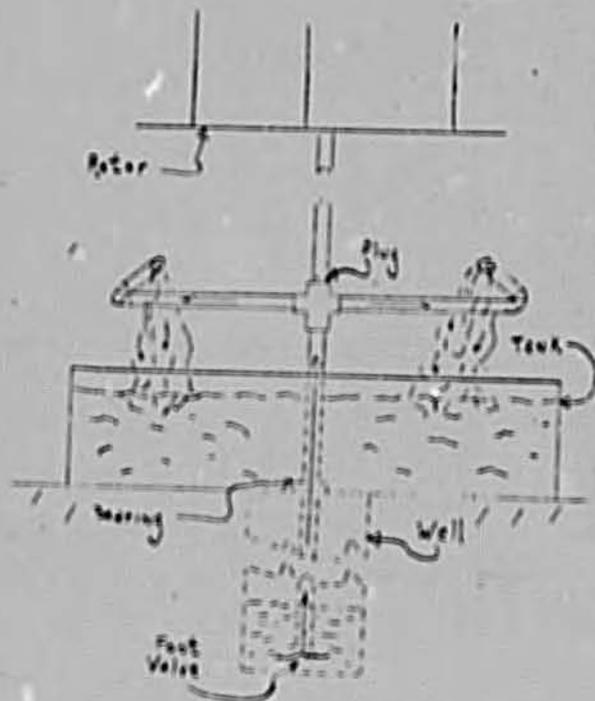
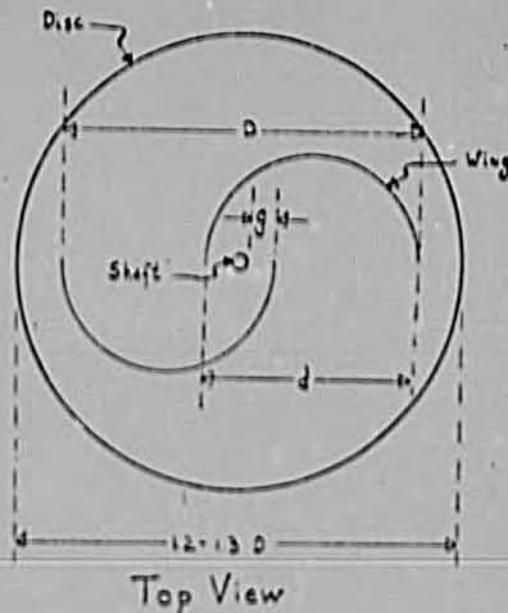
Rotor efficiency was highest at a tip speed ratio of 7-9 (where the outer edge of the wing travels at 7-9 the speed of the wind) and rotor efficiency does not decrease significantly through a tip speed ratio range of .6-1.1. This indicates that the rotor works effectively over a broad range of wind and load conditions. With increasing rotor diameters, output shaft rpm decreased in inverse proportion. Centrifugal forces on a rotor varied inversely with increased rotor diameters (lower shaft rpm's).

Directions And References

Our plans include working in Latin America to help implement the use of wind energy. If you are interested in supporting this effort, contact us. We are preparing a construction booklet on the s-rotor, pumps, and tower to aid in this work.

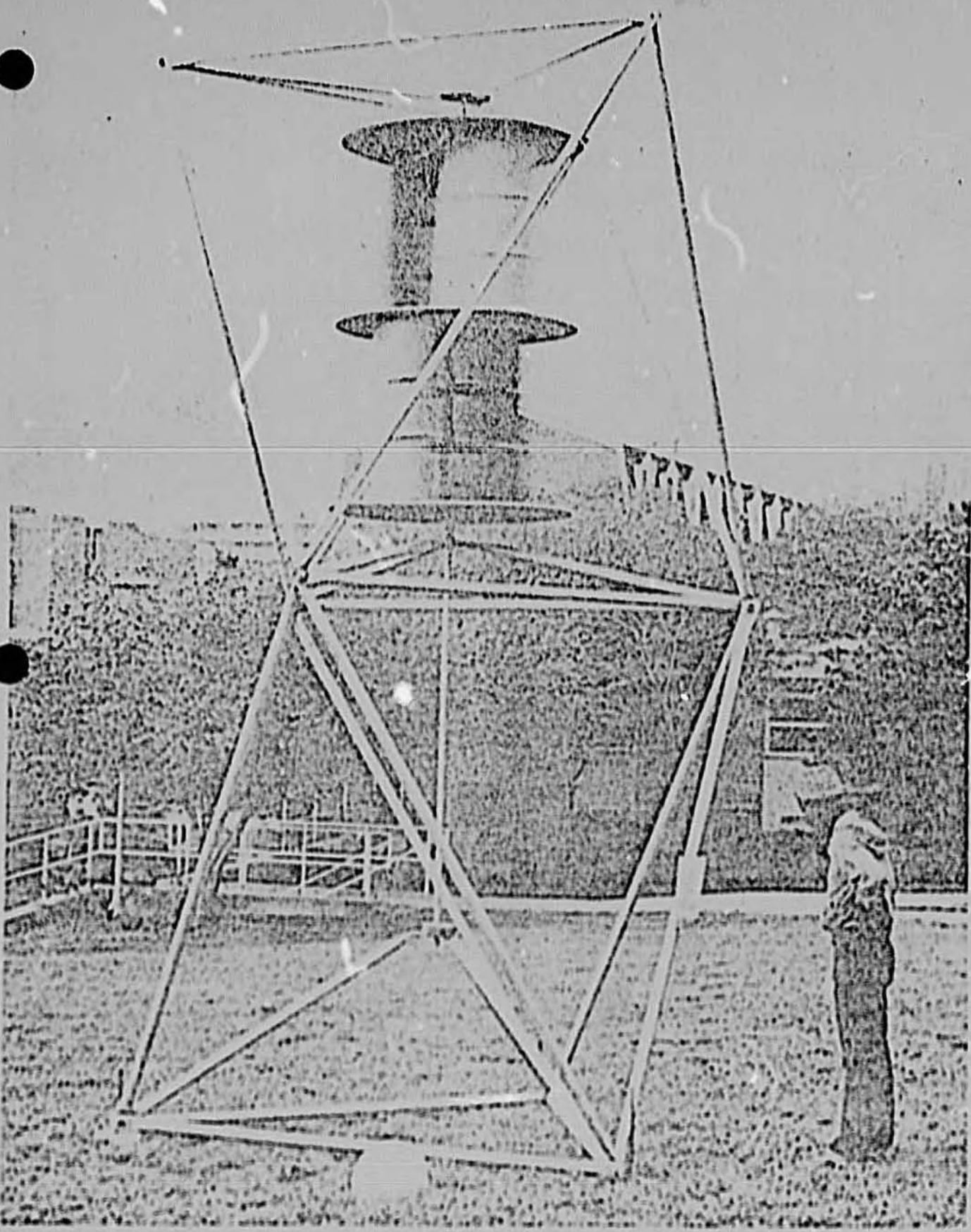
Our work with the rotor is by no means complete and we are currently evaluating it in daily use. It is hoped that by summarizing what we know at this point, we can assist others involved in related work and can become involved in further interchanges of ideas.

We have available a list of s-rotor research reports and of wind and solar "how-to-build-it" booklets which we reprint.



IRRI PUMP

28



Cominus Rotor at the University of Kansas 25th annual Engineering Exposition, Spring 1976 in Lawrence, Kansas. Oil drum design with an octahedron module tower. Shown without water pump. Photo: Steve Blake

THIS IS AN OFF-LINE CITATION LIST GENERATED BY:

CSBIT_IV

S. D. C.'S INTERNATIONAL SEARCH SERVICE

SOLAR COOLING

NUMBER OF CITATIONS PRINTED = 44

FEBRUARY 2, 1979

THIS SEARCH WAS PERFORMED ON NTIS

REQUESTED BY
VICIGONE

PLEASE SEND THIS LISTING TO

MARIA E. VICIGONE
AGENCY FOR INTERNATIONAL DEVELOPMENT 570 FF
WASHINGTON, D.C. 20523

-1-

ACCESSION NUMBER
TITLE
AUTHORS
ORGANIZATIONAL SOURCE
PAGINATION/DATE
ISSUE
NTIS PRICE
NOTES
REPORT NOS.
CONTRACT/GRANT NOS.
CATEGORY CODES
INDEX TERMS
SUPPLEMENTARY TERMS
ABSTRACT

SMO-78-0146C
Status of the DOE Photovoltaic Concentrator
Technology Development Project
Eberburn, S. W.; Schueler, D. G.; Boes, E. C.
Sandia Labs., Albuquerque, N.Mex. Department
of Energy.
1978: 12p
J7925
NTIS Prices: PC A02/MF 201
IEEE photovoltaic specialists conference,
Washington, DC, USA, 5 Jun 1978.
CONF-780919-4
EY-76-C-04-0769
10B, 97H
*Solar cells; *Solar concentrators; Cooling
systems; Design; Encapsulation; fabrication;
Manufacturing; Performance testing;
Photovoltaic cells; Production; Research
programs; Shading; Solar cell arrays; Solar
tracking; Temperature gradients
E004/140501; E004/141000; *Combined
collectors; Solar energy conversion;
Photovoltaic conversion; NTISDE
As the manager of the Department of Energy's
(DOE's) Photovoltaic Concentrator Technology
Development Project, Sandia is developing
low-cost photovoltaic power by taking
advantage of sunlight concentrators that
replace high-cost photovoltaic cells with
lower cost reflective or refractive optical
surfaces. The project includes developing
solar cells designed for high-solar-intensity
applications; finding and developing
promising concentrator concepts; developing
components for use in concentrators such as
reflective and refractive optical devices,
cell encapsulants, cell cooling mechanisms,
and low-cost sun-tracking structures; testing
and evaluating arrays and array components;
studying various aspects of photovoltaic
concentrators such as the effects of
nonuniform illumination, shading, cell
temperature gradients and cell cooling;
developing manufacturing techniques for
large-scale array production; and supporting
the fabrication of full-sized arrays. A
summary of the project's activities is given.
(194 citation 03:047076)

-2-
 ACCESSION NUMBER
 TITLE
 AUTHORS
 ORGANIZATIONAL SOURCE
 PUBLICATION/DATE
 ISSUE
 NTIS PRICES
 NOTES
 REPORT NOS.
 CONTRACT/GRANT NOS.
 CATEGORY CODES
 INDEX TERMS
 SUPPLEMENTARY TERMS
 ABSTRACT

SM29-74-0426C
 Performance of a One Kilowatt Concentrator
 Photovoltaic Array Utilizing Active Cooling
 Burgess, E. L.; Pritchard, D. A.
 Sandia Labs., Albuquerque, N.Mex. Department
 of Energy.
 1978: 3p
 U7826
 NTIS Prices: PC A02/MF A01
 IEEE photovoltaic specialists conference,
 Washington, DC, USA, 5 Jun 1978.
 CONF-780619-5
 EY-76-C-04-0749
 IGB: 974
 *Combined collectors; *Solar cell arrays;
 Cooling systems; Fresnel lens; Natural
 convection; Performance; Power range 100-1000
 w; Silicon solar cells; Solar collectors;
 Solar concentrators; Water
 ERDA/140501; ERDA/141000; Solar energy
 conversion; Photovoltaic cells; Photovoltaic
 conversion. NTISDB
 Operational experience on a 1-kw
 concentrating photovoltaic array
 incorporating silicon solar cells and Fresnel
 lenses is reported. The array was operated in
 two modes of active cooling. The first mode
 provides cell cooling by ramping water
 through tubes attached to the heatsink behind
 the solar cells. The array is also cooled in
 this mode by natural convection from both the
 front and back of the heatsink. The second
 mode of active cooling involves operating the
 array as a combined thermal/electrical
 system. In this combined thermal/electrical
 mode approximately 18% of the incident solar
 energy can be collected for thermal and
 electrical utilization. (ERA citation
 03:049780)

-3-
 ACCESSION NUMBER
 TITLE
 AUTHORS
 ORGANIZATIONAL SOURCE

DOE/JPL/75-7565-4
 Development of a Process for High Capacity
 Arc Heater Production of Silicon for Solar
 Arrays. Low Cost Silicon Solar Array Project.
 Silicon Materials Task. Quarterly Technical
 Report, October--December 1977
 Reed, W. H.
 Westinghouse Electric Corp., Trafford, Pa.
 Power Circuit Breaker Div. Department of
 Energy.

PAGINATION/DATE 1977: 112p
ISSUE J7726
NTIS PRICES NTIS Prices: TC 400/MF 101
CONTRACT/GRANT NOS. A45-7-100-054539
CATEGORY CODES 100: 974
INDEX TERMS *Silicon chlorides; *Silicon solar cells;
Silicon; Chemical reactors; Control systems;
Cooling systems; Economics; Flowsheets;
Gaseous wastes; Production; Purification;
Systems analysis
SUPPLEMENTARY TERMS ERDA/140501; ERDA/060601;
*Reduction (Chemistry); Fabrication;
Photovoltaic cells; Electric arc furnaces;
NTISDE
ABSTRACT A program has been established at
Westinghouse to develop a high temperature
silicon production process using existing
electric arc heater technology. Silicon
tetrachloride and a reductant will be
injected into an arc heated mixture of
hydrogen and argon. Under these high
temperature conditions, a very rapid reaction
is expected to occur and proceed essentially
to completion, yielding silicon and gaseous
sodium chloride. Techniques for high
temperature separation and collection of the
molten silicon will be developed using
standard engineering approaches, and the salt
vapor will later be electrolytically
separated into its elemental constituents for
recycle. While the overall program objective
is to produce 1000 metric tons of high
quality silicon per year on a continuous
basis, Phase I was defined as a comprehensive
feasibility and engineering review of the
reaction process, and a formulation of the
design for a test system to experimentally
verify the high temperature reaction. Phase
II, currently underway, involves a multi-task
approach including (1) a detailed engineering
analysis of the entire process; (2) design,
fabrication, and assembly of the experimental
system; (3) experimental testing of the
reduction reaction to produce silicon; and
(4) complementary research programs to
augment the experimental system design.
Progress in each of these areas is detailed.
(ERDA citation 03:047050)

-4-

ACCESSION NUMBER
TITLE AT150E/D/450
Solar Thermal Power Generation, 1978; Solar Thermal Heating and Cooling, 1978; Solar Thermal Components, 1978

TITLE NOTE
ORGANIZATIONAL SOURCE Quarterly repts
New Mexico Univ., Albuquerque, Technology Application Center.

PAGINATION/DATE
ISSUE 1978, 12 Issues.
07826

NTIS PRICES
AVAILABILITY 4115 Prices: Subscription
Paper copy available on subscription, North American Continent; price \$240.00/year, all others write for quote. Subscription provides quarterly three separate reports: 'Solar Thermal Power Generation', 'Solar Thermal Heating and Cooling', and 'Solar Thermal Components'.

NOTES
CATEGORY CODES See also NTISUB/C/450.
INDEX TERMS 104; 106; 97N; 97i; 97J; 898
*Solar thermal power plants; *Electric power generation; *Solar heating systems; *Solar cooling systems; *Solar power generation; *Bibliographies; Solar collectors; Solar power plants; Electric power plants; Solar space heating; Solar furnaces; Heat pumps; Solar water heating; Photovoltaic conversion; Bioconversion; Biomass; wind power generation; Ocean thermal power plants; Solar air conditioning; Subassemblies; Concentrating collectors

SUPPLEMENTARY TERMS Solar stills; Greenhouses; Heat exchangers; Irrigation; Solar driers; Crop driers. Flat plate collectors; Solar energy concentrators; Abstracts; NTISAC

ABSTRACT This bibliographic series cites and abstracts the literature and technical papers on electrical power generation primarily through solar thermal processes, the heating and cooling of buildings with solar thermal energy, and components applied to solar thermal energy utilization.

-5-

ACCESSION NUMBER
TITLE 109-4577-1
Hybrid Photovoltaic/Thermal Solar Energy System

AUTHORS
ORGANIZATIONAL SOURCE Kern, E. C. Jr; Russell, M. C.
Massachusetts Inst. of Tech., Lexington, Lincoln Lab. Department of Energy.

PAGINATION/DATE
ISSUE 27 Mar 78; 39p
07823

NTIS PRICES
 CONTRACT/GRANT NOS.
 CATEGORY CODES
 INDEX TERMS

NTIS Prices: FC A03/MF A01
 EG-77-5-02-4577
 134; 10a; 97N; 97J; 89B
 *Houses; *Office buildings; *Solar cell
 arrays; *Solar collectors; *Solar cooling
 systems; *Solar heating systems; *Hybrid
 systems; Computer calculations; Cost;
 Economic analysis; Heat pumps; Meteorology;
 Performance; Sensible heat storage; Solar air
 conditioners; Solar-assisted heat pumps;
 Vapor compression refrigeration cycle
 ERDA/140301; ERDA/140501; Photovoltaic
 conversion; NTISDE

SUPPLEMENTARY TERMS

ABSTRACT

Heating and cooling systems that use hybrid
 solar energy collectors (combination
 photovoltaic-thermal) have the potential for
 considerable energy savings, particularly
 when the system includes a heat pump.
 Economic evaluations show that photovoltaic
 systems are potentially most economical, but
 results depend critically on future collector
 costs as well as energy prices. Results are
 based on a specially developed computer
 program that predicted the total auxiliary
 energy required for five different solar
 heating/cooling systems. Performance
 calculations for a modeled residence and
 small office building were made using
 meteorological data from four geographic
 locations. Annual system costs were also
 calculated. (ERA citation 03:042488)

-6-
 ACCESSION NUMBER
 TITLE

FB-202 9-1/45L
 Workshop on Solar Energy for the Villages of
 Tanzania. Held at Dar es Salaam, Tanzania on
 August 11-19, 1977

ORGANIZATIONAL SOURCE

Tanzania National Scientific Research
 Council, Dar es Salaam; National Research
 Council, Washington, D.C. Board on Science
 and Technology for International
 Development; Agency for International
 Development, Washington, D.C. Office of
 Science and Technology.
 1978. 177p

PAGINATION/DATE
 ISSUE
 NTIS PRICES
 NOTES

07821
 NTIS Prices: FC A09/MF A01
 Sponsored in part by National Research
 Council, Washington, D.C. Board on Science
 and Technology for International Development.
 AID/csd-2584
 10A; 97N
 *solar energy; *Tanzania; *Meetings; Solid

CONTRACT/GRANT NOS.
 CATEGORY CODES
 INDEX TERMS

SUPPLEMENTARY TERMS
ABSTRACT

waste disposal; Biogas process; Wind power; Windmills; Photovoltaic power generation; Electric power generation; Water supply; Solar stills; Solar drying; Refrigerating; Solar cooling systems; Utilization; Reviews
 NTIS/ADOST; NTIS/ASNR

The seminar/workshop's purposes were: (1) to review the state-of-the-art of small-scale solar energy devices, including both the technical and economic aspects of their utilization; and (2) to suggest short- and long-range projects using solar devices in the villages, with particular emphasis on recommendations for implementation.

-7-
ACCESSION NUMBER
TITLE

COG-4094-5
 Solar Energy Alternatives for the United States Embassy and for Rural Development Projects within the Republic of Upper Volta
 Kern, E. C., Jr.

AUTHORS
ORGANIZATIONAL SOURCE

Massachusetts Inst. of Tech., Lexington, Lincoln Lab., Department of Energy.

PAGINATION/DATE
ISSUE

7 Mar 78; 45p
 07820

NTIS PRICES
CONTRACT/GRANT NOS.

NTIS Prices: IC A03/MF A01

CATEGORY CODES
INDEX TERMS

EX-76-C-02-4014
 10B; 97N

SUPPLEMENTARY TERMS

*Office buildings; *Photovoltaic power plants; *Solar cooling systems; Upper Volta; Cost; Developing countries; Energy consumption; Energy demand; Feasibility studies; Rural areas; Solar cell arrays
 ERDA/140600; ERDA/140901; ERDA/140300;

ABSTRACT

*Energy policy; Government policies; NTISDE
 This report is organized in three sections: solar cooling options for the new Embassy office building, electrification of Fada N' Gourma using solar photovoltaic versus conventional energy systems and an overview of the potential for village solar photovoltaic energy utilization in Upper Volta. The analysis indicates that the least cost alternative for cooling the new offices is to modify existing plans, which call for standard electric room air conditioning units, and to incorporate energy conservation measures in the building construction and operation. (ERD citation 03:037092)

8-
ACCESSION NUMBER A10/3606-1417.21
TITLE Conceptual Design and Systems Analysis of Photovoltaic Systems, Volume II. Study Results. Final Report
AUTHORS Kirpich, A.
ORGANIZATIONAL SOURCE General Electric Co., Philadelphia, Pa. Space Div. Department of Energy.
PAGINATION/DATE 19 Mar 77; 33pp
ISSUE J7618
NTIS PRICES NTIS Prices: PC A15/WF 101
CONTRACT/GRANT NOS. EY-76-C-14-3625
CATEGORY CODES 100: 974
INDEX TERMS *Photovoltaic power plants; *Solar cell arrays; *Systems analysis; Commercial buildings; Houses; School buildings; Computer calculations; Cooling systems; Cost; Design; Economics; Electric batteries; Electric utilities; Energy storage systems; Inverters; Performance; Power conditioning circuits; Power range 1-10 kw; Power range 10-100 kw; Power range 100-1000 kw; Simulation; Solar concentrators
SUPPLEMENTARY TERMS ERDA/140500; ERDA/140E01; NTISDE
ABSTRACT This investigation of terrestrial PV systems considered the technical and economic feasibility for systems in three size categories: a small system of about 12 kW peak output for on-site residential use; a large 1500 kW central power plant contributing to the bulk energy of a utility system power grid; and an intermediate size system of about 250 kW for use on public or commercial buildings. In each category, conceptual designs were developed, performance was analyzed for a range of climatic regions, economic analyses were performed, and assessments were made of pertinent institutional issues. The report consists of three volumes. Volume I contains a Study Summary of the major study results. This volume contains the detailed results pertaining to on-site residential photovoltaic systems, central power plant photovoltaic systems, and intermediate size systems applied to commercial and public buildings. Volume III contains supporting appendix material. (ERA citation 93:032895)

-9-

ACCESSION NUMBER
TITLE
ORGANIZATIONAL SOURCE
PAGINATION/DATE
ISSUE
NTIS PRICES
CONTRACT/GRANT NOS.
CATEGORY CODES
INDEX TERMS

A10/2748-12(1/51)
Photovoltaic Systems Concept Study. Final Report
Spectrolab, Inc., Sylmar, Calif. Department of Energy.
Apr 77; 212p
J7818
NTIS Prices: PC A10/MF A01
EY 76-C-04-2748
100: 97N
*Electric utilities; *Photovoltaic power plants; *Solar cell arrays; *Solar-assisted heat pumps; *Economic analysis; Computer codes; Cost; Evaporative cooling; Financial incentives; Life-cycle cost; Market; Mathematical models; Nuclear industry; Peak-load pricing; Power demand; Rock beds; Solar air heaters; Solar collectors
ERDA/140600; ERDA/141000; ERDA/140501; NTISDE
The following appendices are included: economic theory, electric utilities, and peak load pricing; evaluating the total cost of an on-site solar energy system; derivation of PEPS cost model; PEPS economic analysis model; scenarios; the effect of governmental "subsidies" on the nuclear power industry; discussion of energy industry subsidies; extension of the Hottel-Whillier-Bliss model to the analysis of combined photovoltaic/thermal flat plate collectors; analysis of solar-augmented rock-bed/heat pump system; IRMSYS results for Washington, D.C. residence with air collectors, rock-bed storage, and parallel Airsearch heat pump; tabulation of electrical loads for Phoenix, Riverside, and Cleveland using a simplified hourly method; evaporative air coolers; cooling efficiency and electrical consumption; and Hoover Dam operation. (ERA citation 03:02893)*

SUPPLEMENTARY TERMS
ABSTRACT

-10-

ACCESSION NUMBER
TITLE
AUTHORS
ORGANIZATIONAL SOURCE
PAGINATION/DATE
ISSUE
NTIS PRICES

FB-231 200/651
Survey of the Emerging Solar Energy Industry - 1977 Edition
Berens, Justin A.
Solar Energy Information Services, San Mateo, Calif.
1977; 417p
07816
NTIS Prices: PC\$60.00/MF\$60.00

NOTES
REPORT NOS.
CATEGORY CODES
INDEX TERMS

Library of Congress Catalog Card no. 77-71604.
SOLIS-77/01

101, 974; 97J; 615

*Solar energy; *Surveys; *Directories. Solar air conditioning; Solar space heating; Solar water heating; Swimming pools; Solar collectors; Concentrating collectors; Flat plate collectors; Wind power; Evacuated tube collectors; Agriculture; Solar thermal power plants; Electric power generation; Photovoltaic conversion; Orbital solar power plants; Ocean thermal energy conversion; Business; Marketing; Economics; Legislation; Public utilities; Reviewing; National Energy Plan; Biological energy conversion; NTISSEIS

SUPPLEMENTARY TERMS

ABSTRACT

The Survey of the Emerging Solar Energy Industry offers the first comprehensive overview of an exciting new industry that will revolutionize the way we live. It reviews the six major subdivisions of solar technology in considerable depth, i.e., heating and cooling; solar thermal electric; photovoltaics; wind energy; ocean thermal; and bioconversion. It traces the catalytic role of the federal government in spurring the development of solar technology and includes a comprehensive analysis of all state government solar-oriented legislation. The impact of solar technology on the utility industry is examined; all major solar projects of the electric utilities are listed and some of the major demonstration projects are discussed in detail. The research activities of universities, nonprofit organizations and government laboratories are identified by technical area. All leading companies (both publicly and privately owned--including a number of the "Fortune 500") which are now active in the field are listed. In the two Directories that have been incorporated as part of the Survey, Consensus market forecasts are presented and commented upon. The long range financial implications of break-throughs in certain technologies are pointed out. (Copyright (c) 1977 Solar Energy Information Services.)

- 11 -

ACCESSION NUMBER
TITLE

SAND-77-7020

Terrestrial Photovoltaic Power systems with
Sunlight Concentration. Annual Progress
Report, January 1, 1976--December 31, 1976
Arizona State Univ., Tempe, Coll. of
Engineering Sciences. *Department of Energy,
1977: 195p

ORGANIZATIONAL SOURCE

PAGINATION/DATE
ISSUE

07816

NTIS PRICES

NTIS Prices: PC A09/MF A01

CONTRACT/GRANT NOS.

EY-76-C-04-0709

CATEGORY CODES

100: 974

INDEX TERMS

*Solar cells; *Solar concentrators;
Concentration ratio; Cooling systems;
Efficiency; Experiment planning; Fins;
Geometry; Performance testing; Research
programs; Shading; Simulation; Surface
treatments; Temperature effects; Thermal
analysis

SUPPLEMENTARY TERMS

EEDA/140501; ERCA/141000; Photovoltaic cells;
Photovoltaic conversion; Solar energy
conversion; NTISDE

ABSTRACT

Research work on the development of solar
cell arrays using solar concentrators is
reviewed. The status of concentrated solar
cell and system testing is reported including
cell characteristics at high intensities,
temperature dependence of cells, front
surface cooling, multiple cell concepts
shading effects, and surface texturing for
increased efficiency. Research on thermal
testing and analysis is described in detail.
(ECA citation 03:027955)

- 12 -

ACCESSION NUMBER
TITLE

SAND-76-7008

Terrestrial Photovoltaic Power systems with
Sunlight Concentration. Semi-Annual Progress
Report, January 1, 1976--June 30, 1976
Arizona State Univ., Tempe, Coll. of
Engineering Sciences. *Department of Energy,
1976: 132p

ORGANIZATIONAL SOURCE

PAGINATION/DATE
ISSUE

07816

NTIS PRICES

NTIS Prices: PC A07/MF A01

CONTRACT/GRANT NOS.

EY-76-C-04-0709

CATEGORY CODES

100: 974

INDEX TERMS

*Solar cells; *Solar concentrators;
Concentration ratio; Cooling; Efficiency;
Fins; Performance testing; Silicon solar
cells; Temperature

SUPPLEMENTARY TERMS

EEDA/140501; ERCA/141000; Photovoltaic cells;
Photovoltaic conversion; Solar energy

ABSTRACT

conversion: 11150E
 Several silicon cells especially designed for concentration by Spectrolab were tested in concentrated sunlight. For constant temperature operation all of these cells showed an increase in efficiency up to about 10 to 15 suns and then a gradual decrease as the intensity continued to increase. Cells with 20 grids/cm and 40 grids/cm were tested in three concentrating test beds: A five foot diameter paraboloid ($1 < CR < 500$); a circular Fresnel lens ($1 < CR < 80$); and the fixed mirror linear trough ($1 < CR < 30$). The temperature characteristics of the concentration cells were experimentally shown to be similar to conventional space type cells with efficiency linearly decreasing with temperature. They did however maintain their superiority at high solar intensities and elevated temperatures. Very little effect was observed in the electrical output of cells when various conductivity water solutions were on top of the cells as would be the condition if front surface cooling of the cells were desired. Since the cell efficiency is critically important in determining the cost of concentration systems, some effort was directed toward increasing the efficiency of cells. Surface texturing was experimentally investigated and it was found that uniform tetrahedral surfaces could be obtained if the surface is sensitized with a carbon compound before etching. Also the potential of increasing efficiencies by putting different material cells in optical series was analytically investigated, and thermal testing of solar cell array cooling with passive finned heat sink arrays is described. (ERA citation 03:027994)

- 13 -

ACCESSION NUMBER
 TITLE

AUTHORS
 ORGANIZATIONAL SOURCE

PAGINATION/DATE
 ISSUE

NTIS PRICES
 CATEGORY CODES
 INDEX TERMS

EPRI-ER-589-5R
 Perspectives on Utility Central Station
 Photovoltaic Applications
 Dulles, E. A.; Bos, P. B.
 Electric Power Research Inst., Palo Alto,
 Calif.
 Jan 78; 54p
 0791E
 NTIS Prices: PC 401/MF 101
 100, 07N
 *Photovoltaic power plants; Comparative

SUPPLEMENTARY TERMS

ABSTRACT

evaluations. Compound parabolic concentrators; Cooling systems; Cost; Design; Economics; Solar concentrators
EAD4/140000. Solar energy conversion. Solar cells; Photovoltaic cells; MISCELL
This report develops nominal cost and performance goals for solar photovoltaic conversion devices intended for large-scale electric utility applications. The objective is to provide an improved basis for establishing research and development priorities for photovoltaic devices and conversion concepts. Comparisons are made among a number of generic power plant conceptual designs, with the aid of an array design parameter that is defined to include array-area-related costs, overall power plant efficiency, and average available insolation. The analysis indicates that flat plate approaches without concentration or tracking have good prospects for commercial viability if device conversion efficiencies near 10 percent can be combined with installed device costs under \$20/m² exp 2 (\$2/ft² exp 2) and device lifetimes in excess of 20 years. Thin-film approaches have potential for achieving these cost and performance goals because of low material content and potentially low fabrication costs. Very high efficiency devices coupled with concentrations in excess of about 100:1 represent a viable alternative if sufficiently high conversion efficiencies (25 percent or more) can be achieved. Such devices are likely to be expensive, but high concentrations may make their costs acceptable. Several device types and converter approaches exist or have been proposed that have potential for reaching these efficiencies. In contrast to flat plate approaches, however, high-concentration approaches may have the disadvantage of requiring active cooling. Approaches involving low-to-medium concentration appear to have limited potential for large-scale applications. Required efficiencies are likely to be comparable to those needed for high-concentration approaches, but the concentration ratios are not likely to be high enough to make the photovoltaic device costs tolerable. (ERA citation 03:026029)

- 11 -

ACCESSION NUMBER ALO/3656-141V.011 App. 1

TITLE Conceptual Design and System Analysis of Photovoltaic Systems. Volume III. Appendices. Final Report. June 1975--March 1977

ORGANIZATIONAL SOURCE General Electric Co., Philadelphia, Pa. Space Div. *Department of Energy.

PAGINATION/DATE 19 Mar 77; 56pp

ISSUE J7616

NTIS PRICES NTIS Prices: PC A24/RF A01

CONTRACT/GRANT NOS. ET-76-C-04-3656

CATEGORY CODES 100; 974

INDEX TERMS *Photovoltaic power plants; *Solar cell arrays; Commercial buildings; Houses; School buildings; Calculation methods; Computer calculations; Cooling load; Cost; Design; Economics; Electric batteries; Electric utilities; Market; Performance; Power conditioning circuits; Power distribution; Power range 1-10 kw; Power range 10-100 kw; Power range 100-1000 kw; Simulation; Solar concentrators; Solar tracking; Systems analysis

SUPPLEMENTARY TERMS ERDA/140500; ERDA/140501; *Solar energy conversion; Photovoltaic conversion; NTISDE

ABSTRACT The investigation of terrestrial PV systems considered the technical and economic feasibility for systems in three size categories: a small system of about 12 kw peak output for on-site residential use; a large 1500 Mw central power plant contributing to the bulk energy of a utility system power grid, and an intermediate size system of about 250 kw for use on public or commercial buildings. In each category, conceptual designs were developed, performance was analyzed for a range of climatic regions, economic analyses were performed, and assessments were made of pertinent institutional issues. The report consists of three volumes. Volume I contains a Study Summary of the major study results. Volume II contains the detailed results pertaining to on-site residential photovoltaic systems, central power plant photovoltaic systems, and intermediate size systems applied to commercial and public buildings. This volume contains supporting appendix material. (ERA citation 03:028007)

- 15 -

ACCESSION NUMBER
TITLE
ORGANIZATIONAL SOURCE
PUBLICATION/DATE
ISSUE
NTIS PRICES
CONTRACT/GRANT NOS.
CATEGORY CODES
INDEX TERMS

TID-22782
Institutional Applications of Solar Total Energy Systems. Second Quarterly Report
Resource Planning Associates, Inc.,
Washington, D.C. Department of Energy.
Oct 77. 95p
07515
4115 Prices: FC A05/MF A01
EG-77-C-04-2706
13A; 105; 10A; 97N; 97J; 97I; 89B
*Photovoltaic power plants; *Solar cooling systems; *Solar heating systems; *Solar thermal power plants; *Solar water heaters; *Total energy systems; Buildings; Cost; Decision making; Demonstration programs; Design; Fossil fuels; Government policies; Heating load; Local government; Market; Mathematical models; Planning; State government; Systems analysis

SUPPLEMENTARY TERMS

ERDA/140704; ERDA/140600; ERDA/140702;
ERDA/290100; ERDA/290600; Cost estimates;
NTISDB

ABSTRACT

The applicability of solar total energy (STE) systems is being analyzed in the industrial, commercial, residential, and institutional building sectors. The "applications analysis" is being conducted in the institutional sector, which has been defined to include eight subsectors: hospitals, primary and secondary schools, colleges and universities, public-administration buildings, military installations, prisons, post offices, and airports. The three major components of the study are (1) a market assessment, (2) the development of conceptual designs, and (3) an examination of federal policies aimed at speeding the commercialization of STE systems. An alternative regional fuel-price scenario is presented that results in higher projected fossil-fuel and electricity prices. The decision process is defined in greater detail, and the results of interviews with key decisionmakers are presented. Finally, the market model developed for use in estimating STE system sales and resultant energy savings is described. The preliminary design was refined and capital-cost and performance estimates for the various institutional subsectors were developed. In addition, a photovoltaic STE system design was developed. Various federal policies that could be implemented to speed the

commercialization of STE systems in the institutional sector were explored. A federal demonstration strategy was studied and a set of visibility criteria to be used in selecting appropriate demonstration sites was presented. (ERA citation 03:023417)

-16-

ACCESSION NUMBER
TITLE

AI-ERDA-13203

Commercial Applications of Solar Total Energy Systems. Third Quarterly Progress Report. November 1, 1976--January 31, 1977

ORGANIZATIONAL SOURCE

Atoms International Div., Caroga Park, Calif. Department of Energy.

PAGINATION/DATE
ISSUESep 77; 156p
07815

NTIS PRICES

NTIS Prices: PC A08/MF A01

CONTRACT/GRANT NOS.

EY-76-C-03-1210

CATEGORY CODES

13A; 106; 97N; 97J; 97I; 89B

INDEX TERMS

*Commercial buildings; *Solar cooling systems; *Solar heating systems; *Solar power plants; *Total energy systems; Algorithms; Brayton cycle; Climates; Computer calculations; Cost; Energy demand; Energy storage; Feasibility studies; Forecasting; Insolation; Market; Mathematical models; Photovoltaic power plants; Rankine cycle; Regional analysis; Simulation; solar energy; Solar thermal power plants

SUPPLEMENTARY TERMS

ERDA/140704; ERDA/140901; ERDA/259001; ERDA/290600; NTISDE

ABSTRACT

The application of solar Total Energy System (STES) to the commercial sector (e.g., office buildings, shopping centers, retail stores, etc.) in the United States is investigated. Candidate solar-thermal and solar-photovoltaic concepts are considered for providing on-site electrical power generation as well as thermal energy for both heating and cooling applications. The solar-thermal concepts include the use of solar concentrators (distributed or central-receiver) for collection of the thermal energy for conversion to electricity by means of a Rankine cycle or Brayton-cycle power-conversion system. Recoverable waste heat from the power-generation process is utilized to help meet the building thermal energy demand. Evaluation methodology is identified to allow ranking and/or selection of the most cost-effective concept for commercial-building applications. (ERA citation 03:023417)

-17-

ACCESSION NUMBER
TITLE

FB-277 018/BSL

The Magnitude of the Federal Solar Energy Program and the Effects of Different Levels of Funding

ORGANIZATIONAL SOURCE

General Accounting Office, Washington, D.C.
Energy and Minerals Div.PAGINATION/DATE
ISSUE

2 Feb 78: 65p

U7810

NTIS PRICES
REPORT NOS.

NTIS Prices: PC A04/MF A01

E0-76-27

CATEGORY CODES

10A; 97N

INDEX TERMS

*Solar energy; *Energy source development; *Financing; Solar power generation; Biomass; Photovoltaic conversion; Solar thermal power plants; Wind power generation; Ocean thermal energy conversion; Cost estimates; Objectives; Government policies; Solar space heating; Solar air conditioning; Solar heating; National government; Reviewing; Research projects

SUPPLEMENTARY TERMS
ABSTRACTBiological energy conversion; NTISGA0
This report discusses the Federal solar energy program, its objectives, and major efforts; projected program costs through 1983; effects of increased/decreased funding on the solar energy program; and, mechanisms available to encourage the use of solar energy.

-18-

ACCESSION NUMBER
TITLE

DOL-tr-43

Ministry of Research and Technology of the Federal Republic of Germany Program of Technologies for Utilization of Solar Energy (1977--1980)

PAGINATION/DATE
ISSUE

1977: 73p

U7814

NTIS PRICES
AVAILABILITY
CATEGORY CODES

NTIS Prices: PC A04/MF A01

Translation: source information not available.

10A; 97N

INDEX TERMS

*German Federal Republic; *Solar energy; Photovoltaic conversion; Planning; Research programs; Solar air conditioning; Solar heat engines; Solar space heating; Solar thermal power plants; Solar water heating; Technology assessment; Technology utilization

SUPPLEMENTARY TERMS

EFD4/140000; Translations; West Germany; NTISDET

ABSTRACT

The solar technology development and utilization program of the Federal Republic of Germany is described. Assessments of the

16

various solar technologies are summarized, and plans for research and development, commercialization, and utilization are outlined. (ERI citation 03:023350)

-19-

ACCESSION NUMBER
TITLE

AN-2949 440/651

A Survey of Considerations for solar Energy
Facility Applications
Final rept.

TITLE NOTE

AUTHOR

ORGANIZATIONAL SOURCE

Jr., Marshall W. Jr

Civil and Environmental Engineering
Development Office Tyndall AFB Fla Detachment
1 (ADIC)

PAGINATION/DATE

Dec 77: 65p

ISSUE

J7609

NTIS PRICES

NTIS Prices: PC A04/MF A01

REPORT NOS.

C: EDO-TR-77-39

CATEGORY CODES

13A: 104: 97H: 97J: 99B

INDEX TERMS

*Solar heating; Air force facilities; Energy
management; Solar energy; Solar collectors;
Technology forecasting; Space heaters;
Retrofitting; Cost estimates; Amortization;
Air force planning; Fossil fuels; Resource
management; Energy consumption; Energy
conversion; Photovoltaic effect; Heat pumps;
Air conditioning equipment; Military
requirements; Remote areas
Environmental impacts; *Solar space heating;
ATISBOOKS

SUPPLEMENTARY TERMS

ABSTRACT

The purpose of this report is to provide Air Force civil engineers some useful information for the planning and programming of solar energy systems to satisfy facility energy requirements. This report has been prepared in response to the belief that considerable interest in solar energy system technology, as well as other alternate energy schemes, is increasing at a rapid pace in the Air Force. A considerable effort is devoted to appraising the current status of fossil fuel energy resources in order to establish the need for expedient work in developing solar energy technology. The current and potential areas of application of solar energy technology are described with special attention devoted to space heating. Additionally, environmental considerations of solar energy technology are described along with the current Air Force solar energy program. This report concludes with some suggestions for establishing a solar energy program on an individual or installation

basis. (Author)

-20-

ACCESSION NUMBER ATISUB/D/145

TITLE Solar Energy Update, 1978

TITLE NOTE Monthly repts.

ORGANIZATIONAL SOURCE Department of Energy, Oak Ridge, Tenn.
Technical Information Center.

PAGINATION/DATE 1978: 12 Issues

ISSUE 07808

NTIS PRICES ATIS Prices: Subscription

AVAILABILITY Paper copy available on subscription, North
American Continent price \$27.50/year; single
copy price PC\$3.25, MF\$3.00; all others write
for quote.

CATEGORY CODES 10A; 97H

INDEX TERMS *Solar energy; *Bibliographies; Solar thermal
power plants; Photovoltaic conversion;
Central receivers; Ocean thermal power
plants; Solar space heating; Solar air
conditioning; Hot water heating; Solar
collectors; Solar energy concentrators; Heat
storage; Tidal power plants; Wave power; Wind
power

SUPPLEMENTARY TERMS Solar water heating; NTISDES

ABSTRACT Solar Energy Update (SEU) provides
abstracting and indexing coverage of current
scientific and technical reports, journal
articles, conference papers and proceedings,
books, patents, theses, and monographs for
all sources on solar energy. The subject
matter covered by SEU includes solar thermal,
photovoltaic, biomass conversion, ocean
thermal, heating and cooling, wind power, and
wave energy.

-21-

ACCESSION NUMBER S2ND-77-G909

TITLE Design and Construction of a One Kilowatt
Concentrator Photovoltaic System

AUTHORS Lanchi, D. L.

ORGANIZATIONAL SOURCE Sandia Labs., Albuquerque, N.Mex.*Energy
Research and Development Administration.

PAGINATION/DATE Aug 77; 16p

ISSUE J7807

NTIS PRICES ATIS Prices: PC 202/MF 731

CONTRACT/GRANT NOS. EY-76-C-04-0729

CATEGORY CODES 100; 97H

INDEX TERMS *Solar cell arrays; *Solar concentrators;
*Fresnel lens; Construction; Cooling; Design;
Modifications; Operation; Silicon solar

SUPPLEMENTARY TERMS
ABSTRACT

cells; solar tracking
ERDA/140501; ERDA/141000; NTISOL
The construction details of a system which uses Fresnel lenses to concentrate sunlight on silicon solar cells are described. The cells are cooled either passively by convection or actively using a pumped fluid coolant. Construction and operation of the array have disclosed several unique problems; future modifications and improved future designs are being considered. (ERA citation 03:02069)

-22-
ACCESSION NUMBER
TITLE
ORGANIZATIONAL SOURCE
PUBLICATION/DATE
ISSUE
NTIS PRICES
CONTRACT/GRANT NOS.
CATEGORY CODES
INDEX TERMS

SAND-76-7006
Investigation of Terrestrial Photovoltaic Power Systems with Sunlight Concentration Spectrolab, Inc., Sylmar, Calif.-Energy Research and Development Administration, Aug 77; 152p
J7707
NTIS Prices: PC A0B/RF A01
EY-76-C-04-07-9-03-5040
16A; 101; 97N
*Solar cells; *Solar concentrators; Alignment; Cooling systems; Cost; Design; Efficiency; Fabrication; Fresnel lens; Parabolic reflectors; Performance testing; Research programs; Simulation; solar tracking
ERDA/140501; ERDA/141000; Reviews; Silicon solar cells; NTISOL

SUPPLEMENTARY TERMS
ABSTRACT

A major Spectrolab task was to recommend a concentrator system that appears best suited for development into a 10 kw prototype. This task resulted in the recommendation of a 2 axis tracking concentrator system using passive cooling. The optics of this system consisted of reflective parabolic troughs, each operating in conjunction with a second stage compound elliptical secondary mirror. A review of the work leading to this recommendation is given. Other program tasks included continuation of experimental work in both the concentrator systems and device area. They included a 2 axis tracking platform equipped with an on-axis fresnel lens system, a non-tracking low concentration system, and a flat array. Solar insolation data, both total and direct along with other important weather data was monitored as necessary during this period. A review of these experiments and their results are given. In the dev design area a low level

but effective effort was directed at upgrading concentrator cell efficiency. The results of this effort substantiated earlier predictions that silicon solar cells could operate efficiently at 100 AMU solar constants and higher. This work is also reviewed. (ERA citation 03:000445)

-23-
ACCESSION NUMBER
TITLE
AUTHORS
ORGANIZATIONAL SOURCE
PAGINATION/DATE
ISSUE
NTIS PRICES
AVAILABILITY
CATEGORY CODES
INDEX TERMS

EP-21501
Canada's Renewable Energy Resources: An Assessment of Potential
Middleton, P.; Argue, R.; Argue, R.; Burrell, T.; Hathaway, G.
Middleton Associates, Toronto (Ontario).
Apr 76; 528p
07801
NTIS Prices: \$F 401
U.S. Sales Only. Microfiche copies only.
10A: 97

*Biomass; *Canada; *Solar energy conversion; *Wave power; *Wind power; *Energy sources; Anaerobic digestion; Economics; Efficiency; Electric generators; Energy conservation; Energy conversion; Energy shortages; Forecasting; Greenhouses; Heat pumps; Implementation; Manures; Methanol; *Near fuels; Photovoltaic conversion; Power generation; Production; Pyrolysis; Residential sector; Service life; Solar air conditioning; Solar space heating; Solid wastes; Technology assessment; Viability; Wind turbines; Wood

SUPPLEMENTARY TERMS

ERDA/291000; ERDA/291400; ERDA/299001;
ERDA/140100; ERDA/090700; NTISERDA

ABSTRACT

Rising costs of conventional, frontier, and nuclear energy production and the prospect of future shortages have prompted a resurgence of interest in alternative, renewable energy technologies. This study constitutes a preliminary step in determining which sources, technologies, and applications may be appropriate in Canada and when and under what conditions they might be technically and economically viable. Principal sources of renewable energy (solar radiation, wind, and biomass), as well as waves, thermal gradients and, sensible heat sources are reviewed to establish, in general terms, their significance in the Canadian context. Next, the technical characteristics, efficiency, costs, impacts, and state of the art of sixteen harnessing or conversion technologies

SOLAR COOLING

are presented as an information base upon which to build an assessment of potential. A method of comparing the life cost of a renewable energy system to that of the likely conventional alternative is proposed and applied in cases where adequate technical and economic data are available. A variety of different economic assumptions are also outlined under which the renewable systems would be cost competitive. This costing methodology is applied in detail to four Case Studies: solar space and water heating--residential; photovoltaics--residential; wind generator--200 kw; and anaerobic digestion of livestock wastes. Finally, the potential for renewable energy approaches in Canada is explored and evaluated from three perspectives: technical viability, economic viability, and implementation. (ERA citation 02:049006)

-24-

ACCESSION NUMBER
 TITLE
 ORGANIZATIONAL SOURCE
 PAGING/DATE
 ISSUE
 NTIS PRICES
 CONTRACT/GRANT NOS.
 CATEGORY CODES
 INDEX TERMS

ERDA-1161V.B)
 Balanced Program Plan, Volume B Analysis for
 Biomedical and Environmental Research
 California Univ., Berkeley, Lawrence Berkeley
 Lab. Energy Research and Development
 Administration.

Oct 76; 77p
 07726

NTIS Prices: FC A05/NF A01
 W 7405-ENG-48
 104; 106; 97R; 68

*Hydroelectric power; *Solar energy; *Tidal
 power; *Wind power; *Environmental impacts;
 Biomass; Ocean thermal energy conversion;
 Photovoltaic conversion; Solar air
 conditioning; Solar space heating; Solar
 thermal power plants; Us eras
 ERDA/140400; ERDA/160500; ERDA/170500;
 ERDA/130600; NTISERDA

SUPPLEMENTARY TERMS

ABSTRACT

The Balanced Program Planning (BPP) effort
 was initiated by the Division of Biomedical
 and Environmental Research (DBER) of ERDA to
 identify and develop a research plan for
 investigating the environmental impacts
 associated with energy technologies being
 developed by ERDA. "Environmental impacts"
 is taken here to refer to pollutants, health
 effects, ecological effects, socioeconomic
 and long-term impacts. As defined for the BPP
 effort, solar energy includes tidal and

21

hydroelectric as well as the more usual categories of solar thermal conversion, photovoltaic conversion, wind energy conversion, ocean thermal conversion, bioconversion, and heating and cooling of buildings. The tides are, of course, more properly considered lunar. Narrative descriptions of the solar energy conversion categories are given. Included are discussions of the technological approaches, planned timescales for development, and potential environmental concerns. The Program Units that are proposed as the basis of the DGER Balanced Program Plan are given. In the interests of brevity and credibility only program units for those environmental effects that are related to technologies under active development, and that are judged to be appropriate for DGER supported research are included. Program Units for research on what are generally considered to be the positive environmental impacts of solar energy, the avoidance of the well-known deleterious impacts of existing non-solar sources of energy, are not included. Research on such positive (i.e., avoidance of negative) impacts of solar energy is not included because the assessment of the negative impacts to be avoided by the use of solar technologies must be researched individually for each of the non-solar energy technologies. Instead, the assessment of the impacts of the solar energy alternative are given so that the benefits of energy scenarios including solar technologies can be correctly assessed in cross-technology studies. (ERA citation 02:047934)

-23-
ACCESSION NUMBER
TITLE
AUTHORS
ORGANIZATIONAL SOURCE
PUBLICATION/DATE
ISSUE
NTIS PRICE
NOTES

CONF-770433-8
Evaluation of a Photovoltaic Central Power Station
McCutchen, D. A.; Pittman, P. F.; Ferber, R. E.; Ruschak, G. C. Jr.; Chowaniec, C. R.
Westinghouse Electric Corp., East Pittsburgh, Pa.
Energy Research and Development Administration.
1977: 16p
07726
NTIS Prices: PC A02/MF A01
29. annual meeting of the American Power Conference, Chicago, Illinois, United States of America (USA), 18 Apr 1977.

CONTRACT/GRANT NOS.
CATEGORY CODES
INDEX TERMS

E1 76-C-04-2744

I&S: 57A

*Photovoltaic cells; *Cadmium sulfide solar cells; Cooling systems; Cost; Cost benefit analysis; Design; Economics; Evaluation; Inverters; Mirrors; Parabolic collectors; Power range 10-1000 mw; Reliability; Silicon solar cells; Solar concentrators; Solar reflectors; Solar tracking; Transformers ERDA/1406600, solar energy conversion; Photovoltaic conversion; N151874

SUPPLEMENTARY TERMS

ABSTRACT

The solar plant consists of an "array subsystem," which includes the cells and their supporting surface, a supporting structure and tracking equipment, and a "power conversion subsystem," principally composed of solid state inverters and transformers. Many design variations were examined for each of these components. Since solar cells are expensive, the array design effort explored the use of lenses and mirrors to concentrate the solar radiation on the cells, when either a flat, unconcentrated cell array or a concentrator device is not aimed directly at the sun, its output decreases; therefore, low-cost solar tracking arrays were designed to increase the daily energy yield. Because the conversion efficiency of photovoltaic cells decreases with temperature, forced air and water cooling were considered in addition to natural convection cooling. The annual energy output was calculated for each plant concept in Phoenix, using the solar cell technology expected to be available in about 1990: for the silicon single crystal cell used in the space program, a 10% conversion efficiency and the 1985 ERDA cost goal of 500\$/kwp (peak) for this cell (1975) was postulated. At the peak solar radiation in Phoenix, about $1.1 \text{ kW/m}^2 \times 2$, this implies a cell cost of $800/\text{m}^2 \times 2$. Photovoltaic power plants were also designed for an advanced concept cell, a thin polycrystalline film of Cu sub 2 5-CdS with a projected efficiency of only 10%, but the potential for markedly reduced material and manufacturing costs 100\$/kwp or $111/\text{m}^2 \times 2$ was assumed as a representative cost for this cell in the late 1990's consistent with the ERDA goal of 100\$/kwp cells by 2000 A.D. (ERA citation 02:045262)

-26-

ACCESSION NUMBER
TITLE
AUTHORS
ORGANIZATIONAL SOURCE
PAGINATION/DATE
ISSUE
NTIS PRICES
CONTRACT/AGENCY NOS.
CATEGORY CODES
INDEX TERMS
SUPPLEMENTARY TERMS
ABSTRACT

LN-5307
Ecological Considerations of the Solar
Alternative
Bavilsson, M.; Gnetter, D.; Wilson, K.
California Univ., Berkeley. Lawrence Berkeley
Lab. Energy Research and Development
Administration.
Feb 77: 48p
J7723
NTIS Prices: PC 243/MF A01
W-74CS 246-48
100: 974: 978, 68
*Solar energy conversion; *Wind power;
*Environmental impacts; Agriculture; Biomass;
Ecosystems; Environmental effects; Ocean
thermal power plants; Process heat; Solar air
conditioners; Solar cells; Solar heating
systems
ERC4/140400; ERCA/170500; Biological energy
conversion; Photovoltaic cells; Solar cells;
NTIS/ERDA
The main solar technologies are considered
including solar thermal power, photovoltaic
cells, ocean thermal power, wind energy,
solar heating and cooling, bioconversion, and
agricultural and process heat. The direct and
indirect ecological and environmental impacts
of these technologies are discussed. (ERA
citation C2.040426)

-27-

ACCESSION NUMBER
TITLE
ORGANIZATIONAL SOURCE
PAGINATION/DATE
ISSUE
NTIS PRICES
CATEGORY CODES
INDEX TERMS

ERDA-77-47/5
Solar Program Assessment: Environmental
Factors
Energy Research and Development
Administration Washington, D.C. Div. of
Solar Energy.
Mar 77: 73p
J7723
NTIS Prices: PC 204/MF A01
100: 684: 974
-Environmental impact statements; *Solar
energy; *Total energy systems; Air quality;
Central receivers; Construction; Cooling
towers; Dusts; Environmental impacts; Heat
storage; Land use; legal aspects; Noise
pollution; Photovoltaic power plants; Safety;
Social impact; Solar space heating; Solar
thermal power plants; Solar water heaters;
Tower focus power plants; Waste heat; Water
pollution; Water quality; Working fluids

SUPPLEMENTARY TERMS

ERDA/149400; ERDA/295001; ERDA/299100.
 NTIS5804

ABSTRACT

This report presents and prioritizes the major environmental, safety, and social/institutional issues associated with the further development of Solar Total Energy Systems (STES). Solar total energy systems represent a specific application to the Federally-funded solar technologies. To provide a background for this analysis, the basic concepts of STES are reviewed, as are their resource requirements. The potential effects of these systems on the full range of environmental concerns (e.g., air and water quality, biosystems, safety, social/institutional structures, etc.) are then discussed in terms of both their relative significance and possible solutions. Although the development of STES will contribute to environmental problems common to any construction project or energy-producing technology (i.e., air pollutants resulting from cooling tower "drift"), only those impacts unique to the solar portion of the technology are discussed in depth. Finally, an environmental work plan is presented, listing R and D proposals and a NEPA work plan that might help clarify and/or alleviate specific environmental problems. (EPA citation 02:041180)

-28-

ACCESSION NUMBER
TITLE

477-20514/95L
 Analysis of GaAs and Si Solar Energy Hybrid
 Systems

TITLE NOTE

Final Report

AUTHORS

Heinbuckel, J. H.; Roberts, A. S., Jr.
 Old Dominion Univ. Research Foundation,
 Norfolk, Va.

ORGANIZATIONAL SOURCE

Car 77: 129p

PAGINATION/DATE

3151*

ISSUE

NTIS PRICES

NTIS Prices: PC 107/MF A01

REPORT NOS

4154 CR-2800

CONTRACT/GRANT NOS.

4451-11707

CATEGORY CODES

100: 974

INDEX TERMS

*Gallium arsenides; *Hybrid circuits;
 *Silicon; *Solar energy conversion; Air
 conditioning; Cost effectiveness; Electric
 power supply; Energy policy; Heating; Solar
 energy

SUPPLEMENTARY TERMS

Silicon solar cells; Solar space heating;
 Photovoltaic cell; TISNUSA
 Various silicon hybrid systems are modeled

ABSTRACT

and compared with a gallium arsenide hybrid system. The hybrid systems modeled produce electric power and also thermal power which can be used for heating or air conditioning. Various performance indices are defined and used to compare the system performance: capital cost per electric power out; capital cost per total power out; capital cost per electric power plus mechanical power; annual cost per annual electric energy; and annual cost per annual electric energy plus annual mechanical work. These performance indices indicate that concentrator hybrid systems can be cost effective when compared with present day energy costs.

29-
ACCESSION NUMBER 4115UB/C/1-5
TITLE Solar Energy Update, January 1977. Abstracts 1-228
TITLE NOTE Monthly Repts.
ORGANIZATIONAL SOURCE Energy Research and Development Administration, Oak Ridge, Tenn. Technical Information Center.
PAGINATION/DATE Jan 77; 12 issues
ISSUE 07713
NTIS PRICES NTIS Prices: Subscription
AVAILABILITY Paper copy available on subscription. North American Continent price \$27.50/year; single copy price PC13.25/AF13.00; all others write for quote.
REPORT NOS. SEU-77/1
CATEGORY CODES IDA; 97C; 97I; 97J
INDEX TERMS *solar energy; *Bibliographies; Solar energy conversion; Photovoltaic conversion; Thermionic conversion; Photosynthesis; Biological energy conversion; Photovoltaic power plants; Solar energy concentrators; Solar collectors; Solar thermal power plants; Solar sea power plants; Solar space heating; Solar air conditioning; Solar furnaces; Solar stills; Solar water heaters; Tidal power; Wind power; Abstracts
SUPPLEMENTARY TERMS 4115UB/C/1-5
ABSTRACT Solar Energy Update (SEU) provides abstracting and indexing coverage of current scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs for all sources on solar energy. The subject matter covered by SEU includes solar thermal, photovoltaic, biomass conversion, ocean thermal, heating and cooling, wind power, and

ware energy.

-30-

ACCESSION NUMBER
TITLE

FB 260 594/751
Proceedings of First Semiannual EPRI Solar
Program Review Meeting and Workshop Held in
San Diego, California, on March 8-12, 1976.
Volume 1: Solar Heating and Cooling of
Buildings

TITLE NOTE
AUTHOR'S
ORGANIZATIONAL SOURCE

Special rept.
Soc. P
Atlas Corp., Santa Clara, Calif. Electric
Power Research Inst., Palo Alto, Calif.
12 Mar 76: 124p

PAGINATION/DATE
ISSUE
NTIS PRICES
NOTES

07705
NTIS Prices: PC 406/RF 401
See also Volume 2, FB-260 595.
EPRI/ER-283-SR-201-1; EPRI/ER-283-SR
131; 104; 974; 893; 973

CATEGORY CODES
INDEX TERMS

*Solar space heating; *Solar air
conditioning; *Meetings; Research projects;
Insulation; Heat pumps; Cost estimates;
Photovoltaic conversion
4115EPRI

SUPPLEMENTARY TERMS
ABSTRACT

Content: A brief description of the ERDA
solar Program covering current and projected
activities in the thermal applications and
electric applications; Solar heating and
cooling of buildings - requirements
definition and impact analysis; Individual
load center-solar heating and cooling
residential project; An investigation of
methods to improve heat pump performance and
reliability in a northern climate; Solar
materials and components test program; Solar
data verification project.

-31-

ACCESSION NUMBER
TITLE

000-2590-2
Terrestrial Photovoltaic Power Systems with
Sunlight Concentration. Annual Progress
Report, January 1, 1975--December 31, 1975
Baker, C. E.

AUTHOR'S
ORGANIZATIONAL SOURCE

Arizona State Univ., Tempe, Coll. of
Engineering and Applied Sciences, Spectrolab,
Inc., Sylmar, Calif. Energy Research and
Development Administration.

PAGINATION/DATE
ISSUE
NTIS PRICES
CONTRACT/GRANT NOS.

31 Jan 76: 297p
07622
NTIS Prices: PC\$9 MF\$3.00
E(11-1) 2590

CATEGORY CODES
INDEX TERMSSUPPLEMENTARY TERMS
ABSTRACT

10B: 970
 *Solar cell arrays; *Solar cells; Cooling;
 Efficiency; Fabrication; Radiant flux
 density; Solar concentrators
 ERDA/140501; ERDA/500600; NTISERDA
 This annual report is for the second year of
 a program to investigate the characteristics
 of the components and the total system using
 sunlight concentrated onto solar cells. The
 second year was primarily to experimentally
 investigate the conclusions of the first year
 of analytical studies. Cells have been
 fabricated that are designed for different
 intensities. Typically the efficiency of a
 cell will increase from its 11 percent at AM1
 peak to efficiency at the designed
 concentration level and return to its initial
 efficiency at about 3 times its designed
 concentration level. The developed cells have
 been tested under high intensity simulators
 and in concentrated sunlight and have shown
 to have the predicted response. The
 experimental testing of passive cooling
 limitations for cooling cells with just
 finned arrangements in the back of the cell
 has been completed in the controlled
 environment of a wind tunnel. These
 experiments have confirmed the heat transfer
 coefficients that had been used in the
 analytical studies. Testing was done to
 collect heat transfer coefficients for actual
 wind conditions and these data show good
 agreement with the controlled wind tunnel
 data. Four photovoltaic/concentrator system
 experiments have been started with CR of
 about 3, 10, 25, and 100. System analysis has
 indicated that photovoltaic concentration
 systems may be attractive in low solar
 irradiation areas such as Cleveland. (ERA
 citation 01.015869)

-32-

ACCESSION NUMBER
 TITLE
 AUTHOR(S)
 ORGANIZATIONAL SOURCE
 PAGINATION/DATE
 ISSUE
 NTIS PRICE(S)
 CATEGORY CODES
 INDEX TERMS

NSF-74-22
 Energy Research and Technology. Interim
 Bibliography of Reports, with Abstracts
 Guthrie, M. P.
 Oak Ridge National Lab., Tenn. *National
 Science Foundation, Washington, D.C.
 Jun 74; 71p
 NTIS
 NTIS Prices: FCS4.50/MFS2.25
 10A: 97
 (*Energy sources; *Bibliographies); (*Solar

SOLAR COOLING

energy; (*Research programs); (*Energy conversion; Research programs); (*Energy storage; Research programs); Buildings; Energy; Geothermal energy; Heating; Indexes; Information; Information retrieval; Oceans; Photosynthesis; Photovoltaic conversion; Solar air conditioning; Thermal gradients; Transport; Wind energy

SUPPLEMENTARY TERMS ERDA/293000; ERDA/990300; ERDA/295000; ERDA/300000; ERDA/250000; NTISERDA

ABSTRACT The bibliography contains 218 listings of documents on solar energy heating and cooling of buildings; solar thermal conversion; wind energy conversion; solar energy bioconversion to fuels; ocean thermal energy conversion; photovoltaic energy conversion; geothermal energy; energy conversion and storage; energy systems; energy resources; and energy and fuel transportation. The report title, the name and address of the reporting organization, a brief description including the originating organization's number and the number of pages, the name of the author or authors, the report date, the NSF grant or contract number, an abstract, descriptors useful in indexing and retrieval from computer data banks, and information on the availability of the report are included.

ACCESSION NUMBER PB-248 507/CSI

TITLE Project Independence Blueprint, Task Force Report, Solar Energy

TITLE NOTE Final rept

ORGANIZATIONAL SOURCE Federal Energy Administration, Washington, D.C. Project Independence.

PAGINATION/DATE Nov 74; 565p

ISSUE U7607

NTIS PRICES NTIS Prices: 1CS13.50/MFS2.25

NOTES See also PB-248 508.

REPORT NOS. FEA/N-75/5-18

CATEGORY CODES 10A; 57G

INDEX TERMS *Solar energy conversion; Solar space heating; Solar air conditioning; Solar power generation; Wind power generation; Solar sea power plants; Photovoltaic conversion; Economic analysis; Manpower; Requirements; Reviewing; Feasibility; Forecasting; Scenarios; Energy conservation; Buildings

SUPPLEMENTARY TERMS *Project Independence; Biological energy conversion; NTISXFEA; NTISNSFG

ABSTRACT This report emphasizes the widespread, domestic, long-term, reliable availability of

solar energy resources, and the general environmental acceptability of solar energy power systems. Finally, the report outlines the types of solar energy research, technology development, and system implementation needed to help meet the objectives of Project Independence. This report by the Solar Energy Task Force Report for the Project Independence Blueprint Study concludes that economically viable solar energy conversion systems can be developed and installed in substantial numbers well before the year 2000 to provide significant quantities of energy and power for the U.S. The study describes six technically feasible solar energy technologies for heating and cooling buildings, providing high temperature heat, and producing electric power or clean fuels. The report presents projections of potential upper-bound annual energy contributions of each of the six solar energy technologies at 5-year intervals up to the year 2000 and provides estimates of the equivalent number of barrels of oil that would not be imported if these solar energy techniques were implemented in substitution of derived energy. Portions of this document are not fully legible.

-34-
ACCESSION NUMBER
TITLE
AUTHORS
ORGANIZATIONAL SOURCE

PAGINATION/DATE
ISSUE
NTIS PRICES
CATEGORY CODES
INDEX TERMS

SUPPLEMENTARY TERMS

ABSTRACT

BNWL-5A-5361
Solar Energy Technology
Drumheller, K.
Battelle Pacific Northwest Labs., Richland,
Wash.
22 Mar 75; 34p
N7504
NTIS Prices: FC\$4.00/MF\$2.25
10A: 97C: 97D
-Photovoltaic conversion; Wind power; Solar
air conditioning; Solar cell arrays; Solar
sea power plants; Solar space heating; Solar
thermal power plants
ERDA/140901; ERDA/140501; ERDA/140700;
ERDA/140800; ERDA/170000; NTISERDA
For abstract, see ERA 75 04, number 00513.

-35-

ACCESSION NUMBER
TITLEAUTHORS
ORGANIZATIONAL SOURCEPAGINATION/DATE
ISSUENTIS PRICES
REPORT NOS.
CATEGORY CODES
INDEX TERMSSUPPLEMENTARY TERMS
ABSTRACT

FB-241 620/45L

Solar Energy Projects of the Federal
Government

Magnas, Howard L.

Federal Energy Administration, Washington,
D.C. Office of Energy Data Policy.

Jan 75; 151p

J7515

NTIS Prices: PC\$6.25/MF\$2.25

FEA/C-75/247

10A; 10B; 97G

*Solar energy; *Federal government; Projects;
Allocations; Budgeting; Appropriations;
Federal budgets; Solar heating; Solar air
conditioning; Wind power; Solar power
generation; Solar sea power plants;
Photovoltaic cells; Plants(Botany);
Buildings; Trees
NTISEXFEAThis report identifies 171 Solar Energy
projects administered by 14 different Federal
agencies between July 1973 and January 1975.
Solar categories included are: Heating and
cooling of buildings; wind energy conversion;
solar thermal conversion; ocean thermal
conversion; photovoltaic electric power
systems; and bioconversion to fuels. An
introductory chapter provides an overview and
analysis of the Federal effort in Solar
Energy and categorizes projects by agency,
the amount of funding, and the major program
areas. Appendices provide brief summaries of
each of the 171 projects.

-36-

ACCESSION NUMBER
TITLETITLE NOTE
AUTHORS
ORGANIZATIONAL SOURCEPAGINATION/DATE
ISSUE
NTIS PRICES
NOTES

REPORT NOS.

FB 208 506/05L

Terrestrial Photovoltaic Power Systems with
Sunlight Concentration

Quarterly rept. 1 Jul-30 Sep 74

Bachus, G. E.

Arizona State Univ., Tempe, Engineering
Research Center; National Science Foundation,
Washington, D.C. Research Applied to National
Needs; Textron, Inc., Sylmar, Calif.

Oct 74; 52p

J7508

NTIS Prices: PC\$1.25/MF\$2.25

Prepared in cooperation with Textron, Inc.,
Sylmar, Calif.

NSF/RA/N-74-129

ERC-R-74017, NSF/RANN/5E/GI-41894/PR/74/3

CONTRACT/GRANT NOS.
CATEGORY CODES
INDEX TERMS

NSF-GI-41894
105: 97D

*Solar energy concentrators; *Photovoltaic cells; Performance evaluation; Heat transfer; Heat flux; Fabrication; Optical coatings; Infrared filters; Cooling; Systems analysis; Cost estimates; Design; Tests
Solar cell arrays; NTISNSFRA

SUPPLEMENTARY TERMS
ABSTRACT

A program was initiated to investigate the basic parametric relationships inherent in a solar system that concentrates sunlight onto solar cells. These relationships can then be used to determine the optimum combination of components that minimize the cost per watt of these systems. Work has progressed in each of the six study tasks: solar cell design, solar concentrator, heat rejection, solar tracker, systems analysis. Specific progress includes: analytic model to characterize cell performance, construction of high irradiance cells, assembly of equipment for high irradiance testing, experiments for empirical evaluation of cell mounting interface, completion of heat rejection model for passive and active cooling of solar cell array, development of insolation and ambient weather model, heat transfer analysis for nonuniform illumination on solar cell array, compilation of heat transfer coefficients for various finned surfaces with passive cooling, and methodology for systems simulation model including cost analysis.

-37-
ACCESSION NUMBER
TITLE

N74-31529/25L
Recommendations to RANN/NSF Solar Energy R

AUTHORS
ORGANIZATIONAL SOURCE
PAGINATION/DATE
ISSUE

and T Program
Greeley, Richard S
Mitre Corp., McLean, Va.
Feb 74; 84p
J7508

NTIS PRICES
REPORT NOS.
CATEGORY CODES
INDEX TERMS

NTIS Prices: PC\$4.75/MF\$2.25
N74-21
10A: 97C: 97G

*Solar energy; Solar heating; Solar air conditioning; Solar furnaces; Solar thermal power plants; Solar sea power plants; Photovoltaic cells; Wind power generation; Anaerobic processes; Fermentation; Solar generators; Systems analysis; Project planning; Evaluation; Budgeting; Cost estimates

SUPPLEMENTARY TERMS

Solar space heating; NTISNASA

ABSTRACT

A systems analysis of solar energy programs was conducted and a summary of the results is provided. Various solar energy applications and techniques are expected to become economically competitive with conventionally fueled systems between 1985 and 2000 and, given strong Federal support, could provide significant quantities of energy to the U.S. early in the 21st Century. In order to achieve this result, a set of multi-disciplinary research tasks and proof-of-concept experiments are required to overcome a variety of technical, economic, environmental, social and institutional problems which currently exist. The problems associated with each of seven solar energy applications and techniques are identified and details of proof-of-concept experiments in each area are outlined. Recommended methods for the dissemination and utilization of research results are listed.

33

-38-
ACCESSION NUMBER
TITLE

PB-238 791/851

A Review of the Project Independence Report Submitted to Office of Energy Research and Development, National Science Foundation, January 10, 1975
Final rept.

TITLE NOTE
AUTHORS
ORGANIZATIONAL SOURCE

Globe, Samuel, Craig, Richard A.
Battelle Columbus Labs., Ohio, National Science Foundation, Washington, D.C., Office of Energy Research and Development Policy,
10 Jan 75; 185p

PAGINATION/DATE
ISSUE
NTIS PRICES
CONTRACT/GRANT NOS.
CATEGORY CODES
INDEX TERMS

J7507
NTIS Prices: PCS7.00, MF\$2.25
NSF-C-914
10A: 05D; 97G

*Energy policy; Government policies; Crude oil; Natural gas; Coal; Nuclear energy; Electricity; Shale oil; Manufactured gas; Solar heating; Solar air conditioning; Photovoltaic cells; Geothermal prospecting; Transportation; Residential buildings; Electric utilities; Commercial buildings; Steel plants; Refineries; Plastics industry; Food industry; Paper industry; Aluminum industry; Energy conservation; Energy management; Environmental impacts; Social effect; Cost analysis; International relations; Reviews

SUPPLEMENTARY TERMS
ABSTRACT

*Project Independence; NTISNSFPDA
This report reviews and evaluates the Project

Independence Report (PIR) issued in November 1974 by the Federal Energy Administration. The review includes comments on the PIR as a whole, and also provides detailed critiques of the various topics, strategies, and scenarios as they are discussed by the PIR, including energy and fuel supplies, conservation and demand management, environmental assessment, economic and social impacts, international assessment, and the analytical approach. Special attention is given to the policy implications of the PIR strategies.

-39-

ACCESSION NUMBER
TITLE

FB-238 161/45L

Solar Energy Research Information Meeting of NSF-RANN Grantees held at National Center for Energy Management and Power, Philadelphia, Pa. on 15-16 Mar 73

ORGANIZATIONAL SOURCE

National Center for Energy Management and Power, Philadelphia, Pa. National Science Foundation, Washington, D.C. Research Applied to National Needs.

PAGINATION/DATE
ISSUE

1973; 194p

NTIS PRICES

J7507

NTIS Prices: PC\$7.00/MF\$2.25

NSF/RA/N-73-075; NSF-GI-37124

CATEGORY CODES
INDEX TERMS

IOB: 97C

*Solar energy; *Meetings; Solar heating; Solar power generation; Air conditioning; Thermal power plants; Solar cells; Electric power plants; Photosynthesis; Biosynthesis; Photovoltaic cells; Solar energy concentrators; Optical coatings; Electric power generation; Methane; Hydrogen Solar energy conversion; Solar air conditioning; Solar space heating; Solar thermal power plants; Solar sea power plants; Solar collectors; Solar energy absorbers; NTIS; SFRA

SUPPLEMENTARY TERMS

ABSTRACT

:Contents: Solar-to-thermal energy conversion application to large central power plants; Photothermal conversion of solar energy for large-scale electrical power production; The Minnesota/Honeywell solar power concept; Solar energy thermal converters fabricated by chemical vapor deposition; Low-cost silicon solar cell for large electrical power system-growth of silicon layer on steel substrate; An improved schottky barrier photovoltaic diode for solar energy conversion; Direct solar energy conversion

for large scale terrestrial use. Modeling of solar heating and air conditioning; Conservation & better utilization of electric power by means of thermal energy storage & solar heating. Solar energy residential system modeling; Ocean sited power plants; An inquiry into biological energy conversion; Biophotolysis of water; Technology for the conversion of solar energy to fuel gas; Technology for the conversion of solar energy to fuel gas; Solar energy panel report.

35
-40-
ACCESSION NUMBER
TITLE
TITLE NOTE
AUTHORS
ORGANIZATIONAL SOURCE

PB-236 974/25t
Use of Solar Energy in Buildings in New York State.
Final rept. Oct 73-Apr 74
Oakley, Clyde G.
New York State Assembly Scientific Staff.
Albany. National Science Foundation,
Washington, D.C. office of Intergovernmental
Science and Research Utilization. *Syracuse
Univ., N.Y. dept. of Electrical and Computer
Engineering.

PAGINATION/DATE
ISSUE
NTIS PRICES
NOTES

Apr 74: 42p
J7502
pc \$3.75/MF \$2.25
Continuation of Grant Nsf-Gt-32162. Prepared
by Syracuse Univ., N.Y. dept. of Electrical
and Computer Engineering.

CONTRACT/GRANT NOS.
CATEGORY CODES
INDEX TERMS

Nsf/na/a-72/013: 50-405
Nsf-1sr72-05606-A02
10B: 57C
*New York; *solar heating; Solar cells;
Silicon; Solar power generation; Electric
power generation; Heat storage; Cadmium
sulfides; Commercial buildings; Residential
buildings

SUPPLEMENTARY TERMS

*solar air conditioning; Solar space heating;
Photovoltaic cells; Solar collectors;
Atmosphere

ABSTRACT

A brief history of solar energy use is given and potential advantages and disadvantages of using solar energy are examined. Report presents an overview of solar devices and discusses two common types of solar cells and other parts of a solar electrical system. The impact of increased use of solar heating and cooling and factors that have discouraged use of solar energy are discussed along with possible actions the New York State legislature could take concerning solar energy.

-41-

ACCESSION NUMBER
TITLESand-74-0093
Integration of Photovoltaic and Solar-Thermal
Energy Conversion Systems.AUTHORS
ORGANIZATIONAL SOURCE
PAGINATION/DATE
ISSUEVook, F. I.; Schueler, D. G.
Sandia Labs., Albuquerque, N.mex.
Jul 74; 19p
N3010NTIS PRICES
CONTRACT/GRANT NOS.
CATEGORY CODES
INDEX TERMSpc \$4.00/Mf \$2.25
At(29-1)-789
13A; 97C(*solar space heating, *economics); (*solar
air conditioning, Economics); (*solar water
heaters, Economics); (*parabolic reflectors,
*efficiency); Silicon solar cells; Solar
trackingSUPPLEMENTARY TERMS
ABSTRACT

Ntisaec

For abstract, see Nsa 30 10, number 28835.

-42-

ACCESSION NUMBER
TITLEAd 786 757/551
Alternative Strategies for Optimizing Energy
Supply, Distribution, and Consumption Systems
on Naval Bases, Volume II, advanced Energy
Conservation Strategies.TITLE NOTE
AUTHORSFinal rept. Nov 73-Jan 74
Conroy, T.; Nicholas, J.; Nichols, J.;
Wulfinghoff, D.; Mateyka, J.

ORGANIZATIONAL SOURCE

Booz-Allen and Hamilton Inc Bethesda
Md defense Advanced Research Projects Agency,
Arlington, Va. Civil Engineering Lab. Navy,
Port Hueneme, Calif.PAGINATION/DATE
ISSUE31 Jan 74; 231p
U7425NTIS PRICES
NOTESpc \$7.50/Mf \$2.25
See also Ad-777 471.
Cel-Cr-74.007, NS2399-73-C-0029CATEGORY CODES
INDEX TERMS10A; 10B; 97B; 97C
*energy management; *naval shore facilities;
Solar heating; Fuel cells; Transportation;
Heat engines; Technology; Cost effectiveness;
Energy conservation; Cost analysis; Benefits;
Thermionic converters; Solar collectors
Cost benefit analysis; Electric power
generation; Wind power; Solar air
conditioning; Photovoltaic cells; Misdoon

SUPPLEMENTARY TERMS

ABSTRACT

The report describes five advanced strategies
for optimizing energy supply, distribution,
and consumption systems on naval bases: (1)
solar energy applications; (2) automated
building control and monitoring systems; (3)
electrochemical sources--fuel cells; (4)

advanced transportation technology; and (5) total energy systems. For each advanced strategy, the report contains a technology assessment, a discussion of applicability to the Navy, a discussion of costs and benefits, and recommendations for Navy implementation. (modified author abstract)

-43-

ACCESSION NUMBER
TITLE

Wash-1281-9

Solar Energy Program, Subpanel Report Ix used in Preparing the Aec chairman's Energy Report to the President.

AUTHORS
ORGANIZATIONAL SOURCE

Eggers, A. J. Jr
National Science Foundation, Washington, D.C. (usa).

PAGINATION/DATE
ISSUE

13 Nov 73; 223p
U7414

NTIS PRICES
CATEGORY CODES
INDEX TERMS

pc \$14.25/Mf \$1.45
10A; 97G

(*solar energy *economics); (*wind power, *research programs); Buildings; Cooling; Energy conversion; Photovoltaic effect; Solar heating
Ntisaec

SUPPLEMENTARY TERMS
ABSTRACT

For abstract, see Nsa 29 09, number 23758.

-44-

ACCESSION NUMBER
TITLE
ORGANIZATIONAL SOURCE
PAGINATION/DATE
ISSUE
NTIS PRICES
CONTRACT/GRANT NOS.
CATEGORY CODES
INDEX TERMS

ANL-8045

Solar Energy Evaluation Group Report,
Argonne National Lab., Ill.

Aug 73; 46p
N2812

CONTRACT/GRANT NOS.
CATEGORY CODES
INDEX TERMS

pc \$4.00/Mf \$1.45
W-31-109-eng-38
10B; 57D

(*solar energy, *cooling); (*photochemistry, Solar energy); (*photovoltaic cells, Solar energy); (*thermoelectric conversion, Solar energy); Biological wastes; Biology; Buildings; Energy conversion; Energy storage; In vitro; Research programs; Solar heating; Solar power plants; Uses
Aec

SUPPLEMENTARY TERMS
ABSTRACT

For abstract, see Nsa 28 12, number 32081.

END OF OFF-LINE PRINT

.....
*
* THIS IS AN OFF-LINE CITATION LIST GENERATED BY *
* * * * * *
* _ORBIT__IV *
* * * * * *
* S.D.C.'S INTERNATIONAL SEARCH SERVICE *
* * * * * *
* * * * * *

SOLAR DESALINIZATION

NUMBER OF CITATIONS PRINTED = 34

FEBRUARY 8, 1979

THIS SEARCH WAS PERFORMED ON COMPENDEX

REQUESTED BY
VIGNONE

PLEASE SEND THIS LISTING TO

MARIA E. VIGNONE
AGENCY FOR INTERNATIONAL DEVELOPMENT 570 PP
WASHINGTON, D.C. 20523

-1-

ACCESSION NUMBER
TITLEAUTHORS
ORGANIZATIONAL SOURCESOURCE
JOURNAL CODEN
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMSSUPPLEMENTARY TERMS
ABSTRACT

77-086756
STUDIES ON THE EFFICIENCY OF A SOLAR
DISTILLATION STILL FOR SUPPLEMENTING DRINKING
WATER SUPPLIES IN SOUTH WEST AFRICA.
Van Steenderen, R. A.
NATL INST FOR WATER RES OF THE COUNC FOR SCI
& END RES. PRETORIA, S
Water SA v 3 n 1 Jan 1977 p 1-4
WASADV
445; 446; 471; 802
WATER TREATMENT--Salt Removal
SEAWATER--Salt Removal; WATER SUPPLY--Water
Quality; DESALINATION
SOLAR DISTILLATION STILLS; DRINKING WATER
The investigation described deals with the
use of solar distillation for the
desalination of brackish water or seawater in
South West Africa. A suitable solar ' still
' could supply the basic drinking water
requirements of families living on remote
farms. From various established designs, the
double inclined roof still was chosen for
evaluation under local climatic conditions.
Special attention was given to simplicity of
construction, minimum capital outlay, long
life and ease of operation. Investigations
were carried out on the glass thickness used
in the roof structure, construction features
and performance of the still under various
climatic and environmental conditions. 4
refs.

-2-

ACCESSION NUMBER
TITLEAUTHORS
ORGANIZATIONAL SOURCE
SOURCECATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS
ABSTRACT

77-080463
ECONOMICAL INVESTIGATION OF SOLAR WATER
DISTILLATION IN EGYPT.
Sakr, I. A.; Khalil, M. A.
NATL RES CENT, DOKKI, CAIRO, EGYPT
Proc of the Int Symp on Fresh Water from the
Sea, 5th, Event of the Eur Fed of Chem Eng,
162nd, Alghero, Italy, May 16-20 1976
Sponsored by Eur Fed of Chem Eng Work Party
on Fresh Water from the Sea, 1976 v 2 p
477-482
452; 471; 643; 802; 901
DESALINATION--Economics
HEATING--Solar; SEAWATER--Distillation; WATER
TREATMENT PLANTS--Egypt; SOLAR ENERGY
This paper presents results of an
experimental program in which technological
and economic data are obtained. They show

40

that: the solar intensity has a mean daily value of about 6000 Kcal/m²; and the glass covered unit has a mean total daily productivity of about 3.000 litre/m² day, while for the plastic covered unit is about 2.25 litre/(m² day). The results are shown in table and represented graphically. The results of engineering and economic investigations were used to calculate the capital costs, operating costs and specific water costs for various distillation plant sizes (glass-covered and deep-basin still) for capacities ranging from 1000 to 10,000 litre/day. It is demonstrated that the cost of fresh water production by solar energy in Egypt can be reduced by using improved stills giving higher production and using site facilities to construct the stills with minimum costs.

-3-

ACCESSION NUMBER

TITLE

ORIGINAL TITLE

AUTHORS

ORGANIZATIONAL SOURCE

SOURCE

CATEGORY CODES

INDEX TERMS

X-REFERENCE INDEX TERMS

SUPPLEMENTARY TERMS

ABSTRACT

77-080482

Solar Distillation with Evaporating Wick.

SONNENDESTILLATOREN MIT VERDUNSTUNGSTUCH.

Hirschmann, J.; Rheinlaender, J.

UNIV TEC FEDERICO SANTA MARIA, VALPARAISO,

CHILE

Proc of the Int Symp on Fresh Water from the

Sea, 5th, Event of the Eur Fed of Chem Eng,

162nd, Alghero, Italy, May 16-20 1976

Sponsored by Eur Fed of Chem Eng Work Party

on Fresh Water from the Sea, 1976 v 2 p

447-456

471; 641; 643; 802; 921

DESALINATION--Equipment

HEATING--Solar; DISTILLATION

EQUIPMENT--Design; MATHEMATICAL TECHNIQUES;

HEAT TRANSFER; SEAWATER--Distillation

EVAPORATING WICK

This paper reports from the experimental investigations on solar distillers with evaporating wick realized by the Solar Energy Laboratory of UTFSM at Valparaiso/Chile. The model USM-9 with only one wick facing towards the equator in a flat container of galvanized sheet showed the best efficiency up to now. But the sheet must be replaced by a corrosion-resistant material (f. e. plastics). In order to gain qualitative information about the thermal processes in such systems, theoretical computations have been realized using the analogy between heat and mass transfer. This procedure showed

that the air-circulation caused by the thermo-siphon-effect in the model USM-9 is not always advantageous. Its suppression by avoiding the backward air-volume forces a greater partition of the total incident energy to leave the wick as latent heat of evaporation. Wick-type distillers demonstrate efficiencies which are about 1.3 times higher than those of basin-type systems, but they require more accuracy of construction and maintenance. 8 refs. In German.

-4-

41
 ACCESSION NUMBER
 TITLE
 AUTHORS
 ORGANIZATIONAL SOURCE
 SOURCE
 JOURNAL CODEN
 CATEGORY CODES
 INDEX TERMS
 X-REFERENCE INDEX TERMS
 SUPPLEMENTARY TERMS
 ABSTRACT

77-062137
 DESALTING WATER BY SOLAR DISTILLATION.
 Taylor, Floyd B.
 EPA, AIR & WATER PROGRAMS DIV
 Plumbing Eng v 5 n 3 May-Jun 1977 p 34-35.
 37-38
 PLENDY
 445; 615; 657; 802; 901
 WATER TREATMENT--Salt Removal
 DESALINATION; DISTILLATION; SOLAR ENERGY;
 ENERGY UTILIZATION
 SOLAR DISTILLATION

A discussion of the current state-of-the-art of desalting water with solar energy is presented. Also covered is the utilization of solar energy in the evaporation of brines, the by-product of all desalination processes. Experiments have been conducted with more sophisticated methods of utilizing solar energy where solar heat collectors are arranged to raise the temperature of water by only a few degrees and this energy is used to operate a multiple-effect humidification evaporator.

-5-

ACCESSION NUMBER
 TITLE
 AUTHORS
 ORGANIZATIONAL SOURCE
 SOURCE
 JOURNAL CODEN
 CATEGORY CODES
 INDEX TERMS
 X-REFERENCE INDEX TERMS
 ABSTRACT

77-052186
 SOLAR-ASSISTED DISTILLATION OF SEA WATER.
 Theimat, B. W.; Howe, E. D.
 UNIV OF CALIF, BERKELEY
 NWSIA J v 4 n 1 Jan 1977 p 17-28
 NWSADI
 445; 471; 657; 802; 901
 SEAWATER--Salt Removal
 DISTILLATION; SOLAR RADIATION--Collectors;
 EVAPORATORS; ENERGY UTILIZATION
 The preliminary design of a plant to produce

40 m³/day of fresh water is given. The plant consists of a 15-effect rotating evaporator, together with the solar collector, water storage tanks, flash tank and various pumps and controls. In the rotating evaporator steam is condensed on the inside flat surfaces of narrow cylindrical enclosures and the latent heat furnished thereby is used to partially evaporate sea water from thin films on the other faces of the flat surfaces of the cylinder. The thickness of the films is controlled by radial wipers bearing on the ends of the rotating enclosure and by the speed of rotation. The electrical energy required by the rotor and the several pumps is of the order of 200 kWh/day or 5 kWh/m² of water produced. Estimates of the capital and operating costs indicate that distilled water could be produced more cheaply by the proposed plant than by solar distillation using basin-type distillers. 13 refs.

-6-

ACCESSION NUMBER
TITLEAUTHORS
ORGANIZATIONAL SOURCE
SOURCECATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS
ABSTRACT

77-032331
SOLAR DISTILLATION AND COMBINED DISTILLATION AND WATER HEATING FOR TROPICAL AREAS.
Dunkle, Robert V.
CSIRO, VICTORIA, AUST
Proc of the Southeast Conf on Appl of Sol Energy, 2nd, Baton Rouge, La, Apr 19-22 1976. Sponsored by ERDA (CONF-760423), Oak Ridge, Tenn, 1976. Available from NIS, Springfield, Va p 148-172
402; 602; 615; 657; 901
HOT WATER SUPPLY SYSTEMS
SOLAR ENERGY--Energy Utilization; DISTILLATION
A simple solar water heater intended for use in tropical areas such as Indonesia has been built and preliminary performance tests run under Melbourne conditions. As the major mode of heat loss is due to condensation of the glass it seems reasonable to collect this distillate for household consumption. A solar heater-still combination is built and performance figures are presented. Solar still theory in SI units and generalized curves are presented for determination of solar still and water heating performance. A comparison is made between theoretical and experimental performance of the combination solar still-water heater. 14 refs.

-7-

ACCESSION NUMBER
TITLE
AUTHORS
ORGANIZATIONAL SOURCE
SOURCE

77-030852
SOLAR-ASSISTED DISTILLATION OF SEA WATER.
Tleimat, B. W.; Howe, E. D.
UNIV OF CALIF, BERKELEY
HelioTech and Dev. Proc of the Int Conf,
Dhahran, Saudi Arabia, Nov 2-6 1975 Publ by
Dev Anal Assoc, Cambridge, Mass, 1976 v 2 p
458-462

CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS

802; 901; 615; 657
DESALINATION--Energy Utilization
SOLAR ENERGY--Applications; EVAPORATORS;
SOLAR RADIATION--Collectors

ABSTRACT

The preliminary design of a plant to produce
40 m³/day of fresh water is given. The
plant consists of a 15-effect rotating
evaporator, together with the solar
collector, water storage tanks, flash tank
and various pumps and controls. Steam is
condensed on the inside flat surfaces of
narrow cylindrical enclosures, and latent
heat is used to partially evaporate sea water
from thin films on the other faces. The
electrical energy required is of the order of
5 kWh/m³ of water produced. Cost estimates
indicate that water could be produced more
cheaply by the proposed plant than by
basin-type distillers. 13 refs.

-8-

ACCESSION NUMBER
TITLE
ORIGINAL TITLE
AUTHORS
ORGANIZATIONAL SOURCE
SOURCE

77-035756
Solar Distillation State of the Art Review.
REVUE DE L'ETAT ACTUEL DE LA DISTILLATION
SOLAIRE.
Blanco, P.
COM NAC DE ENERGIAS ESPEC, MADRID, SPAIN
HelioTech and Dev. Proc of the Int Conf,
Dhahran, Saudi Arabia, Nov 2-6 1975 Publ by
Dev Anal Assoc, Cambridge, Mass, 1976 v 2 p
415-423

CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS
ABSTRACT

615; 657; 802
SOLAR ENERGY--Applications
DISTILLATION; DESALINATION
Various types of devices are analyzed and
compared. Technical and economic aspects are
evaluated. 24 refs. In French.

-9-

ACCESSION NUMBER
TITLEAUTHORS
ORGANIZATIONAL SOURCE
SOURCECATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS
ABSTRACT

77-035772
SOLAR DISTILLATION FOR INTENSIVE CULTIVATION
IN ARID LANDS.
Frick, G.; Petamal, M.
UNIV TEC FED SANTA MARIA, VALPARAISO, CHILE
Heliotech and Dev. Proc of the Int Conf,
Dhahran, Saudi Arabia, Nov 2-6 1975 Publ by
Dev Anal Assoc, Cambridge, Mass, 1976 v 2 p
401-412
615; 657; 821
SOLAR ENERGY--Energy Utilization
IRRIGATION; DESALINATION; GREENHOUSES
Use of hermetically-sealed cultivation tents
for agriculture in the deserts of Northern
Chile that permits the reuse of water and
acts as efficient solar stills is described.
Demonstration of their economic feasibility
is given.

-10-

ACCESSION NUMBER
TITLEAUTHORS
ORGANIZATIONAL SOURCE
SOURCE
JOURNAL CODES
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMSSUPPLEMENTARY TERMS
ABSTRACT

76-078598
SOLAR PONDS AS HEAT SOURCE FOR
LOW-TEMPERATURE MULTI-EFFECT DISTILLATION
PLANTS.
Tabor, H.
SCI RES FOUND, JERUSALEM, ISR
Desalination v 17 n 3 Dec 1975 p 289-302
DSLNAH
445; 631; 643; 802; 921
WATER TREATMENT--Salt Removal
WATER HEATERS--Solar; DISTILLATION EQUIPMENT;
OPTIMIZATION
SOLAR PONDS; DISTILLATION PLANTS
Non-convecting solar ponds have the potential
of providing low-temperature heat well below
current fuel prices. The development of
multi-effect distillation plants operating
below 100 DEGREES C allows solar ponds to be
considered as the heat source. The paper
discusses optimization of the size of the
pond and the number of effects used, taking
into account the large variation of pond heat
output between summer and winter.
Application of solar ponds to a better
utilization of the desalination plant and a
reduction in the summer-winter yield ratio is
discussed. 5 refs.

-11-
ACCESSION NUMBER
TITLE
ORIGINAL TITLE
AUTHORS
ORGANIZATIONAL SOURCE
SOURCE
JOURNAL CODEN
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS
ABSTRACT

76-054930
Modified Polyethylene Films for Solar
Distillation Installations.
MODIFITSIROVANNYE POLIETILENOVYE PLENKI DLYA
SOLNECHNYKH OFRESNITELEI.
Umarov, G. Ya.; Asamov, M. K.; Achilov, B.
M.; Sarros, T. K.; Norov, E. Zh.; Tsagaraeva,
N. A.
TASHKENT STATE UNIV. UZB SSR
Geliotekhnika n 2 1976 p 29-33
GLOTAY
817; 615; 657; 444; 471; 802
POLYETHYLENES--Film
SOLAR ENERGY; WATER--Distillation
Modified polyethylene films based on
polyvinyl alcohol have been obtained by the
method of casting. A possibility of using
them as a transparent insulation in solar
distillation plants is shown. A comparison
of the wettability, radiation transmission
coefficient, and output capacity of the
films, depending on the method of film
processing, is carried out. In Russian.

45
-12-
ACCESSION NUMBER
TITLE
ORIGINAL TITLE
AUTHORS
ORGANIZATIONAL SOURCE
SOURCE
JOURNAL CODEN
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS
ABSTRACT

76-035668
Results of Tests of Three Designs of Typical
Sections of Solar Water Distillation Plants.
REZUL'TATY ISPYTANIY TREKH KONSTRUKTSII
TIPOVYKH SEKTSII SOLNECHNOY OPRESNITEL'NOY
USTANOVKI.
Seitkurbanov, S.; Baimamov, R.; Tashnazarov,
B.
PHYS. INST. ACAD OF SCI. TURKM SSR
Geliotekhnika n 5 1975 p 30-33
GLOTAY
444; 445; 802; 615; 657
WATER TREATMENT--Salt Removal
SOLAR ENERGY; WATER RESOURCES--Arid Regions
As a result of a comparison of the specific
efficiency of three typical sections and
judging by the complexity of the manufacture
and assembly of a solar water distillation
plant, it is found that one of the versions
is the best design for such typical sections.
These plants could be used to ensure water
supply in desert regions with fresh water
shortage but having salt water reserves with
salt concentrations of not more than 50-60
g/l. In Russian.

-13-
ACCESSION NUMBER
TITLE
AUTHORS
ORGANIZATIONAL SOURCE
SOURCE
JOURNAL CODEN
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS
ABSTRACT

76-015976
GREENHOUSE SOLAR DISTILLATION UNIT COMBINED
WITH HEAT PIPES (UNSTEADY-STATE CONDITIONS).
Bairamov, R. B.; Tolleev, K.;
Mukhammetdurdyeva, O.
PHYS-TECH INST OF THE ACAD OF SCI OF THE TURK
SSR
Int Chem Eng v 15 n 3 Jul 1975 p 454-456
INCEAX
641; 602
DISTILLATION
HEAT PIPES
A heat balance has been set up allowing for
diurnal variations of the solar radiation and
ambient temperature to permit the calculation
of the thermal conditions and throughput of
solar distillation units with and without
heat pipes. 3 refs.

46
-14-
ACCESSION NUMBER
TITLE
AUTHORS
ORGANIZATIONAL SOURCE
SOURCE
JOURNAL CODEN
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS
SUPPLEMENTARY TERMS
ABSTRACT

00-001591
TWENTY YEARS OF WORK ON SOLAR DISTILLATION AT
THE UNIVERSITY OF CALIFORNIA.
Howe, E. D.; Tleimat, B. W.
UNIV OF CALIF, BERKELEY
Sol Energy v 16 n 2 Oct 1974 p 97-105
SRENA4
615; 657; 802
DISTILLATION
DISTILLATION EQUIPMENT; SOLAR ENERGY; SOLAR
RADIATION--Collectors; SEAWATER--Salt Removal
SOLAR STILL
These studies have led to the development of
still units of relatively small size,
designed for furnishing potable water to
isolated residences or small communities.
Designs have been completed using wooden
frames, precast concrete frames, and precast
styrofoam basins. This paper gives
information on the construction and
performance of the several units; indicates
the need for more effective utilization of
solar energy; and offers a conceptual design
of a solar collector for furnishing
low-pressure steam for operation of a
seawater distillation plant of advanced
design. 13 refs.

-15-

ACCESSION NUMBER
TITLEAUTHORS
ORGANIZATIONAL SOURCE
SOURCE
JOURNAL CODEN
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS
SUPPLEMENTARY TERMS
ABSTRACT

74-073553
DESIGN PHILOSOPHY AND OPERATING EXPERIENCE
FOR AUSTRALIAN SOLAR STILLS.
Cooper, P. I.; Read, W. R. W.
COMMONW SCI AND IND RES ORGAN, VICTORIA, AUST
Sol Energy v 16 n 1 Aug 1974 p 1-8
SRENA4
445; 471; 615; 657; 802
SOLAR RADIATION--Collectors
SEAWATER--Salt Removal; SOLAR ENERGY
SOLAR DISTILLATION; SOLAR STILLS
The development undertaken in Australia and
directed towards understanding both the
theoretical and practical aspects of solar
still operation is described. Operating
experience gained in the field over a number
of years has culminated in the successful
development of Mk VI solar stills. The
performance of these units is presented
together with a summary of the more
significant operating characteristics. A
small, domestic type of solar still is
described and performance figures given. 8
refs.

-16-

ACCESSION NUMBER
TITLEAUTHORS
ORGANIZATIONAL SOURCE
SOURCE
JOURNAL CODEN
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS
SUPPLEMENTARY TERMS
ABSTRACT

00-003955
CASCADE SOLAR STILL FOR DISTILLED WATER
PRODUCTION.
Headley, O. St. C.
UNIV OF WEST INDIES, ST. AUGUSTINE, TRINIDAD
Solar Energy v 15 n 3 Sep 1973 p 245-258
SRENA4
471; 657; 802
SEAWATER--Salt Removal
DISTILLATION; SOLAR RADIATION--Collectors
SOLAR STILLS
The paper describes a new design for a tilted
double-sided solar still with cascade water
trays made of corrugated aluminium which are
positioned 1.25 in. below the glass cover
on insulated supports. The mean effective
water depth is 0.7 in. which leads to high
water temperatures (60 DEGREES -78 DEGREES C)
and a low thermal inertia (15 min) but is
sufficient to ensure two days of maximum
production before dry spots develop. The
cover produces 70-100% of the distillate
depending upon the vapor temperature. 7 refs.

SOLAR DESALINIZATION

-17-

ACCESSION NUMBER
TITLEAUTHORS
ORGANIZATIONAL SOURCESOURCE
JOURNAL CODEN
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMSSUPPLEMENTARY TERMS
ABSTRACT

73-032344
DIGITAL SIMULATION OF EXPERIMENTAL SOLAR STILL DATA.
Cooper, P. I.
COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION, HIGHETT
Solar Energy v 14 n 4 Mar 1973 p 451-468
SRENA4
445: 657; 802; 921
WATER TREATMENT--Distillation
DISTILLATION; SOLAR RADIATION--Collectors;
DATA PROCESSING; MATHEMATICAL MODELS
SOLAR DISTILLATION; SOLAR STILLS; SIMULATION
A comprehensive experimental program was instituted in conjunction with the formulation of a mathematical model and the development of simulation techniques. A qualitative assessment of heat flow within the ground beneath an uninsulated still was made using experimentally recorded ground temperatures. It was possible to verify some of the assumptions proposed for the model and to compare simulated and experimental performance on both a transient and daily basis. 8 refs.

-18-

ACCESSION NUMBER
TITLEAUTHORS
ORGANIZATIONAL SOURCESOURCE
JOURNAL CODEN
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMSSUPPLEMENTARY TERMS
ABSTRACT

73-032343
USE OF WASTE HEAT IN A SOLAR STILL.
Proctor, D.
CSIRO, HIGHETT, VICTORIA, AUST
Solar Energy v 14 n 4 Mar 1973 p 433-449
SRENA4
445: 657; 802
WATER TREATMENT--Distillation
DISTILLATION; SOLAR RADIATION--Collectors;
INTERNAL COMBUSTION ENGINES--waste Heat Utilization
SOLAR DISTILLATION; SOLAR STILLS
System is described that makes it possible to use some of the waste heat of internal combustion engines to produce distilled water in solar stills. The solar still replaces the cooling tower, ponds, or radiators normally used to control the engine temperature. The diesel cooling water in such a system remains separate from the saline water in the solar still. The advantages of using such a system are compared with a conventional solar still. The influence of water production on the

output of the waste heat solar still is discussed. 10 refs.

-19-

ACCESSION NUMBER
TITLE
AUTHORS
SOURCE
JOURNAL CODEN
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS

SUPPLEMENTARY TERMS
ABSTRACT

73-032342
SOLAR STILLs WITH LOW THERMAL INERTIA.
Szulmayer, W.
Solar Energy v 14 n 4 Mar 1973 p 415-421
SRENA4
445; 657; 802
WATER TREATMENT--Distillation
DISTILLATION; PLASTICS; SOLAR
RADIATION--Collectors
SOLAR DISTILLATION; SOLAR STILLs
A small plastic still of approximately 2
ft² area was developed. Incorporating
several unconventional design features, such
as, a floating solar absorber to heat to a
thin layer of surface water, and a
single-sloped roof with a specularly
reflecting back wall. Factors considered
include the significance of the thermal
inertia of the air space between the water
and the roof; the need for separate
consideration of water evaporation and
condensation rates, and the resulting time
delay between their maxima during the daily
cycle. The roof geometry and orientation of
the conventional and experimental stills are
discussed in relation to the sun's altitude.

-20-

ACCESSION NUMBER
TITLE
AUTHORS
ORGANIZATIONAL SOURCE
SOURCE
JOURNAL CODEN
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS

SUPPLEMENTARY TERMS
ABSTRACT

73-032360
THEORY AND EXPERIENCE WITH SOLAR STILLs IN
CHILE.
Frick, German; Hirschmann, Julio
UNIVERSIDAD TECNICA FEDERICO SANTA MARIA,
VALPARAISO, CHILE
Solar Energy v 14 n 4 Mar 1973 p 405-413
SRENA4
445; 657; 802
WATER TREATMENT--Salt Removal
SEAWATER--Salt Removal; SOLAR
RADIATION--Collectors; DISTILLATION
SOLAR STILLs
Theoretical studies of solar stills in Chile
described, deal with efficiency, thermal
balance, thermal inertia, thermal capacity,
thermal conductance, thermal lag and
distillation lag with regard to solar
irradiation maximum, and time constant. Solar

SOLAR DESALINIZATION

still designs with evaporating trays of wood, metal, cement, and plastic, and evaporating cloths of various designs have been tested. Tests were made with glass and plastic covers.

-21-

ACCESSION NUMBER
TITLE

AUTHORS
ORGANIZATIONAL SOURCE

SOURCE
JOURNAL CODEN
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS

SUPPLEMENTARY TERMS
ABSTRACT

73-032304
SOME ASPECTS OF SOLAR DISTILLATION FOR WATER PURIFICATION.

Gomkale, S. D.; Datta, R. L.
CENTRAL SALT AND MARINE CHEMICALS RES INST.
BHAVNAGAR, INDIA

Solar Energy v 14 n 4 Mar 1973 p 387-392

SRENA4

445; 657; 802

WATER--Purification

SOLAR RADIATION--Collectors; WATER

TREATMENT--Distillation

SOLAR DISTILLATION; SOLAR STILLS

In experimental work a solar still design which produces 5 to 7 liters of purified water per day has been developed using aluminum components and polyethylene film as the basliner. A number of such units have been set up to supply distilled water for laboratory work. The development work, including experience gained during the installation and operation of a pilot plant constructed in India forms the basis for the assessment of solar distillation. The possibility of having rainfall collection and solar distillation combined at certain locations is examined.

-22-

ACCESSION NUMBER
TITLE

AUTHORS
ORGANIZATIONAL SOURCE

SOURCE
JOURNAL CODEN
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS

SUPPLEMENTARY TERMS
ABSTRACT

73-023108
INVESTIGATION OF SOME OF THE PARAMETERS INVOLVED IN SOLAR DISTILLATION.

Satcunanathan, S.; Hansen, H. P.
UNIV OF THE WEST INDIES, ST. AUGUSTINE,
TRINIDAD

Solar Energy v 14 n 3 Feb 1973 p 353-363

SRENA4

657; 602

DISTILLATION

SOLAR RADIATION; DISTILLATION EQUIPMENT;

SEAWATER--Salt Removal

SOLAR DISTILLATION; SOLAR STILLS

The results of experiments carried out with a parallel-plate, cascade-type solar still to determine the effects of gap distance, slope

of cover, and cooling of the cover on the performance of the still. It was found that the yield is a maximum for a certain cover slope and that it increased with decreasing gap distance. The yields satisfy available expressions for evaporative heat transfer between parallel surfaces. A performance factor is defined for the yield which takes into account the reflection losses from the cover and is independent of cover slope, orientation, location, and latitude. 18 refs.

-23-

ACCESSION NUMBER
TITLE
AUTHORS
ORGANIZATIONAL SOURCE
SOURCE
JOURNAL CODEN
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS

73-026003
EFFECT OF WIND ON SOLAR DISTILLATION.
Soliman, S. H.
NATIONAL RES CENT. DOKKI, CAIRO, EGYPT
Solar Energy v 13 n 4 Jul 1972 p 403-415
SRENA4
471; 643; 657
SEAWATER--Salt Removal
WATER HEATERS--Solar; SOLAR
RADIATION--Collectors; WIND EFFECTS; HEAT
TRANSFER
SOLAR STILLs

SUPPLEMENTARY TERMS
ABSTRACT

A study was made of roof type solar stills under forced convection conditions. Two arrangements of flow, one parallel to the inclined surfaces of the cover and one parallel to the vertical surfaces of the cover, are investigated. A theoretical equation which gives the heat transfer coefficient for both the inclined and vertical surfaces of the cover is derived. The effect of water and ambient air temperatures, wind velocity, and angle of inclination of the cover on the performance of the still is shown. 16 refs.

-24-

ACCESSION NUMBER
TITLE
AUTHORS
ORGANIZATIONAL SOURCE
SOURCE
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS
ABSTRACT

72-21947
Thermodynamic analysis of a double-effect basin-type solar still
LANTAGNE, M; ALWARD, R
MCGILL UNIV, MONTREAL, QUE
ASME Pap 71-WA/Sol-8 for meeting Nov 28-Dec 2
1971, 11 p
445; 657; 802
WATER TREATMENT--Salt Removal
DISTILLATION; SOLAR RADIATION--Collectors
An experimental size double-effect basin-

SOLAR DESALINIZATION

type solar still is described. The overall energy balance on the still and heat balances on both water basins and the transparent cover are made using experimental data gathered on several representative days. Computations made using hourly heat balances are in good agreement with the theoretical analysis. 19 refs.

-25-

ACCESSION NUMBER
 TITLE
 AUTHORS
 ORGANIZATIONAL SOURCE
 SOURCE
 CATEGORY CODES
 INDEX TERMS
 X-REFERENCE INDEX TERMS
 ABSTRACT

71-67991
 Some comments on solar distillation
 HOWE, ED
 UNIV OF CALIFORNIA, BERKELEY
 Int Solar Energy Soc Conf, Mar 2-6 1970,
 Prepr Pap n 5/18, 7 p
 444; 445; 657
 WATER TREATMENT PLANTS
 POWER GENERATION--Solar; SOLAR
 RADIATION--Collection; WATER RESOURCES
 The apparent dissatisfaction with the solar still at Syml (Greece) and the solar collector at Puerto Penasco (Mexico) makes it desirable to look further into the features of design, construction and operation of solar stills if these are to be effectively employed for water supply. 8 refs.

-26-

ACCESSION NUMBER
 TITLE
 AUTHORS
 ORGANIZATIONAL SOURCE
 SOURCE
 CATEGORY CODES
 INDEX TERMS
 X-REFERENCE INDEX TERMS
 ABSTRACT

71-66867
 Solar distillation techniques, their development and application in India
 GOMKALE, SD; GARG, SK; DATTA, RL
 CENTRAL SALT AND MARINE CHEMICALS RES INST,
 BHAVNAGAR, INDIA
 Int Solar Energy Soc Conf, Mar 2-6 1970,
 Prepr Pap 5/39, 6 p
 444; 445; 615
 WATER TREATMENT PLANTS--India
 POWER GENERATION--Solar; WATER
 RESOURCES--Saline Water
 8 refs.

-27-
ACCESSION NUMBER
TITLE
AUTHORS
ORGANIZATIONAL SOURCE
SOURCE
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS
ABSTRACT

71-64490
Patmos, Kimolos, Nisyros, three solar
distillation units in Greece
KOKKALIARIS, PP
HELLENIC INDUSTRIAL DEVELOPMENT BANK, ATHENS,
GREECE
Int Solar Energy Soc Conf, Mar 2-6 1970,
Prepr Pap n 2/19, 7 p
444; 445; 657
WATER TREATMENT PLANTS--Greece
SOLAR RADIATION--Collectors; WATER
TREATMENT--Salt Removal; WATER RESOURCES
The present paper is concerned with the cost
analysis of investment and operation for the
solar distillation plants in the islands of
Patmos, Kimolos, and Nisyros, as well as with
the efficiency of the above plants. Useful
data pertinent to these plants are also given.

53
-28-
ACCESSION NUMBER
TITLE
AUTHORS
ORGANIZATIONAL SOURCE
SOURCE
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS
ABSTRACT

71-64488
Recent developments and future trends in
solar distillation
READ, WRW
COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RES
ORGANIZATION, HIGHETT, VICTORIA, AUSTRALIA
Int Solar Energy Soc Conf, Mar 2-6 1970,
Prepr Pap n 5/52, 7 p
444; 445; 657
WATER TREATMENT PLANTS--Australia
WATER RESOURCES; SOLAR RADIATION--Collectors
5 refs.

-29-
ACCESSION NUMBER
TITLE
AUTHORS
ORGANIZATIONAL SOURCE
SOURCE
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS
ABSTRACT

71-64618
Water distillation by solar energy
SHSOLIMANSOLARENERGYDEPT; KOBAYASHI, M
NATIONAL RES CENTRE, DOKKI, CAIRO, UAR
Int Solar Energy Soc Conf, Mar 2-6 1970,
Prepr Pap n 5/102, 7 p
445; 446; 615
POWER GENERATION--Solar
WATER WORKS--United Arab Republic; WATER
TREATMENT--Salt Removal
11 refs.

-30-
 ACCESSION NUMBER
 TITLE
 AUTHORS
 ORGANIZATIONAL SOURCE
 SOURCE
 JOURNAL CODEN
 INDEX TERMS
 X-REFERENCE INDEX TERMS
 SUPPLEMENTARY TERMS
 ABSTRACT

71-18112
 Technical cooperation on the solar
 distillation development program of Spain
 LOF, GOG; HUNTER, JA; SIEDER, EN
 CONSULTANT, DENVER COLO
 U S, Office Saline Water, Res Develop Progr
 Rep 397 Sept 1968, 25 p
 XISWA
 SEAWATER--Salt Removal
 DISTILLATION; SOLAR RADIATION--Collectors
 DESALINATION
 A cooperative undertaking between several
 departments of the Government of Spain and
 the Organization for Economic Cooperation and
 Development (OECD) has resulted in the
 design, construction, and operation of a
 nominal 9500 sq ft solar distillation plant
 (about 1000 gpd summer output) at the village
 of Las Marinas, near Almeria, Spain.

-31-
 ACCESSION NUMBER
 TITLE
 AUTHORS
 ORGANIZATIONAL SOURCE
 SOURCE
 CATEGORY CODES
 INDEX TERMS
 X-REFERENCE INDEX TERMS

70-50648
 Technical evaluation of a large scale solar
 distillation plant
 LAWAND, TA
 MC GILL UNIV, MAC DONALD COLL, QUE
 J Eng Power, Trans ASME v 92 Ser A n 2 Apr
 1970 p 95-102
 445; 471; 657; 802
 SEAWATER--Salt Removal
 SOLAR RADIATION

-32-
 ACCESSION NUMBER
 TITLE
 AUTHORS
 ORGANIZATIONAL SOURCE
 SOURCE
 CATEGORY CODES
 INDEX TERMS
 X-REFERENCE INDEX TERMS
 ABSTRACT

70-28082
 Technical evaluation of a large scale solar
 distillation plant
 LAWAND, TA
 BRACE RESEARCH INST, MCGILL UNIV, MONTREAL,
 QUE
 ASME-Paper 69-WA/Sol-8 for meeting Nov 16-20
 1969, 11 p
 641; 643; 657; 803
 DISTILLATION
 SOLAR RADIATION--Collectors; WATER
 HEATERS--Solar; SEAWATER--Salt Removal; HEAT
 TRANSFER
 Theoretical evaluation of the heat and mass
 transfer interchange in an air-inflated
 solar still. Experimental verification tests

were carried out and the results compared with theoretical predictions. The percentage of unaccounted heat losses on the overall balance was under 3% for most tests. 26 refs.

-33-

ACCESSION NUMBER
TITLE

ORIGINAL TITLE

AUTHORS
ORGANIZATIONAL SOURCE
SOURCE

CATEGORY CODES

INDEX TERMS

X-REFERENCE INDEX TERMS

ABSTRACT

70-07454

Use of solar radiation for distillation of sea water

Meerwasser- Destillation unter Ausnutzung der Sonnenstrahlung

DELYANNIS, A; DELYANNIS, E

TECHNISCHE HOCHSCHULE, ATHENS, GREECE

Chemie Ingenieur Technik v 41 n 3 Feb 10 1969
p 90-6

443; 471; 472; 484; 931; 932; 445; 802

SEAWATER--Salt Removal

SOLAR RADIATION--Evaporation

Production of fresh water from sea water by evaporation using solar radiation and subsequent collection of condensate is cheap process involving very little expenditure regarding apparatus and maintenance; such process of course can be used only in countries having hot climate; furthermore, large installation area is required; indirectly, its efficiency can be improved substantially if rain water can be collected from roof of plant. 20 refs. In German.

-34-

ACCESSION NUMBER
TITLE

AUTHORS
ORGANIZATIONAL SOURCE
SOURCE

CATEGORY CODES

INDEX TERMS

X-REFERENCE INDEX TERMS

ABSTRACT

70-03776

Digital simulation of transient solar still processes

COOPER, PI

UNIV OF WESTERN AUSTRALIA, NEDLANDS

Solar Energy v 12 n 3 May 1969 p 313-31

931; 932; 802

SEAWATER--Salt Removal

DISTILLATION; SOLAR RADIATION--Collectors

Water depth, wind velocity, still insulation, double glass covers, cover slope and daily variability are investigated; finite difference approach is used to simulate heat flow to and from soil; results of simulation indicate that water depth has little effect on productivity; higher wind velocities and ambient temperatures increase output by small amount; double glass covers considerably reduce output; how effect on still performance of some changes can be predicted

By considering effect on water temperature
and water-glass temperature difference. 17
refs.

***** END OF OFF-LINE PRINT *****

-1-

ACCESSION NUMBER
TITLE
AUTHORS

ORGANIZATIONAL SOURCE
SOURCE

CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS
SUPPLEMENTARY TERMS
ABSTRACT

78-090342
HAWAII GEOTHERMAL PROJECT.
Kihara, D. H.; Chen, B. H.; Takahashi, P. K.;
Yuen, P. C.

UNIV OF HAWAII, HONOLULU
ANS Top Meet: Energy and Miner Resour
Recovery, Colo Sch of Mines, Golden, Apr
12-14 1977 Publ by DOE (CONF-770440).
Washington, DC, 1977. Available from NTIS,
Springfield, Va p 77-88

615: 641: 481
GEOTHERMAL ENERGY--Hawaii
GEOLOGY--Engineering
HAWAII GEOTHERMAL PROJECT

A site in the Puna district near the eastern
rift of Kilauea volcano was selected for an
experimental geothermal well. This site is
located at an elevation of approximately 600
feet above sea level, 25 miles east of
Kilauea and 1/4 mile south of the first
vents of the 1955 eruption. Nominal ten foot
core samples were taken at depths of 456,
1057, 1412, 2230, 2876, 3666, 4447, 5400,
6029, and 6445 feet. Cutting samples were
obtained roughly every ten feet during
drilling. A summary of the preliminary
analysis of core samples and cuttings is
given. Results for the well and the
geothermal reservoir are presented in detail.
Potential power output was estimated at
approximately 3MW, while the reservoir was
found to be a tight formation with
permeability thickness of about 880
millidarcy-feet.

-2-

ACCESSION NUMBER
TITLE

AUTHORS

ORGANIZATIONAL SOURCE
SOURCE

JOURNAL CODEN
CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS
ABSTRACT

77-048935
CHEMICAL AND ISOTOPIC INVESTIGATIONS OF
GROUNDWATER IN POTENTIAL GEOTHERMAL AREAS IN
HAWAII.

McMurtry, Gary M.; Fan, Pow-Foong; Coplen,
Tyler B.

UNIV OF HAWAII, HONOLULU
Am J Sci v 277 n 4 Apr 1977 p 438-458

AJSCAP
481: 444: 544: 615: 641
GEOCHEMISTRY--Groundwater
GEOPHYSICS--Geothermal; GEOTHERMAL ENERGY
The chemical and isotopic compositions of
Hawaiian groundwater were studied to locate
and evaluate potential geothermal areas.

Analyses were made of 43 samples from 27 wells, two coastal springs, local precipitation, and steam. Three methods of chemical geothermometry were applied: (1) silica, (2) Na-K-Ca, and (3) stable isotope or deuterium-oxygen-18. Based on the silica and stable isotope methods, the most promising geothermal areas are the summit of Kilauea Volcano and the area near geothermal test hole 3 in the Puna district (east rift zone of Kilauea Volcano) 43 refs.

-3-
ACCESSION NUMBER
TITLE

AUTHORS

ORGANIZATIONAL SOURCE
SOURCE

CATEGORY CODES
INDEX TERMS
ABSTRACT

77-017149
GEOTHERMAL ENERGY IN HAWAII -- HYDROTHERMAL SYSTEMS.
Shupe, John W.; Kamins, Robert M.; Yuen, Paul C.

UNIV OF HAWAII, HONOLULU
Intersoc Energy Convers Eng Conf, 11th, Proc, State Line, Nev, Sep 12-17 1976 Publ by AIChE, New York, NY, 1976 v 1 SAE Pap 769120 p 696-703

481; 615; 641; 912
GEOTHERMAL ENERGY--Research
The Hawaii Geothermal Project (HGP) research program involves an interdisciplinary team of researchers from throughout the University system which conducts scientific investigations on short-range exploratory and applied technology tasks to assist in the early development of any conventional hydrothermal systems in Hawaii, as well as long-range studies of a more basic nature. A general case study or progress report is given on Phase I, the exploratory geophysical survey program, with supporting activity in engineering, socioeconomic, and environmental programs; and Phase II, the research drilling program. Preliminary results and projections on the potential of geothermal power for Hawaii are presented. 13 refs.

-4-
ACCESSION NUMBER
TITLE

AUTHORS
ORGANIZATIONAL SOURCE
SOURCE
JOURNAL CODEN

76-066984
PROSPECTS FOR GEOTHERMAL ENERGY ON THE ISLAND OF OAHU, HAWAII.
Furumoto, Augustine S.
UNIV OF HAWAII, HONOLULU
Geotherm Energy v 4 n 6 Jun 1976 p 7-25
GTEMAJ

CATEGORY CODES
INDEX TERMS
ABSTRACT

481; 615; 641

GEOHERMAL ENERGY

A review on the potential geothermal sources development program implementation on the island of Oahu, Hawaii is made. Numerous attempts to initiate geothermal exploration have been met both with encouragement and opposition. Studies have been undertaken, but no definite decisions have been reached. This article proposes immediate exploration for geothermal resources, since it is imperative that every potential energy source be exploited without delay. 26 refs.

-5-
ACCESSION NUMBER
TITLE

75-081223

HAWAII OVERVIEW -- PARTIAL PRESENTATION ON THE GEOHERMAL RESOURCE EXPLORATION AND DEVELOPMENT POTENTIAL OF THE STATE OF HAWAII.

AUTHORS
ORGANIZATIONAL SOURCE
SOURCE

Harrenstien, Howard

UNIV OF HAWAII, HONOLULU

Geotherm Resour Counc Conf, 1st, El Centro, Calif, Feb 16-18 1972. Spec Rep n 1: Geotherm Overviews of the West US. Spec Rep n 2: Comper.d of First Day Pap Rep 1 Pap E. 21 p. Publ by Geotherm Resour Counc, Davis, Calif. 1973

CATEGORY CODES
INDEX TERMS
X-REFERENCE INDEX TERMS

615; 641; 481; 484; 902

GEOHERMAL ENERGY--Legislation

LEGISLATION; GEOPHYSICS--Geothermal;

GEOLOGY--Hawaii; ELECTRIC POWER GENERATION;

VOLCANOES

ABSTRACT

Tabulations and maps supported overview of state requirements and potential sources of power supply. 7 refs.

..... END OF OFF-LINE PRINT

.....
*
* THIS IS AN OFF-LINE CITATION LIST GENERATED BY
*
* _ORBIT_...
*
* S.D.C.'S INTERNATIONAL SEARCH SERVICE
*
*
*

METHANE FROM ORGANIC WASTES

NUMBER OF CITATIONS PRINTED = 43

FEBRUARY 8, 1979

THIS SEARCH WAS PERFORMED ON AGRICOLA

REQUESTED BY
VIGNONE

PLEASE SEND THIS LISTING TO

MARIA E. VIGNONE
AGENCY FOR INTERNATIONAL DEVELOPMENT 570 PP
WASHINGTON, D.C. 20523

-1-
ACCESSION NUMBER 789142428
TITLE SOLAR APPLICATIONS APPROPRIATE TO THE VILLAGE
(INCLUDES HYDROPOWER, BIOGAS, WINDMILLS, AND
PHOTOVOLTAIC POWER GENERATORS)
SOURCE IN WORKSHOP ON SOLAR ENERGY FOR THE VILLAGES
OF TANZANIA, P. 26-46.
PUBLICATION DATE 1978
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER TJB10.W62 1977
PRIMARY CATEGORY CODE 550500
INDEX TERM TANZANIA

-2-
ACCESSION NUMBER 789140933
TITLE METHAANGAS UIT DUNNE MEST / METHANE GAS FROM
LIQUID MANURE (BIOGAS, NEW SOURCES OF ENERGY)
AUTHORS POELMA, H R
SOURCE LANDBOUWKD TIJDSCHR. 90 (8): 206-208.
PUBLICATION DATE 1978 AUG
DOCUMENT TYPE ARTICLE
LANGUAGE DUT
NAL CALL NUMBER 105.2 GR3
PRIMARY CATEGORY CODE 550500
SECONDARY CATEGORY CODE 650500

63

-3-
ACCESSION NUMBER 789136678
TITLE BORTSKAFFELSE AF STALDGODNING GENNEM
KOMPOSTERING OG PRODUKTION AF BIOGAS /
DISPOSAL OF STABLE MANURE THROUGH COMPOSTING
AND PRODUCTION OF BIOGAS (ENERGY)
AUTHORS SAMS, T
SOURCE UGESKR AGRON HORTONOMER FORSTKANDIDATER
LICENTIATER. 123 (33): 791, 793-797.
PUBLICATION DATE 1978 AUG
DOCUMENT TYPE ARTICLE
LANGUAGE DAN
NAL CALL NUMBER S11.U35
PRIMARY CATEGORY CODE 601000
SECONDARY CATEGORY CODE 550500

-4-
ACCESSION NUMBER 789135141
TITLE ENERGY FROM ANIMAL WASTES (BIOGAS, METHANE)
ORGANIZATIONAL SOURCE MINNESOTA AGRICULTURAL EXPERIMENT STATION
SOURCE MINN SCI. 33 (3): 15.
PUBLICATION DATE 1977
DOCUMENT TYPE ARTICLE
SOURCE NAME AG EXP
LANGUAGE ENG
NAL CALL NUMBER 100 M668
PRIMARY CATEGORY CODE 550500

-5-
ACCESSION NUMBER 789132798
TITLE UTILIZATION OF LIVESTOCK EXCRETA FOR METHANE
GAS PRODUCTION (AGRICULTURAL WASTES)
AUTHORS HIGAKI, S
SOURCE J SOC AGRIC MACH JAP. 39 (1): 101-104.
PUBLICATION DATE 1977 JUN
DOCUMENT TYPE ARTICLE
LANGUAGE JPN
NAL CALL NUMBER 58.9 501
PRIMARY CATEGORY CODE 650500

-6-
ACCESSION NUMBER 789914038
TITLE THE FEASIBILITY OF METHANE PRODUCTION FROM
DAIRY ANIMAL WASTES: THE FARMER'S PERSPECTIVE
AUTHORS CAPENER, H R
AUTHORS BRAITHWAITE, D C
ORGANIZATIONAL SOURCE NEW YORK (STATE) AGRICULTURAL EXPERIMENT
STATION, GENEVA
ORGANIZATIONAL SOURCE NEW YORK (STATE) CORNELL AGRICULTURAL
EXPERIMENT STATION, ITHACA
SOURCE N Y FOOD LIFE SCI Q. 11(1): 18-20
PUBLICATION DATE 1978
DOCUMENT TYPE ARTICLE
SOURCE NAME US PUB
LANGUAGE ENG
NAL CALL NUMBER 595.E2
PRIMARY CATEGORY CODE 550500
INDEX TERM ENERGY
INDEX TERM FUEL
INDEX TERM DAIRY
INDEX TERM WASTE
INDEX TERM FEASIBILITY STUDIES
ABSTRACT EXTRACT: THE PURPOSE OF THE STUDY WAS TO
EXAMINE THE NATURE AND LEVEL OF THE FARMERS'
INTEREST IN UTILIZING READILY AVAILABLE
SUPPLIES OF ANIMAL WASTE TO GENERATE AN

ALTERNATIVE SOURCE OF ENERGY FOR THE FARM AND HOME. OF PRIMARY INTEREST WAS A BETTER UNDERSTANDING OF HOW GENERATING METHANE GAS FITS INTO THE WASTE HANDLING PROCEDURES AND POLLUTION-CONTROL REGULATIONS THAT FARMERS ARE CURRENTLY WRESTLING WITH. SINCE CORNELL ENGINEERS ARE STILL DESIGNING AND DEVELOPING THE FEASIBILITY FEATURES OF GENERATING METHANE GAS AT THE FARM SITE, DETAILED FINANCIAL ASPECTS WERE NOT FULLY EXPLORED.

-7-
ACCESSION NUMBER
TITLE

65
SOURCE
PUBLICATION DATE
DOCUMENT TYPE
SOURCE NAME
LANGUAGE
NAL CALL NUMBER
PRIMARY CATEGORY CODE
SECONDARY CATEGORY CODE
INDEX TERM
INDEX TERM
INDEX TERM

789112590
RESEARCH ON BIOGAS (METHANE) IN DEVELOPING COUNTRIES (FARM WASTE RECYCLING, PHILIPPINES, INDIA, AFRICA)
COMPOST SCI. 19 (2): 24-27.
1978 APR
ARTICLE
US PUB
ENG
57.8 C734
650500
550500
PHILIPPINE ISLANDS
INDIA
AFRICA

-8-
ACCESSION NUMBER
TITLE

AUTHORS
SOURCE
PUBLICATION DATE
DOCUMENT TYPE
SOURCE NAME
LANGUAGE
NAL CALL NUMBER
PRIMARY CATEGORY CODE
SECONDARY CATEGORY CODE

789112589
DOME-SHAPED BIOGAS PLANT (WASTE RECYCLING, METHANE GAS PRODUCTION, EQUIPMENT)
KHANDELWAL, K C
COMPOST SCI. 19 (2): 22-23.
1978 APR
ARTICLE
US PUB
ENG
57.8 C734
550500
650500

-7-
ACCESSION NUMBER 779101113
TITLE SOLAR ENERGY IN AGRICULTURE (SOLAR PUMP FOR
IRRIGATION, CABINET DRYER FOR FARM PRODUCTS,
WATER HEATER)
AUTHORS GARG, H P
SOURCE INDIAN FARMING, 27 (2): 21-22, 39.
PUBLICATION DATE 1977 MAY
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER 22 IN283
PRIMARY CATEGORY CODE 550500

-8-
ACCESSION NUMBER 779032315
TITLE SOLAR WATER PUMP FOR LIFT IRRIGATION
AUTHORS RAO, D P
AUTHORS RAO, K S
SOURCE SOL ENERGY, 18 (5): 405-411.
PUBLICATION DATE 1976
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER TJB10.A156
PRIMARY CATEGORY CODE 551000

..... END OF OFF-LINE PRINT

660

-4-
ACCESSION NUMBER 779127701
TITLE WATER PUMPS DRIVEN BY PHOTOVOLTAIC MODULES
(FOR LARGE SCALE IRRIGATION AND FULL
ELECTRIFICATION OF ARID AREAS. SOLAR ENERGY)
AUTHORS DURAND, H
AUTHORS NAAIJER, G J
SOURCE IN HELIOTECHNIQUE AND DEVELOPMENT;
PROCEEDINGS OF THE INTERNATIONAL CONFERENCE,
2: 315-330.
PUBLICATION DATE 1976
DOCUMENT TYPE ARTICLE
SOURCE NAME US PUB
LANGUAGE ENG
NAL CALL NUMBER TJB10.146 1975
PRIMARY CATEGORY CODE 550500

-5-
ACCESSION NUMBER 779127700
TITLE SOLAR ENERGY APPLICATIONS TO WATER PUMPING
AND AGRICULTURE (HEATING)
AUTHORS WEINEL, M P
SOURCE IN HELIOTECHNIQUE AND DEVELOPMENT;
PROCEEDINGS OF THE INTERNATIONAL CONFERENCE,
2: 307-314.
PUBLICATION DATE 1976
DOCUMENT TYPE ARTICLE
SOURCE NAME US PUB
LANGUAGE ENG
NAL CALL NUMBER TJB10.146 1975
PRIMARY CATEGORY CODE 550500

-6-
ACCESSION NUMBER 779121832
TITLE GETTING WATER FROM THE SUN (SOLAR ENERGY FOR
PUMPING, IRRIGATION)
AUTHORS LARSON, D L
AUTHORS SANDS, C D II
ORGANIZATIONAL SOURCE ARIZONA UNIVERSITY COOPERATIVE EXTENSION
SERVICE
ORGANIZATIONAL SOURCE ARIZONA UNIVERSITY COLLEGE OF AGRICULTURE
SOURCE PROG AGRIC ARIZ. 28 (4): 10-17.
PUBLICATION DATE 1976
DOCUMENT TYPE ARTICLE
SOURCE NAME AG EXP
LANGUAGE ENG
NAL CALL NUMBER 6 P9452
PRIMARY CATEGORY CODE 550500
SECONDARY CATEGORY CODE 602000

-1-
ACCESSION NUMBER 789133245
TITLE THE RECOVERY OF SOLAR ENERGY STORED IN GROUND
WATER HEAT PUMP EXPERIMENT (GREENHOUSE FUEL
CONSERVATION)
AUTHORS CORM. RY. Y
AUTHORS DALL. J L
SOURCE ACTA HORTIC. 76: 259-262.
PUBLICATION DATE 1978 JUL
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER 80 AC62
PRIMARY CATEGORY CODE 550500

-2-
ACCESSION NUMBER 789092899
TITLE BILAN TECHNIQUE ET ECONOMIQUE CONCERNANT
L'UTILISATION DE MOTOPOMPES SOLAIRES POUR LE
POMPAGE DE L'EAU EN ZONE SAHELIENNE /
TECHNICAL AND ECONOMIC BALANCE ON THE
UTILIZATION OF SOLAR MOTOR PUMPS FOR PUMPING
WATER IN THE SAHEL ZONE
AUTHORS DELAS. A
SOURCE BULL INF CNEEMA (CENT NATL ETUD EXP MACH
AGRIC). 240: 55-60.
PUBLICATION DATE 1978 JAN
DOCUMENT TYPE ARTICLE
LANGUAGE FRE
NAL CALL NUMBER 58.9 FB43B
PRIMARY CATEGORY CODE 550500
INDEX TERM AFRICA

-3-
ACCESSION NUMBER 779127702
TITLE WATER PUMPING--A PRACTICAL APPLICATION OF
SOLAR ENERGY
AUTHORS FIATTE. F
AUTHORS CLEMOT. M
SOURCE IN HELIOTECHNIQUE AND DEVELOPMENT;
PROCEEDINGS OF THE INTERNATIONAL CONFERENCE.
2: 331-339.
PUBLICATION DATE 1976
DOCUMENT TYPE ARTICLE
SOURCE NAME US PUB
LANGUAGE ENG
NAL CALL NUMBER TJB10.146 1975
PRIMARY CATEGORY CODE 550500
INDEX TERM REVIEW

F8074606

.....
.
THIS IS AN OFF-LINE CITATION LIST GENERATED BY
_ORBIT_IV
S.D.C.'S INTERNATIONAL SEARCH SERVICE
.
.....

SOLAR ENERGY FOR PUMPING WATER

NUMBER OF CITATIONS PRINTED = 8

FEBRUARY 8, 1979

THIS SEARCH WAS PERFORMED ON AGRICOLA

REQUESTED BY
VIGNONE

PLEASE SEND THIS LISTING TO

MARIA E VIGNONE
AGENCY FOR INTERNATIONAL DEVELOPMENT 570 PP
WASHINGTON, D.C. 20523

NAL CALL NUMBER 448.3 C33 (3)
PRIMARY CATEGORY CODE 600500

-42-
ACCESSION NUMBER
TITLE

9063954
CHANGES IN BIOCHEMICAL CONSTITUENT OF SOME
ORGANIC WASTE MATERIALS UNDER ANAEROBIC
METHANE FERMENTATION. (AGRICULTURAL PRODUCTS)
AUTHORS PRASAD, C R
AUTHORS GULATI, K C
AUTHORS IDNANI, M A
SOURCE INDIAN J AGR SCI, 40 (10): 921-924.
PUBLICATION DATE 1970 OCT
NOTES BIBLIOGRAPHY: P. 923-924.
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER 22 AG831
PRIMARY CATEGORY CODE 150000

-43-
ACCESSION NUMBER
TITLE

9071629
METHANE FORMATION OF SOME ORGANIC MATERIALS
ADMIXED WITH COWDUNG
AUTHORS PRASAD, C R
AUTHORS GULATI, K C
AUTHORS IDNANI, M A
SOURCE INDIAN J AGR SCI, 40 (4): 360-365.
PUBLICATION DATE 1970 APR
NOTES BIBLIOGRAPHY: P. 364-365.
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER 22 AG831
PRIMARY CATEGORY CODE 800000

..... END OF OFF-LINE PRINT

NAL CALL NUMBER 511.493
PRIMARY CATEGORY CODE 650500

-39-
ACCESSION NUMBER 749056106
TITLE METHANE GAS PRODUCTION FROM ANIMAL WASTES
AUTHORS LAPP, H M
AUTHORS SCHULTE, D D
AUTHORS BUCHANAN, L C
SOURCE PUBL AGRIC CAN. 1528. 9 P.
PUBLICATION DATE 1974
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER 7 C16PU
PRIMARY CATEGORY CODE 650500

-40-
ACCESSION NUMBER 9399293
TITLE BIO-GAS PLANT / GENERATING METHANE FROM
ORGANIC WASTES
AUTHORS SINGH, RAM BUX
ORGANIZATIONAL SOURCE GOBAR GAS RESEARCH STATION
SOURCE AJITMAL, INDIA, GOBAR GAS RESEARCH STATION,
95 P. ILLUS.
PUBLICATION DATE 1973
DOCUMENT TYPE MONOGRAPH
LANGUAGE ENG
NAL CALL NUMBER OD305.HG55
PRIMARY CATEGORY CODE 800500
INDEX TERM METHANE
INDEX TERM WASTE PRODUCTS

-41-
ACCESSION NUMBER 9134374
TITLE ABBAU VON HUMINSAUREN UND BITUMEN / 13C
(CARBON)/12C- INVESTIGATIONS/12C-UNTERSUCHUNGEN
AM ENTSTEHENDEN BIOGAS BEIM MIKROBIELLEN
DECOMPOSITION OF HUMIC ACIDS AND BITUMEN
AUTHORS MATSCHKE, J
AUTHORS MASS, I
AUTHORS GEISSLER, C
AUTHORS STEINBRENNER, K
SOURCE ZENTRALB BAKTERIOL PARASITENK INFektionsKR
HYG ABT 2 NATURW. 127 (2): 166-171. REF. ENG.
SUM.
PUBLICATION DATE 1972
DOCUMENT TYPE ARTICLE
LANGUAGE GER

-35-
ACCESSION NUMBER 749112317
TITLE STATE OF THE ART: METHANE GAS GENERATION FROM
AGRICULTURAL WASTES. (ENERGY SOURCES)
AUTHORS MILNE, C M
ORGANIZATIONAL SOURCE MONTANA STATE UNIVERSITY COOPERATIVE
EXTENSION SERVICE
SOURCE FOL COOP EXT SERV AGRIC EXP STN MONT STATE
UNIV. 160. 7 P.
PUBLICATION DATE 1974 APR
DOCUMENT TYPE ARTICLE
SOURCE NAME AG EXT
LANGUAGE ENG
NAL CALL NUMBER 275.29 M76FL
PRIMARY CATEGORY CODE 650500

-36-
ACCESSION NUMBER 749097359
TITLE IS IT POSSIBLE TO CONVERT ANIMAL WASTES TO
METHANE GAS?
SOURCE HOARDS DAIRYM, 119 (20): 1240B-1240C
PUBLICATION DATE 1974 OCT
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER 44.B H65
PRIMARY CATEGORY CODE 650500

-37-
ACCESSION NUMBER 749082327
TITLE WIE AKTUELL IST HEUTE BIOGAS? / HOW CURRENT
IS BIOGAS TODAY? (FUELS)
AUTHORS DÖHNE, E
AUTHORS BRENNENDORFER, M
SOURCE LANDTECHNIK, 29 (7): 302-307.
PUBLICATION DATE 1974 JUL
DOCUMENT TYPE ARTICLE
LANGUAGE GER
NAL CALL NUMBER 58.B L235
PRIMARY CATEGORY CODE 550500

-38-
ACCESSION NUMBER 749064520
TITLE PRODUKTION AF BIOGAS FRA SVINEGODNING /
PRODUCTION OF BIOGAS FROM SWINE MANURE
SOURCE DET NYE DAN LANDBRUG, 5 (4): 14-15.
PUBLICATION DATE 1974 APR
DOCUMENT TYPE ARTICLE
LANGUAGE DAN

-32-
ACCESSION NUMBER 759018345
TITLE ALTERNATIVE ENERGIKILDER. 3. BIOGAS--ELLER
GODNINGSGAS / ALTERNATIVE ENERGY SOURCES. 3.
BIOGAS OR MANURE GAS
AUTHORS BERTHELSEN, I
SOURCE UGESKR AGRON. 3 (21): 427-429.
PUBLICATION DATE 1974 MAY
DOCUMENT TYPE ARTICLE
LANGUAGE DAN
NAL CALL NUMBER 511.034
PRIMARY CATEGORY CODE 650500

-33-
ACCESSION NUMBER 759431975
TITLE STATE OF THE ART / METHANE GAS GENERATION
FROM AGRICULTURAL WASTES
AUTHORS MILNE, CHARLES M
SOURCE BOZEMAN, (7) P.
PUBLICATION DATE 1974
SERIES STATEMENT MONTANA STATE UNIVERSITY. COOPERATIVE
EXTENSION SERVICE. FOLDER 100
DOCUMENT TYPE MONOGRAPH
SOURCE NAME AG EXT
LANGUAGE ENG
NAL CALL NUMBER 275.29 M76FOL NO.160
PRIMARY CATEGORY CODE 650500

-34-
ACCESSION NUMBER 759004462
TITLE METHANE FROM MANURE AT THE ORGANIC
DEMONSTRATION FARM: WE'RE LEARNING HOW TO TAKE
A LITTLE ENERGY FROM MANURE BEFORE RETURNING
IT TO THE FIELDS
AUTHORS SMYSER, S
SOURCE ORG GARD FARMING, 21 (10): 30-32, 34.
PUBLICATION DATE 1974 OCT
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER 57.8 OR32
PRIMARY CATEGORY CODE 550500
INDEX TERM PENNSYLVANIA

7

-29-

ACCESSION NUMBER 759111322
TITLE FROM WASTE TO GAS: BUILD YOUR OWN GENERATOR
(GARBAGE AND ANIMAL MANURE CAN PRODUCE
METHANE GAS)
SOURCE AGRIC LOS BANDS. 13 (3): 9-10.
PUBLICATION DATE 1974 SEP
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER S19 A3
PRIMARY CATEGORY CODE 650500

-30-

ACCESSION NUMBER 759657874
TITLE BIO-GAS PLANT / GENERATING METHANE FROM
ORGANIC WASTES
AUTHORS SINGH, RAM BUX
ORGANIZATIONAL SOURCE GOBAR GAS RESEARCH STATION
SOURCE AJITHAL, GOBAR GAS RESEARCH STATION, 103 P.
ILLUS.
PUBLICATION DATE 1974
NOTES REPRINT OF THE 1973 ED. BIBLIOGRAPHY: P.
69-70.
DOCUMENT TYPE MONOGRAPH
LANGUAGE ENG
NAL CALL NUMBER QD305.H655 1974
PRIMARY CATEGORY CODE 800500
INDEX TERM METHANE
INDEX TERM WASTE PRODUCTS

-31-

ACCESSION NUMBER 759077932
TITLE FUEL FROM ORGANIC WASTE: METHANE GAS
PRODUCTION
AUTHORS BOSHOFF, W H
SOURCE SPAN. 18 (1): 29-30.
PUBLICATION DATE 1975
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER 4G4.B SP2
PRIMARY CATEGORY CODE 550500

-26-
 ACCESSION NUMBER 759666125
 TITLE METHANE : / (ATOMIC ROOSTER'S HERE) / BY
 STEVEN SAMPSON ; EDITED BY ANDREW MACKILLOP.
 --
 AUTHORS SAMPSON, STEVEN.
 SOURCE WADEBRIDGE : WADEBRIDGE ECOLOGICAL CENTRE.,
 (1), 72 P. : ILL., FACSIMS., PLANS : 30 CM.
 PUBLICATION DATE 1974
 NOTES BIBLIOGRAPHY: P. 69-81.
 DOCUMENT TYPE MONOGRAPH
 LANGUAGE ENG
 NAL CALL NUMBER TD930 .S25
 PRIMARY CATEGORY CODE 650500
 INDEX TERM AGRICULTURAL WASTES.
 INDEX TERM REFUSE AS FUEL.
 INDEX TERM METHANE.

-27-
 ACCESSION NUMBER 769025603
 TITLE METHANE PRODUCTION FROM ANIMAL WASTES. 1.
 FUNDAMENTAL CONSIDERATIONS
 AUTHORS LAPP, H M
 AUTHORS SCHULTE, D D
 AUTHORS SPARLING, A B
 AUTHORS BUCHANAN, L C
 SOURCE CAN AGRIC ENG. 17 (2): 97-102. REF.
 PUBLICATION DATE 1975 DEC
 DOCUMENT TYPE ARTICLE
 LANGUAGE ENG
 NAL CALL NUMBER 5B.B C164
 PRIMARY CATEGORY CODE 650500

-28-
 ACCESSION NUMBER 769021130
 TITLE METHANE'S BIG TEST (ENERGY AND MANURE FROM
 ANIMAL WASTES)
 AUTHORS WOLF, R
 SOURCE ORG GARD FARMING. 22 (12): 136. 138-139.
 PUBLICATION DATE 1975 DEC
 DOCUMENT TYPE ARTICLE
 LANGUAGE ENG
 NAL CALL NUMBER 57.B OR32
 PRIMARY CATEGORY CODE 550500
 SECONDARY CATEGORY CODE 601000

INDEX TERM AGRICULTURAL WASTES
 INDEX TERM BIBLIOGRAPHY.
 INDEX TERM METHANE
 INDEX TERM BIBLIOGRAPHY
 INDEX TERM ANIMAL WASTE
 INDEX TERM BIBLIOGRAPHY.
 INDEX TERM MANURE GASES
 INDEX TERM BIBLIOGRAPHY.
 INDEX TERM BACTERIA, ANAEROBIC
 INDEX TERM BIBLIOGRAPHY.

-24-
 ACCESSION NUMBER 769674282
 TITLE FOOD, FUEL, FERTILIZER : / PROCEEDINGS /
 EDITOR: PETER J. CATANIA. --
 AUTHORS CATANIA, PETER J. ED.
 ORGANIZATIONAL SOURCE SYMPOSIUM (ON) USES OF AGRICULTURAL WASTES.
 REGINA, SASKATCHEWAN, 1974.
 ORGANIZATIONAL SOURCE CANADIAN PLAINS RESEARCH CENTER.
 SOURCE REGINA, SASKATCHEWAN : CANADIAN PLAINS
 RESEACH CENTER., VI. 371 P. : ILL. --
 PUBLICATION DATE 1975
 SERIES STATEMENT CANADIAN PLAINS PROCEEDINGS : V. 2.
 DOCUMENT TYPE MONOGRAPH
 LANGUAGE ENG
 NAL CALL NUMBER S655.S9 1974
 PRIMARY CATEGORY CODE 100500
 INDEX TERM AGRICULTURAL WASTES
 INDEX TERM CONGRESSES.
 INDEX TERM FERTILIZERS AND MANURES
 INDEX TERM CONGRESSES.
 INDEX TERM METHANE.

-25-
 ACCESSION NUMBER 769082686
 TITLE THE ECONOMIC AND TECHNICAL FEASIBILITY OF
 METHANE GENERATION FROM AGRICULTURAL WASTES
 AUTHORS JEWELL, W J
 AUTHORS MORRIS, G R
 SOURCE IN FOOD, FUEL, FERTILIZER; PROCEEDINGS OF
 SYMPOSIUM ON USES OF AGRICULTURAL WASTES. P.
 132-164. REF.
 PUBLICATION DATE 1975
 DOCUMENT TYPE ARTICLE
 LANGUAGE ENG
 NAL CALL NUMBER S655.S9 1974
 PRIMARY CATEGORY CODE 650500

-21-
ACCESSION NUMBER 779012593
TITLE UTILIZATION OF BIOGAS FOR FARM PRODUCTION
ENERGY
AUTHORS WILLIAMS, D W
AUTHORS MCCARTY, T R
AUTHORS MORRIS, G R
AUTHORS GUNKEL, W W
AUTHORS PRICE, D R
SOURCE TRANS ASAE (AM SOC AGRIC ENG), 19 (6):
1034-1040, 1044, REF.
PUBLICATION DATE 1976 DEC
DOCUMENT TYPE ARTICLE
SOURCE NAME US PUB
LANGUAGE ENG
NAL CALL NUMBER 290.9 AM321
PRIMARY CATEGORY CODE 550500

-22-
ACCESSION NUMBER 769119351
TITLE EFFECT OF TEMPERATURE, INOCULUM AND AGITATION
ON (FUEL) BIOGAS PRODUCTION FROM CATTLE DUNG
AUTHORS NEELAKANTAN, S
AUTHORS SONDHI, H S
AUTHORS MITTAL, C P
SOURCE INDIAN J DAIRY SCI, 29 (3): 226-229.
PUBLICATION DATE 1976 SEP
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER 44.B 1N2B
PRIMARY CATEGORY CODE 200500

-23-
ACCESSION NUMBER 769673929
TITLE THE ANAEROBIC DIGESTION OF LIVESTOCK WASTES
TO PRODUCE METHANE, 1946-JUNE 1975 : / A
BIBLIOGRAPHY WITH ABSTRACTS / COMPILED BY
GREGG SHADDUCK, JAMES A. MOORE. --
AUTHORS SHADDUCK, GREGG
AUTHORS MOORE, JAMES A; COMP.
ORGANIZATIONAL SOURCE MINNESOTA UNIVERSITY, DEPT. OF AGRICULTURAL
ENGINEERING.
SOURCE (ST. PAUL, MINN : AGRICULTURAL ENGINEERING
DEPT., UNIVERSITY OF MINNESOTA), VIII, 103 P.
: ILL.
PUBLICATION DATE 1975
DOCUMENT TYPE MONOGRAPH
LANGUAGE ENG
NAL CALL NUMBER Z5074.W355
PRIMARY CATEGORY CODE 650500

-18-
ACCESSION NUMBER 779071017
TITLE PRODUCING METHANE GAS FROM ANIMAL WASTES
(HEAT ENERGY FROM ORGANIC MATERIALS)
ORGANIZATIONAL SOURCE U.S. AGRICULTURAL RESEARCH SERVICE
SOURCE CA-H U S AGRIC RES SERV. 10, 3 P.
PUBLICATION DATE 1974 AUG
DOCUMENT TYPE ARTICLE
SOURCE NAME USDA
LANGUAGE ENG
NAL CALL NUMBER AS21 R44A2
PRIMARY CATEGORY CODE 550500

-19-
ACCESSION NUMBER 779064207
TITLE GAS METANO O "BIOGAS": FUENTE BARATA DE
ENERGIA Y FERTILIZANTE DEL GUANO ANIMAL /
METHANE GAS, OR "BIOGAS", A CHEAP SOURCE OF
ENERGY AND FERTILIZER FROM ANIMAL GUANO
AUTHORS JEDLICKA, A
SOURCE SIMIENTE. 46 (3/4): 33-37.
PUBLICATION DATE 1976 DEC
DOCUMENT TYPE ARTICLE
LANGUAGE SPA
NAL CALL NUMBER 9.3 514
PRIMARY CATEGORY CODE 601000

-20-
ACCESSION NUMBER 779044229
TITLE BIOGAS ELLER KOMPOSTERINGSVARME / BIOGAS OR
COMPOSTING HEAT (ENERGY SOURCES)
AUTHORS BERTHELSEN, L
SOURCE UGESKR AGRON HORTONOMER FORSTKANDIDATER
LICENTIATER. 122 (8/9): 162-164.
PUBLICATION DATE 1977 FEB
DOCUMENT TYPE ARTICLE
LANGUAGE DAN
NAL CALL NUMBER S11 U34
PRIMARY CATEGORY CODE 550500
SECONDARY CATEGORY CODE 200500

117

88

METHANE FROM ORGANIC WASTES

-15-
 ACCESSION NUMBER 789024681
 TITLE BIOGAS--SCHLAGWORT ODER REALITAT? / BIOGAS. A
 KEY WORD OR REALITY? (POSSIBLE USE IN FARMING)
 AUTHORS BIOLLEY, R
 SOURCE GRUNE. 105 (50): 23-27.
 PUBLICATION DATE 1977 DEC
 DOCUMENT TYPE ARTICLE
 LANGUAGE GER
 NAL CALL NUMBER 17 SCH9
 PRIMARY CATEGORY CODE 550500

-16-
 ACCESSION NUMBER 779131672
 TITLE A COST-BENEFIT ANALYSIS OF BIOGAS PRODUCTION
 IN RURAL INDIA: SOME POLICY ISSUES
 AUTHORS SANGHI, A K
 AUTHORS DAY, D
 SOURCE IN AGRICULTURE AND ENERGY. W. LOCKERETZ, ED.,
 P. 607-724. REF.
 PUBLICATION DATE 1977
 DOCUMENT TYPE ARTICLE
 SOURCE NAME US PUB
 LANGUAGE ENG
 NAL CALL NUMBER 5494.5 F5A37
 PRIMARY CATEGORY CODE 550500
 SECONDARY CATEGORY CODE 101500
 INDEX TERM INDIA

-17-
 ACCESSION NUMBER 779108789
 TITLE PRODUCTION OF PANELBOARD FROM RESIDUE LEFT
 FROM THE FERMENTATION OF ORGANIC WASTE
 (MIXTURE OF WOODY TISSUE, PAPER, AND OTHER
 PLANT MATERIALS) FOR METHANE
 AUTHORS WALTERS, C S
 AUTHORS PFEFFER, J I
 AUTHORS CHOW, P
 SOURCE FOR PROD J. 27 (9): 12-20. REF.
 PUBLICATION DATE 1977 SEP
 DOCUMENT TYPE ARTICLE
 SOURCE NAME US PUB
 LANGUAGE ENG
 NAL CALL NUMBER 99.9 F7662J
 PRIMARY CATEGORY CODE 650500
 SECONDARY CATEGORY CODE 352000

-12-
ACCESSION NUMBER 789045780
TITLE BIOGAS TECHNOLOGY UTILISATION IN INDIA
(EFFICIENT USE OF ORGANIC WASTE MATERIALS)
AUTHORS SIKKA, P
SOURCE SCI CULT, 44 (1): 24-26.
PUBLICATION DATE 1978 JAN
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER 475 SCI24
PRIMARY CATEGORY CODE 550500
SECONDARY CATEGORY CODE 650500
INDEX TERM INDIA

-13-
ACCESSION NUMBER 78903313B
TITLE METHANE FERMENTATION OF ANIMAL WASTES
AUTHORS MILLER, D L
SOURCE IN A CONFERENCE ON CAPTURING THE SUN THROUGH
BIOCONVERSION; PROCEEDINGS, P. 361-364.
PUBLICATION DATE 1976
DOCUMENT TYPE ARTICLE
SOURCE NAME USDA
LANGUAGE ENG
NAL CALL NUMBER TP360 C66
PRIMARY CATEGORY CODE 650500

-14-
ACCESSION NUMBER 789032721
TITLE BIOGAS PRODUCTION DURING ANAEROBIC DIGESTION
OF LIVESTOCK EXCRETA
AUTHORS BANSAL, M L
AUTHORS MITTAL, C P
AUTHORS SONDHI, H S
AUTHORS NEELAKANTAN, S
SOURCE INDIAN J DAIRY SCI, 30 (4): 338-340. REF.
PUBLICATION DATE 1977 DEC
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER 44.8 IN2B
PRIMARY CATEGORY CODE 650500

08

-9-
ACCESSION NUMBER 789089408
TITLE BIOGAS--ALTERNATIV ENERGI? /
BIOGAS--ALTERNATIVE FORM OF ENERGY?
AUTHORS GRON, G
AUTHORS CHRISTENSEN, J
SOURCE UGESKR AGRON HORTONOMER FORSTKANDIDATER
LICENTIATER, 122 (26): 543-546.
PUBLICATION DATE 1977 JUN
DOCUMENT TYPE ARTICLE
LANGUAGE DAN
NAL CALL NUMBER 511.035
PRIMARY CATEGORY CODE 550500

-10-
ACCESSION NUMBER 789086788
TITLE FUELS VIA BIOCONVERSION (PHOTOSYNTHETIC
PRODUCTION OF ORGANIC MATTER AND THE
SUBSEQUENT PROCESSING OF THIS MATERIAL TO
OTHER FUELS SUCH AS ALCOHOL AND METHANE)
AUTHORS KEENAN, J D
SOURCE ENERGY CONVERS, 16 (3): 95-103. REF.
PUBLICATION DATE 1977
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER TK2896.E49
PRIMARY CATEGORY CODE 550500

-11-
ACCESSION NUMBER 789057001
TITLE ANAEROBIC FERMENTATION OF PLANT MATERIALS
INTO ACIDS AND BIOGAS (UTILIZATION OF
AGRICULTURAL AND ANIMAL WASTES AS AN ENERGY
SOURCE)
AUTHORS NEELAKANTAN, S
AUTHORS SONDHI, H S
AUTHORS MANDCHA, A
AUTHORS SARMA, S C
SOURCE CURR SCI, 47 (5): 149-151.
PUBLICATION DATE 1978 MAR
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER 475 SCI23
PRIMARY CATEGORY CODE 200500
SECONDARY CATEGORY CODE 650500

18

THIS IS AN OFF-LINE CITATION LIST GENERATED BY
_ORBIT_IV
S.D.C.'S INTERNATIONAL SEARCH SERVICE

WINDMILLS

NUMBER OF CITATIONS PRINTED = 57

FEBRUARY 15, 1979

THIS SEARCH WAS PERFORMED ON AGRICOLA

REQUESTED BY
VIGNONE

PLEASE SEND THIS LISTING TO

MARIA E. VIGNONE
AGENCY FOR INTERNATIONAL DEVELOPMENT 570 PP
WASHINGTON, D.C. 20523

82

-1-
 ACCESSION NUMBER 789673916
 TITLE ENGINEERING OF WIND ENERGY SYSTEMS / / JAMES
 F. SANAS, WILLIAM N. SULLIVAN. --
 AUTHORS BANAS, JAMES F
 SULLIVAN, WILLIAM N
 ORGANIZATIONAL SOURCE SANDIA LABORATORIES,
 SOURCE ALBUQUERQUE, N.M. : SANDIA LABORATORIES :
 AVAILABLE FROM NATIONAL TECHNICAL INFORMATION
 SYSTEM., 27 P. : ILL. --
 PUBLICATION DATE 1976
 NOTES PREPARED BY SANDIA LABORATORIES FOR THE
 UNITED STATES ENERGY RESEARCH AND DEVELOPMENT
 ADMINISTRATION UNDER CONTRACT AT (29-1)-789.
 SERIES STATEMENT INCLUDES BIBLIOGRAPHICAL REFERENCES.
 DOCUMENT TYPE SANDIA LABORATORIES. SSAND : 75-0530
 SOURCE NAME MONOGRAPH
 LANGUAGE US PUB
 NAL CALL NUMBER ENG
 PRIMARY CATEGORY CODE T4925.B38
 INDEX TERM B50500
 INDEX TERM WINDMILLS.
 INDEX TERM AIR-TURBINES.
 INDEX TERM POWER (MECHANICS)

-2-
 ACCESSION NUMBER 789142428
 TITLE SOLAR APPLICATIONS APPROPRIATE TO THE VILLAGE
 (INCLUDES HYDROPOWER, BIOMASS, WINDMILLS, AND
 PHOTOVOLTAIC POWER GENERATORS)
 SOURCE IN WORKSHOP ON SOLAR ENERGY FOR THE VILLAGES
 OF TANZANIA, P. 26-46.
 PUBLICATION DATE 1978
 DOCUMENT TYPE ARTICLE
 LANGUAGE ENG
 NAL CALL NUMBER TUR10.W62 1977
 PRIMARY CATEGORY CODE B50500
 INDEX TERM TANZANIA

-3-
 ACCESSION NUMBER 789700169
 TITLE WIND POWER POTENTIAL OF ALASKA / / TUNIS
 WENTINK. --
 AUTHORS WENTINK, TUNIS
 SOURCE (SPRINGFIELD, VA.) : NATIONAL TECHNICAL
 INFORMATION SERVICE., 2 V.
 PUBLICATION DATE 1976
 NOTES PT. I PREPARED FOR NATIONAL SCIENCE
 FOUNDATION, PT. II PREPARED FOR ENERGY
 RESEARCH AND DEVELOPMENT ADMINISTRATION.

DOCUMENT TYPE	DIVISION OF SOLAR ENERGY. PB-238 507.
SOURCE NAME	FLD/2729/T12-76/1. INCLUDES BIBLIOGRAPHICAL
LANGUAGE	REFERENCES.
NAL CALL NUMBER	MONOGRAPH
PRIMARY CATEGORY CODE	US PUB
INDEX TERM	ENG
INDEX TERM	00931.W4
INDEX TERM	650500
INDEX TERM	WIND POWER.
	WINDS
	ALASKA
	WINDMILLS.

-4-	
ACCESSION NUMBER	789128436
TITLE	EVALUATION OF TEMPERATURE INVERSIONS AND WIND
	MACHINE ON FROST PROTECTION IN SOUTHERN
	OREGON (ORCHARD CROPS)
AUTHORS	BATES, E
ORGANIZATIONAL SOURCE	LONSARD, P
SOURCE	OREGON AGRICULTURAL EXPERIMENT STATION
PUBLICATION DATE	SPEC REP OREG AGRIC EXP STN. 514. 19 P.
DOCUMENT TYPE	1978 JUL
SOURCE NAME	ARTICLE
LANGUAGE	AG EXP
NAL CALL NUMBER	ENG
PRIMARY CATEGORY CODE	100 OR3M
SECONDARY CATEGORY CODE	452000
INDEX TERM	351000
	OREGON

-5-	
ACCESSION NUMBER	789103337
TITLE	WIND- UND WASSERMUHLN IM
	SCHLESWIG-HOLSTEINISCHEN FREILICHTMUSEUM /
	WIND AND WATER MILLS IN THE
	SCHLESWIG-HOLSTEIN OUTDOOR MUSEUM
AUTHORS	FINCK, H
SOURCE	MUHLE MISCHFUTTERLICH. 114 (40): 575-577.
PUBLICATION DATE	1977 OCT
DOCUMENT TYPE	ARTICLE
LANGUAGE	GER
NAL CALL NUMBER	298.B M89
PRIMARY CATEGORY CODE	550500
INDEX TERM	GERMANY (FEDERAL REPUBLIC)

-6-
ACCESSION NUMBER 779662764
TITLE WINDMILLS / / BY FRANK BRANGWYN AND HAYTER
PRESTON. --
AUTHORS BRANGWYN, FRANK SIR; 1867-1956.
AUTHORS PRESTON, HAYTER; 1891-
ORGANIZATIONAL SOURCE GALE RESEARCH COMPANY.
SOURCE DETROIT, GALE RESEARCH CO... 126 P. ILLUS. 22
CV.
PUBLICATION DATE 1923
NOTES REPRINT OF THE 1923 ED.
DOCUMENT TYPE MONOGRAPH
LANGUAGE ENG
NAL CALL NUMBER T.823.P7 1975
PRIMARY CATEGORY CODE B50500
INDEX TERM WINDMILLS.

-7-
ACCESSION NUMBER 789081255
TITLE CALCULO DE AGUADAS / CALCULATION OF
(WINDMILL-OPERATED LIVESTOCK) WATERING
SYSTEMS (ENGINEERING ASPECTS)
AUTHORS MENDEZ DUHAU, F
AUTHORS GASSIBAYLE, E
SOURCE REV CREA ASOC ARGENT CONSORCIOS REG EXP
AGRIC. 12 (64): 39-43.
PUBLICATION DATE 1977 AFR
DOCUMENT TYPE ARTICLE
LANGUAGE SPA
NAL CALL NUMBER 5535.A748
PRIMARY CATEGORY CODE 550500

-8-
ACCESSION NUMBER 789066406
TITLE WIND POWER FOR INDIA (WINDMILLS COULD PROVIDE
BOTH WATER AND ELECTRICITY FOR VILLAGERS)
AUTHORS TEWARI, S K
SOURCE SUNWORLD, 4: 7-9.
PUBLICATION DATE 1977 MAY
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER T.810.A159
PRIMARY CATEGORY CODE 550500
INDEX TERM INDIA

-9-

ACCESSION NUMBER 789036200
TITLE ENERGY FROM THE WIND (WINDMILLS)
AUTHORS PATRICK, M A
SOURCE EDUC CHEM, 15 (1): 12-15, MAP.
PUBLICATION DATE 1978 JAN
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER QD1.E3
PRIMARY CATEGORY CODE 550500

-10-

ACCESSION NUMBER 779691118
TITLE WINDMILLS OF ENGLAND / / BY R. J. BROWN. --
AUTHORS BROWN, R J: 1937-
SOURCE LONDON : HALE.. 256 P. : ILL.
PUBLICATION DATE 1976
NOTES BIBLIOGRAPHY: P. 251. INCLUDES INDEX.
DOCUMENT TYPE MONOGRAPH
LANGUAGE ENG
NAL CALL NUMBER T4R25.B7
PRIMARY CATEGORY CODE 550500
INDEX TERM WINDMILLS
INDEX TERM ENGLAND.

-11-

ACCESSION NUMBER 779688937
TITLE MASHINY DLIA ZASHCHITY POCHV OT VETROVOI
EROSII / / N. V. KRASNOSHCHIEKOV. - / MACHINES
FOR SOIL PROTECTION AGAINST WIND EROSION.
AUTHORS KRASNOSHCHIEKOV, NIKOLAI VASIL'EVICH
SOURCE MOSKVA : ROSSEL'KHOZIZDAT.. 222 P. : ILL.
PUBLICATION DATE 1977
DOCUMENT TYPE MONOGRAPH
LANGUAGE RUS
NAL CALL NUMBER 5683.K7
PRIMARY CATEGORY CODE 551000
SECONDARY CATEGORY CODE 601500
INDEX TERM AGRICULTURAL MACHINERY
INDEX TERM RUSSIA.
INDEX TERM SOIL EROSION
INDEX TERM RUSSIA.
INDEX TERM SOIL CONSERVATION
INDEX TERM RUSSIA.

7

-12-
 ACCESSION NUMBER 779686680
 TITLE FOOD FROM WINDMILLS : / A REPORT ON THE WIND
 MILL IRRIGATION PROJECT INITIATED BY THE
 AMERICAN PRESBYTERIAN MISSION AT ONO STATION
 IN ETHIOPIA / BY PETER L. FRAENKEL : (FOR
 THE) INTERMEDIATE TECHNOLOGY DEVELOPMENT
 GROUP LTD. --
 AUTHORS' FRAENKEL, PETER
 SOURCE LONDON : (INTERMEDIATE TECHNOLOGY
 PUBLICATIONS LTD.).. (5). 56. XIX P. : ILL..
 MAP. PORTS. : 30 CM.
 PUBLICATION DATE 1975
 NOTES BIBLIOGRAPHY: P. XVIII-XIX.
 DOCUMENT TYPE MONOGRAPH
 LANGUAGE ENG
 NAL CALL NUMBER TC927.F7
 PRIMARY CATEGORY CODE BS0500
 INDEX TERM IRRIGATION ENGINEERING.
 INDEX TERM WINDMILLS.
 INDEX TERM UNDERDEVELOPED AREAS
 INDEX TERM TECHNOLOGY.

-13-
 ACCESSION NUMBER 779681840
 TITLE WIND-CATCHERS : / AMERICAN WINDMILLS OF
 YESTERDAY AND TOMORROW / VOLTA TORREY. --
 AUTHORS' TORREY, VOLTA: 1905-
 SOURCE BRATTLEBORO VT. : S. GREENE PRESS.. XI. 226
 P. : ILL. : 24 CM.
 PUBLICATION DATE 1976
 NOTES INCLUDES BIBLIOGRAPHICAL REFERENCES AND INDEX.
 DOCUMENT TYPE MONOGRAPH
 SOURCE NAME US PUB
 LANGUAGE ENG
 NAL CALL NUMBER TH923.T67
 PRIMARY CATEGORY CODE SS0500
 INDEX TERM WINDMILLS
 INDEX TERM UNITED STATES
 INDEX TERM HISTORY.
 INDEX TERM WINDMILLS
 INDEX TERM HISTORY.

LIB 112

-14-
ACCESSION NUMBER
TITLE

AUTHORS
SOURCE

PUBLICATION DATE
DOCUMENT TYPE
LANGUAGE
NAL CALL NUMBER
PRIMARY CATEGORY CODE
SECONDARY CATEGORY CODE
INDEX TERM

779065133
RESULTS OF DEVELOPMENT OF SOIL PROTECTIVE
TECHNOLOGY AND EVALUATION OF A SYSTEM OF
MACHINES FOR SOILS LIABLE TO WIND EROSION IN
THE STEPPE AREAS OF THE ALTAI TERRITORY
RADIUKHIN, A S
IN VETROVAIA EROZIJA I PLODORODIE POCHV. A.
I. SARAJEV, & OTHERS, EDS., P. 151-155.
1976
ARTICLE
RUS
S625.RBV4
601500
551000
USSR

-15-
ACCESSION NUMBER
TITLE

AUTHORS
SOURCE
PUBLICATION DATE
DOCUMENT TYPE
LANGUAGE
NAL CALL NUMBER
PRIMARY CATEGORY CODE
INDEX TERM

779062713
AN EVALUATION OF FROST PROTECTION (IN AN
APPLE ORCHARD) PROVIDED BY A WIND MACHINE IN
THE OKANAGAN VALLEY OF BRITISH COLUMBIA
DAVIS, R L
CAN J PLANT SCI. 57 (1): 71-74.
1977 JAN
ARTICLE
ENG
450 C16
452000
CANADA

-16-
ACCESSION NUMBER
TITLE

AUTHORS
SOURCE

PUBLICATION DATE
DOCUMENT TYPE
SOURCE NAME
LANGUAGE
NAL CALL NUMBER
PRIMARY CATEGORY CODE

779059432
THE CONSUMER'S COST OF ELECTRICITY FROM
WINDMILLS
QUINN, B
IN INTERSOCIETY ENERGY CONVERSION ENGINEERING
CONFERENCE PROCEEDINGS, 11TH (V. 2):
1746-1753.
1976
ARTICLE
US PUB
ENG
TJ163.9.157 1976
550500

88

-17-
 ACCESSION NUMBER 779033808
 TITLE A SET OF MACHINES AND IMPLEMENTS FOR AREAS
 EXPOSED TO WIND EROSION
 AUTHORS SUCHKOV, V T
 SOURCE IN PUTI INTENSIFIKATSII SEL'SKOGO KHOZIAISTVA
 TSELINNYKH RAINONOV. I. S. SHATILOV & OTHERS.
 EDS.. P. 342-345.
 PUBLICATION DATE 1976
 DOCUMENT TYPE ARTICLE
 LANGUAGE RUS
 NAL CALL NUMBER S469.R9PB
 PRIMARY CATEGORY CODE 551000

-18-
 ACCESSION NUMBER 779678899
 TITLE WIND ENERGY CONVERSION / / R. M. MILLER ...
 (ET AL.). --
 AUTHORS MILLER, R H
 SOURCE CAMBRIDGE, MASS. : MASSACHUSETTS INSTITUTE OF
 TECHNOLOGY, DEPT. OF AERONAUTICS AND
 ASTRONAUTICS., 179 P. : ILL --
 PUBLICATION DATE 1976
 NOTES PROGRESS REPORT, JULY 15, 1975-FEB. 15, 1976.
 AER7500826. INCLUDES BIBLIOGRAPHICAL
 REFERENCES.
 SERIES STATEMENT U.S. NATIONAL TECHNICAL INFORMATION SERVICE.
 PB : 256198
 DOCUMENT TYPE MONOGRAPH
 SOURCE NAME US PUB
 LANGUAGE ENG
 NAL CALL NUMBER 157.B R29 NO.256198
 PRIMARY CATEGORY CODE 550500

-19-
 ACCESSION NUMBER 769677731
 TITLE WIND MACHINES : / REPORT / BY FRANK R.
 ELDRIDGE. --
 AUTHORS ELDRIDGE, FRANK R
 ORGANIZATIONAL SOURCE NATIONAL SCIENCE FOUNDATION. RESEARCH APPLIED
 TO NATIONAL NEEDS PROGRAM.
 SOURCE WASHINGTON : U.S. SUPT. OF DOCS., GOVT.
 PRINTING OFFICE., 77 P. : ILL. --
 PUBLICATION DATE 1976
 NOTES BIBLIOGRAPHY: P. 75-76. PREPARED FOR NATIONAL
 SCIENCE FOUNDATION. RESEARCH APPLICATIONS
 DIRECTORATE. RANK-RESEARCH APPLIED TO
 NATIONAL NEEDS. DIVISION OF ADVANCED ENERGY
 AND RESOURCES. RESEARCH AND TECHNOLOGY UNDER
 GRANT NO. AER-75-12937.

69

SERIES STATEMENT NATIONAL SCIENCE FOUNDATION, RESEARCH APPLIED
TO NATIONAL NEEDS PROGRAM. SNSF-RA-N : 75-051

DOCUMENT TYPE MONOGRAPH

LANGUAGE ENG

NAL CALL NUMBER T1825.E4

PRIMARY CATEGORY CODE 550500

SECONDARY CATEGORY CODE 850500

INDEX TERM WINDMILLS.

INDEX TERM WIND POWER.

INDEX TERM POWER RESOURCES.

-20-

ACCESSION NUMBER 769677516

TITLE MATERIAL AND MANUFACTURING CONSIDERATIONS FOR
VERTICAL-AXIS WIND TURBINES / / LAWRENCE I.
WEINGARTEN, LOUIS V. FELTZ. --

AUTHORS WEINGARTEN, LAWRENCE I

AUTHORS FELTZ, LOUIS V

ORGANIZATIONAL SOURCE SANDIA LABORATORIES.

SOURCE ALBUQUERQUE, N.M. : SANDIA LABORATORIES.. 14
LEAVES. --

PUBLICATION DATE 1975

NOTES BIBLIOGRAPHY:- LEAF 12.

SERIES STATEMENT SANDIA LABORATORIES. SSAND : 75-5512

DOCUMENT TYPE MONOGRAPH

LANGUAGE ENG

NAL CALL NUMBER T1825.W4

PRIMARY CATEGORY CODE 850500

INDEX TERM WINDMILLS.

-21-

ACCESSION NUMBER 769108044

TITLE MASCHINENEINSATZ BEI DER WIEDERAUFFORSTUNG
DER WINDWURF- UND WINDWALDBRANDFLACHEN IM
NORDWESTDEUTSCHEN FLACHLAND / USE OF MACHINES
IN REAFFORESTATION OF WIND THROW AND FOREST
FIRE DAMAGED AREAS IN NORTHWESTERN GERMAN
LOWLAND AREAS

AUTHORS STREHLKE, B

SOURCE FORSTTECH INF. 28 (4): 25-27.

PUBLICATION DATE 1976 APR

DOCUMENT TYPE ARTICLE

LANGUAGE GER

NAL CALL NUMBER 99.8 F7794

PRIMARY CATEGORY CODE 351500

INDEX TERM GERMANY (FEDERAL REPUBLIC)

96

-22-
 ACCESSION NUMBER 769674665
 TITLE INNOVATIVE WIND MACHINES / / BY RICHARD E.
 WALTERS (ET AL.). --
 AUTHORS WALTERS, RICHARD E
 SOURCE MORGANTOWN : WEST VIRGINIA UNIVERSITY.. VII.
 150 P. . ILL. --
 PUBLICATION DATE 1975
 NOTES SIX MONTH REPORT. MAR. 1 - AUG. 31, 1975.
 PREPARED UNDER GRANT AER 7500367-000.
 INCLUDES BIBLIOGRAPHICAL REFERENCES.
 U.S. NATIONAL TECHNICAL INFORMATION SERVICE.
 PB : 252617
 SERIES STATEMENT
 DOCUMENT TYPE MONOGRAPH
 LANGUAGE ENG
 NAL CALL NUMBER 157.8 R29 NO.252617
 PRIMARY CATEGORY CODE 550500

-23-
 ACCESSION NUMBER 769673530
 TITLE THE DARRIEUS TURBINE : / A PERFORMANCE
 PREDICTION MODEL USING MULTIPLE STREAMTUBES /
 J. M. STRICKLAND. --
 AUTHORS STRICKLAND, J H
 ORGANIZATIONAL SOURCE SANDIA LABORATORIES. ADVANCED ENERGY PROJECTS
 DEPT.
 SOURCE ALBUQUERQUE, N.M. : SANDIA LABORATORIES.. 36
 P. . ILL. --
 PUBLICATION DATE 1975
 NOTES PREPARED BY SANDIA LABORATORIES FOR THE
 UNITED STATES ENERGY RESEARCH AND DEVELOPMENT
 ADMINISTRATION UNDER CONTRACT AT (29-1)-789.
 BIBLIOGRAPHY: P. 31.
 SANDIA LABORATORIES. SSAND : 75-0431
 SERIES STATEMENT
 DOCUMENT TYPE MONOGRAPH
 LANGUAGE ENG
 NAL CALL NUMBER TN012.57
 PRIMARY CATEGORY CODE 750500
 INDEX TERM WINDMILLS.
 INDEX TERM WIND POWER.
 INDEX TERM AIR-TURBINES.

-24-
 ACCESSION NUMBER 769673292
 TITLE INSTALLATION AND INITIAL OPERATION OF A 4100
 WATT WIND TURBINE / / BY HENRY B. TRYON AND
 TIMOTHY RICHARDS. --
 AUTHORS TRYON, HENRY B
 AUTHORS RICHARDS, TIMOTHY
 ORGANIZATIONAL SOURCE LEWIS RESEARCH CENTER.

91

SOURCE CLEVELAND : LEWIS RESEARCH CENTER :
REPRODUCED BY NATIONAL TECHNICAL INFORMATION
SERVICE.. 28 P. : ILL. --

PUBLICATION DATE 1975
NOTES PREPARED BY NASA LEWIS RESEARCH CENTER.
SERIES STATEMENT U.S. NATIONAL AERONAUTICS AND SPACE
ADMINISTRATION. \$NASA TM X : 71831

DOCUMENT TYPE MONOGRAPH
LANGUAGE ENG
NAL CALL NUMBER TK2435 I7
PRIMARY CATEGORY CODE 750500
INDEX TERM WINDMILLS.
INDEX TERM DYNAMOS
INDEX TERM DESIGN AND CONSTRUCTION.

-23-
ACCESSION NUMBER 769672477
TITLE WINDMILLS / / SUZANNE BEEDELL : FOREWORD BY
HENRY LONGHURST. --
AUTHORS BEEDELL, SUZANNE MOLLIE
SOURCE NEW YORK : SCRIBNER.. 143 P. : ILL. : 26 CM.
PUBLICATION DATE 1975
NOTES BIBLIOGRAPHY: P. 141. INCLUDES INDEX.
DOCUMENT TYPE MONOGRAPH
LANGUAGE ENG
NAL CALL NUMBER TUR25.B36
PRIMARY CATEGORY CODE 850500
INDEX TERM WINDMILLS.

-24-
ACCESSION NUMBER 769069796
TITLE GIRMILL (CYCLOGIRO WINDMILL) INVESTIGATION
FOR GENERATION OF ELECTRICAL POWER
AUTHORS BRULLE, R V
AUTHORS LARSEN, H C
SOURCE IN PROCEEDINGS OF THE SECOND WORKSHOP ON WIND
ENERGY CONVERSION SYSTEMS.. 2D: 452-460.
PUBLICATION DATE 1975
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER TUR25.W6 1975
PRIMARY CATEGORY CODE 550500

cb

-27-
ACCESSION NUMBER 769069785
TITLE APPLIED AERODYNAMICS OF WIND POWER MACHINES
AUTHORS WILSON, R E
SOURCE IN PROCEEDINGS OF THE SECOND WORKSHOP ON WIND
ENERGY CONVERSION SYSTEMS., 2D: 234-238. REF.
1975
PUBLICATION DATE
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER T4825.W6 1975
PRIMARY CATEGORY CODE 550500

-28-
ACCESSION NUMBER 769069788
TITLE SAILWIND WINDMILL TECHNOLOGY
AUTHORS SKEENEY, T E
SOURCE IN PROCEEDINGS OF THE SECOND WORKSHOP ON WIND
ENERGY CONVERSION SYSTEMS., 2D: 224-228.
1975
PUBLICATION DATE
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER T4825.W6 1975
PRIMARY CATEGORY CODE 550500

-29-
ACCESSION NUMBER 769069783
TITLE FRENCH INVESTIGATIONS ON LARGE WIND
GENERATORS, INCLUDING DIFFERENT TYPES OF
MACHINES AND STUDIES OF SITES
AUTHORS ARGAND, A
SOURCE IN PROCEEDINGS OF THE SECOND WORKSHOP ON WIND
ENERGY CONVERSION SYSTEMS., 2D: 173-181. MAP.
1975
PUBLICATION DATE
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER T4825.W6 1975
PRIMARY CATEGORY CODE 550500
INDEX TERM FRANCE

-30-
ACCESSION NUMBER 769069777
TITLE WIND MACHINES FOR THE CALIFORNIA AQUEDUCT
AUTHORS LINDLEY, C A
SOURCE IN PROCEEDINGS OF THE SECOND WORKSHOP ON WIND
ENERGY CONVERSION SYSTEMS., 2D: 104-111. MAP.
1975
PUBLICATION DATE
DOCUMENT TYPE ARTICLE
LANGUAGE ENG

93

NAL CALL NUMBER TWR25.W6 1975
 PRIMARY CATEGORY CODE 602000
 INDEX TERM CALIFORNIA

-31-
 ACCESSION NUMBER 709669872
 TITLE WINDMILLS & WATERMILLS / / JOHN REYNOLDS. -/
 REPRINTED WITH CORRECTIONS. --
 AUTHORS REYNOLDS, JOHN
 SOURCE LONDON : H. EVELYN., 196 P., (2) LEAVES OF
 PLATES : ILL. (SOME COL.) : 25 CM. --
 PUBLICATION DATE 1974
 NOTES BIBLIOGRAPHY: P. 192-193. INCLUDES INDEX.
 SERIES STATEMENT EXCURSIONS INTO ARCHITECTURE
 DOCUMENT TYPE MONOGRAPH
 LANGUAGE ENG
 NAL CALL NUMBER TWR23.R48 1974
 PRIMARY CATEGORY CODE B50500
 INDEX TERM WINDMILLS.
 INDEX TERM WATER MILLS.

-32-
 ACCESSION NUMBER 769670077
 TITLE ELECTRIC POWER FROM THE WIND : / A PRACTICAL
 GUIDE TO WIND-GENERATED POWER SYSTEMS FOR
 INDIVIDUAL APPLICATIONS / HENRY M. CLEWS. -/
 REV.. EXPANDED AND UPDATED. --
 AUTHORS CLEWS, HENRY
 ORGANIZATIONAL SOURCE SOLAR WIND CO.
 SOURCE EAST HOLDEN, ME. : SOLAR WIND CO... 40 P. :
 ILL.
 PUBLICATION DATE 1974
 NOTES BIBLIOGRAPHY: P. 38-39.
 DOCUMENT TYPE MONOGRAPH
 LANGUAGE ENG
 NAL CALL NUMBER TWR25.C52 1974
 PRIMARY CATEGORY CODE B50500
 INDEX TERM ELECTRIC POWER PRODUCTION.
 INDEX TERM WINDMILLS.

-33-
 ACCESSION NUMBER 759662764
 TITLE WINDMILLS. / BY FRANK BRANGWYN AND HAYTER
 PRESTON.
 AUTHORS PRESTON, HAYTER: 1891
 AUTHORS BRANGWYN, SIR FRANK: 1867-1956 ILLUS.
 ORGANIZATIONAL SOURCE GALE RESEARCH COMPANY.
 SOURCE DETROIT, GALE RESEARCH COMPANY., 126 P. ILLUS.
 PUBLICATION DATE 1975

74

NOTES
DOCUMENT TYPE
LANGUAGE
NAL CALL NUMBER
PRIMARY CATEGORY CODE
INDEX TERM

REPRINT OF THE 1923 ED.
MONOGRAPH
ENG
T4823.P7 1974
550500
WINDMILLS.

-34-
ACCESSION NUMBER
TITLE

759662390
WIND MOTORS: THEORY, CONSTRUCTION, ASSEMBLY
AND USE IN DRAWING WATER AND GENERATING
ELECTRICITY

AUTHORS
SOURCE
PUBLICATION DATE
NOTES

CHAMPLY, RENE; 1865-1940
SPRINGFIELD, VA., 246 P. ILLUS.
1975
TRANSLATION OF HIS THEORIE, CONSTRUCTION,
MONTAGE, UTILISATION AU PUISAGE DE L'EAU ET A
LA PRODUCTION DE L'ELECTRICITE. U.S. NATIONAL
TECHNICAL INFORMATION SERVICE, N75-1982.
U.S. NATIONAL AERONAUTICS AND SPACE
ADMINISTRATION, NASA TT F16201

SERIES STATEMENT

DOCUMENT TYPE
LANGUAGE
NAL CALL NUMBER
PRIMARY CATEGORY CODE
INDEX TERM
INDEX TERM

MONOGRAPH
ENG
T4825.C5
850500
WINDMILLS
AIR-TURBINES

-33-
ACCESSION NUMBER
TITLE

759099553
DER WIEDEREINSATZ VON WINDKRAFT. EIN BEITRAG
ZUR ENERGIEKRISIS UND ENERGIEVERSORGUNG. 3 /
THE FURTHER USE OF WIND POWER. A CONTRIBUTION
TO THE ENERGYCRISIS AND ENERGY SUPPLY. 3.
(MILLING)

AUTHORS
SOURCE
PUBLICATION DATE
DOCUMENT TYPE
LANGUAGE
NAL CALL NUMBER
PRIMARY CATEGORY CODE
INDEX TERM

WEYER, I
MUEHLE MISCHFUTTERTECH, 112 (32): 422-426. REF.
1975 AUG
ARTICLE
GER
298.8 M89
550500
GERMANY (FEDERAL REPUBLIC)

95

-36-
ACCESSION NUMBER
TITLE

AUTHORS
SOURCE
PUBLICATION DATE
DOCUMENT TYPE
LANGUAGE
NAL CALL NUMBER
PRIMARY CATEGORY CODE
INDEX TERM

759099552
DER WIEDEREINSATZ VON WINDKRAFT. EIN BEITRAG
ZUR ENERGIEKRISE UND ENERGIEVERSORGUNG. 2 /
THE FURTHER USE OF WIND POWER. A CONTRIBUTION
TO THE ENERGY CRISIS AND ENERGY SUPPLY. 2.
(MILLING)
WEYER, I
MÜHLE MISCHFUTTERTECH, 112 (31): 409-412.
1975 AUG
ARTICLE
GER
298.8 W89
550500
GERMANY (FEDERAL REPUBLIC)

-37-
ACCESSION NUMBER
TITLE
AUTHORS
SOURCE
PUBLICATION DATE
DOCUMENT TYPE
LANGUAGE
NAL CALL NUMBER
PRIMARY CATEGORY CODE
INDEX TERM

759099101
THE WINDMILL IN CALIFORNIA
MANNING, R S
J WEST, 14 (3): 33-39. REF.
1975 JUL
ARTICLE
ENG
F591 J6
550500
CALIFORNIA

-38-
ACCESSION NUMBER
TITLE

AUTHORS
SOURCE

PUBLICATION DATE
DOCUMENT TYPE
LANGUAGE
NAL CALL NUMBER
PRIMARY CATEGORY CODE

759099219
DER WIEDEREINSATZ VON WINDKRAFT. EIN BEITRAG
ZUR ENERGIEKRISE UND ENERGIEVERSORGUNG /
FURTHER USE OF WIND POWER. A CONTRIBUTION TO
THE ENERGY CRISIS AND ENERGY SUPPLY (MILLS)
WEYER, I
MÜHLE MISCHFUTTERTECH, 112 (30): 395-399.
W&P. (CONTINUED)
1975 JUL
ARTICLE
GER
298.8 W89
550500

96

-39-
ACCESSION NUMBER 759039540
TITLE L'ELECTRICITE A BON COMPTE AVEC LES EOLIENNES
/ ELECTRICITY WITH GOOD ACCOUNT WITH WINDMILLS
AUTHORS NENIN, J
SOURCE FETTES MOD. 28: 27-30.
PUBLICATION DATE 1975 FEB
DOCUMENT TYPE ARTICLE
LANGUAGE FRE
NAL CALL NUMBER 5871.F4
PRIMARY CATEGORY CODE 550500

-40-
ACCESSION NUMBER 759065744
TITLE W KRAJU WIATRAKOW I TULIPANOW / IN THE
COUNTRY OF WINDMILLS AND TULIPS (FARM
BUILDINGS, NETHERLANDS)
AUTHORS PLUCINSKI, A
SOURCE BUDOWNICTWO WIEJSK. 27 (2): 13-14.
PUBLICATION DATE 1975 FEB
DOCUMENT TYPE ARTICLE
LANGUAGE POL
NAL CALL NUMBER 296.8 DB5
PRIMARY CATEGORY CODE 550500
INDEX TERM NETHERLANDS

-41-
ACCESSION NUMBER 759063646
TITLE WINDMILLS FOR SHEEP FARMS
AUTHORS RYZHOV, S V
SOURCE OVTSEVODSTVO. 2: 33-35.
PUBLICATION DATE 1975 FEB
DOCUMENT TYPE ARTICLE
LANGUAGE RUS
NAL CALL NUMBER 45.8 OV72
PRIMARY CATEGORY CODE 550500
INDEX TERM USSR

-42-
ACCESSION NUMBER 759060411
TITLE WIATRAK JAKO ZABYTEK POLSKIEGO BUDOWNICTWA
DREWNIANEGO / WINDMILLS AS RELICS OF POLISH
WOODEN ARCHITECTURE
AUTHORS PASYMOWSKI, Z
SOURCE PRZEGL ZBOZ MLYN. 18 (12): 31-32.
PUBLICATION DATE 1974 DEC
DOCUMENT TYPE ARTICLE
LANGUAGE POL

NAL CALL NUMBER	298.8 P95
PRIMARY CATEGORY CODE	550500
INDEX TERM	POLAND
-43-	
ACCESSION NUMBER	759653440
TITLE	WATER-MILLS, WINDMILLS AND HORSE-MILLS OF SOUTH AFRICA
AUTHORS	WALTON, JAMES; 1911-
SOURCE	CAPIT TOWN, C. STRUIK PUB., 204, P. ILLUS., MAPS.
PUBLICATION DATE	1974
NOTES	BIBLIOGRAPHY: P. 188.
DOCUMENT TYPE	MONOGRAPH
LANGUAGE	ENG
NAL CALL NUMBER	T.823.W3
PRIMARY CATEGORY CODE	850500
INDEX TERM	WINDMILLS
INDEX TERM	AFRICA, SOUTH
INDEX TERM	HISTORY
INDEX TERM	WATER MILLS
INDEX TERM	AFRICA, SOUTH
INDEX TERM	HISTORY
-44-	
ACCESSION NUMBER	749100054
TITLE	STUDIES IN ANTARTIC LICHENS. II. LICHENS FROM THE WINDMILL ISLANDS, WILKES LAND. (BUELLIA SCREDIANUS, LECIDEA ANDERSONII)
AUTHORS	FILSON, R B
SOURCE	MUELLERIA, 3 (1): 9-36. MAP. REF.
PUBLICATION DATE	1974 JUL
DOCUMENT TYPE	ARTICLE
LANGUAGE	ENG
NAL CALL NUMBER	250 MBB
PRIMARY CATEGORY CODE	401000
-45-	
ACCESSION NUMBER	9392273
TITLE	THE WINDMILL YESTERDAY AND TODAY
AUTHORS	DE LITTLE, R J
SOURCE	LONDON, J. BAKER, 101 P. ILLUS.
PUBLICATION DATE	1972
NOTES	BIBLIOGRAPHY: P. 101
DOCUMENT TYPE	MONOGRAPH
LANGUAGE	ENG
NAL CALL NUMBER	T.823.D38
PRIMARY CATEGORY CODE	550500
SECONDARY CATEGORY CODE	850500

86

WINDMILLS

INDEX TERM	WINDMILLS
INDEX TERM	HISTORY

-46-	
ACCESSION NUMBER	9142925
TITLE	WIND POWER POTENTIAL AND ITS UTILIZATION IN COASTAL AREAS OF WEST PAKISTAN. (WINDMILLS, GROUND WATER, PUMPING)
AUTHORS	LATIF, K
SOURCE	INDUS. 14 (5): 6-27. MAP.
PUBLICATION DATE	1972 JUN
DOCUMENT TYPE	ARTICLE
LANGUAGE	ENG
NAL CALL NUMBER	T0201.155
PRIMARY CATEGORY CODE	602000
INDEX TERM	PAKISTAN
-47-	
ACCESSION NUMBER	9250195
TITLE	DE MOLENS ZOALS ZE WAREN EN ZOALS IK HEN HEB GEKEND / VAND. VOERING EN PAL / WINDMILLS. PAST AND PRESENT: STAY, LINING AND RATCHET
AUTHORS	SIPMAN, ANTON
SOURCE	ZUTPHEN, DE WALBURG PERS. 57 P. ILLUS.
PUBLICATION DATE	1971
DOCUMENT TYPE	MONOGRAPH
LANGUAGE	DUT
NAL CALL NUMBER	T.823.55
PRIMARY CATEGORY CODE	550500
INDEX TERM	WINDMILLS
-48-	
ACCESSION NUMBER	9025410
TITLE	MACHINES AND EQUIPMENT FOR PREVENTING WIND AND WATER EROSION OF SOIL
AUTHORS	SPIRIN, A
AUTHORS	PILIUGIN, L
AUTHORS	PLISHKIN, A
SOURCE	TEKH SEL'SKOM KHOZ. 9: 51-56.
PUBLICATION DATE	1971
DOCUMENT TYPE	ARTICLE
LANGUAGE	RUS
NAL CALL NUMBER	58.8 M11
PRIMARY CATEGORY CODE	551000

69

-49-
 ACCESSION NUMBER 9000400
 TITLE WINDMILL GRASS IN PENNSYLVANIA; WINDMILL
 GRASS (CHLORIS VERTICILLATA NUTTAL) IN
 PENNSYLVANIA
 AUTHORS MURRAY, W
 SOURCE BARTONIA, 40: 19-20. MAP.
 PUBLICATION DATE 1971 AUG
 DOCUMENT TYPE ARTICLE
 LANGUAGE ENG
 NAL CALL NUMBER 451 P532
 PRIMARY CATEGORY CODE 401000

-50-
 ACCESSION NUMBER 9334675
 TITLE NEDERLANDSE MOLENS / IN OUDE ANSICHTEN /
 DUTCH WINDMILLS IN OLD PICTURES
 AUTHORS LAMSAALDEN, L VAN
 SOURCE ZALTSOMMEL, EUROPEESE BIBLIOTHEEK, 160 P.
 ILLUS.
 PUBLICATION DATE 1970
 SERIES STATEMENT IN OUDE ANSICHTEN
 DOCUMENT TYPE MONOGRAPH
 LANGUAGE DUT
 NAL CALL NUMBER TJ823.L3
 PRIMARY CATEGORY CODE 551000
 INDEX TERM WINDMILLS

-51-
 ACCESSION NUMBER 9325738
 TITLE PRIMENENIE VETRODVIKATELEI V SEL'SKOM
 KHOZIAISTVE / APPLICATION OF WIND-MILLS IN
 AGRICULTURE
 AUTHORS GLUSHCHENKO, VLADIMIR PETROVICH
 SOURCE MOSKVA, MASHGIZ, 97. (2) P. ILLUS.
 PUBLICATION DATE 1959
 NOTES BIBLIOGRAPHY: P. (99)
 DOCUMENT TYPE MONOGRAPH
 LANGUAGE RUS
 NAL CALL NUMBER 5707.G5
 PRIMARY CATEGORY CODE 300000
 INDEX TERM FEEDING STUFFS
 INDEX TERM IMPLEMENTS AND MACHINERY
 INDEX TERM FEEDING STUFFS
 INDEX TERM PROCESSING
 INDEX TERM WINDMILLS

100

WINDMILLS

-52-
 ACCESSION NUMBER 9094785
 TITLE MACHINES FOR PROCESSING THE SOIL AND SOWING
 IN REGIONS DAMAGED BY WIND EROSION
 AUTHORS MAKARETS, I K
 AUTHORS PAPAIEV, A G
 AUTHORS TSURTSUNIYA, B V
 AUTHORS KUZNETSOV, I U A
 SOURCE TRAKTORNY SELKHOZMASHINY, 2: 23-25.
 PUBLICATION DATE 1970 FEB
 DOCUMENT TYPE ARTICLE
 LANGUAGE RUS
 NAL CALL NUMBER 58.8 T68
 PRIMARY CATEGORY CODE 300000

-53-
 ACCESSION NUMBER 9087396
 TITLE CROP PROTECTION BY HEATING, WIND MACHINES,
 AND OVERHEAD IRRIGATION
 AUTHORS GERSER, J F
 SOURCE HORTSCIENCE, 5 (5): 428-431.
 PUBLICATION DATE 1970 OCT
 NOTES BIBLIOGRAPHY, P. 430-431.
 DOCUMENT TYPE ARTICLE
 LANGUAGE ENG
 NAL CALL NUMBER 581.H6
 PRIMARY CATEGORY CODE 700000
 SECONDARY CATEGORY CODE 850000

-54-
 ACCESSION NUMBER 9061705
 TITLE WIND MACHINE OPERATION IN FLORIDA CITRUS
 GROVES
 AUTHORS REESE, R L
 SOURCE CITRUS VEG MAG, 33 (11): 8-9.
 PUBLICATION DATE 1970 JUL
 NOTES BIBLIOGRAPHY: P. 9.
 DOCUMENT TYPE ARTICLE
 LANGUAGE ENG
 NAL CALL NUMBER 80 C498
 PRIMARY CATEGORY CODE 700000

101

-55-
ACCESSION NUMBER 9049757
TITLE *FROST* PROTECTION BY HEATING, WIND MACHINES
AND IRRIGATION
AUTHORS GERSER, J F
SOURCE MICH STATE HORT SOC ANNU REP. P. 24-32.
PUBLICATION DATE 1969
NOTES BIBLIOGRAPHY: P. 31-32.
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER B1 175B
PRIMARY CATEGORY CODE 700000

-56-
ACCESSION NUMBER 9030472
TITLE EVALUATING A SMALL LABORATORY WIND MACHINE
AUTHORS WHITE, R M
SOURCE AMER SOC AGR ENG TRANS ASAE. 12 (4): 550-551
PUBLICATION DATE 1969 AUG
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER 290.9 AW32T
PRIMARY CATEGORY CODE 300000

-57-
ACCESSION NUMBER 9025169
TITLE AN EMPIRICAL DESCRIPTION OF COLD PROTECTION
PROVIDED BY A WIND MACHINE
AUTHORS REESE, R L
AUTHORS GERSER, J F
SOURCE J AMER SOC HORT SCI. 94 (6): 697-700.
PUBLICATION DATE 1969 NOV
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER B1 5012
PRIMARY CATEGORY CODE 300000

..... END OF OFF-LINE PRINT

102

THIS IS AN OFF-LINE CITATION LIST GENERATED BY
_ORBIT_IV
S.D.C.'S INTERNATIONAL SEARCH SERVICE

REFORESTATION

NUMBER OF CITATIONS PRINTED = 14

FEBRUARY 15, 1979

THIS SEARCH WAS PERFORMED ON AGRICOLA

REQUESTED BY
VIGNONE

PLEASE SEND THIS LISTING TO

MARIA E. VIGNONE
AGENCY FOR INTERNATIONAL DEVELOPMENT 570 PP
WASHINGTON, D.C. 20523

103

5

-1-

ACCESSION NUMBER 789696255
 TITLE SEED PROBLEMS OF SOME DEVELOPING COUNTRIES IN ASIA, AFRICA AND LATIN AMERICA AND SCOPE FOR INTERNATIONAL COOPERATION / / S. K. KAVRA. -- KATRA, S K
 AUTHORS STOCKHOLM : SKOGSHOGSKOLAN.. 57 LEAVES. --
 SOURCE 1974
 PUBLICATION DATE BIBLIOGRAPHY: LEAVES 54-57.
 NOTES STOCKHOLM, SKOGSHOGSKOLAN, INSTITUTIONEN FOR SKOGSFORYNGRING, RAPPORTER OCH UPPSATSER.
 SERIES STATEMENT RESEARCH NOTES : NO. 49
 DOCUMENT TYPE MONOGRAPH
 LANGUAGE ENG
 NATIONAL CALL NUMBER SD409.575 NO.49
 PRIMARY CATEGORY CODE 351500

-2-

ACCESSION NUMBER 789693630
 TITLE HARVESTING MAN-MADE FORESTS IN DEVELOPING COUNTRIES : / A MANUAL ON TECHNIQUES, ROADS, PRODUCTION AND COSTS / (BY ULF SUNDBERG). --
 AUTHORS SUNDBERG, ULF
 ORGANIZATIONAL SOURCE STYRELSEN FOR INTERNATIONELL UTVECKLING.
 ORGANIZATIONAL SOURCE FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS.
 SOURCE ROME : FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS.. VIII. 185 P. : ILL. : 28 CM.
 PUBLICATION DATE 1976
 NOTES *SWEDISH FUNDS-IN-TRUST, FOI: TF-INT 74 (SKT). SUPPORTED BY THE SWEDISH INTERNATIONAL DEVELOPMENT AUTHORITY (SIDA).
 DOCUMENT TYPE BIBLIOGRAPHY: P. 181-185.
 SOURCE NAME MONOGRAPH
 LANGUAGE FAO
 NATIONAL CALL NUMBER ENG
 PRIMARY CATEGORY CODE SD539.F62
 INDEX TERM 352000
 INDEX TERM LOGGING
 INDEX TERM HANDBOOKS, MANUALS, ETC.
 INDEX TERM FORESTS AND FORESTRY
 INDEX TERM UNDERDEVELOPED AREAS.
 INDEX TERM LUMBER
 INDEX TERM TRANSPORTATION.

104

-3-
ACCESSION NUMBER 789016050
TITLE ARE U.S. ANIMAL SCIENTISTS PREPARED TO HELP
SMALL FARMERS IN DEVELOPING COUNTRIES?
AUTHORS MCDOWELL, R E
SOURCE CORNELL INT AGRIC DEV MIMEOGR, 58, 25 P. REF.
PUBLICATION DATE 1977 NOV
DOCUMENT TYPE ARTICLE
SOURCE NAME US PUB
LANGUAGE ENG
NAL CALL NUMBER 281.8 CB14
PRIMARY CATEGORY CODE 350500
SECONDARY CATEGORY CODE 101000
INDEX TERM UNITED STATES

-4-
ACCESSION NUMBER 779119948
TITLE SYSTEMS DYNAMICS AND THE GENERATION AND
UTILIZATION OF FOREST SECTOR INVESTMENTS IN
DEVELOPING COUNTRIES (PROGRAMS)
AUTHORS STRAIN, A A
SOURCE MITT BUNDESFORSCHUNGSANST FORST HOLZWIRTSCH.
112: 89-102.
PUBLICATION DATE 1976 MAR
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER 99.9 R273
PRIMARY CATEGORY CODE 351000

-5-
ACCESSION NUMBER 779048103
TITLE THE EXISTING AND POTENTIAL ROLES OF FORESTRY
IN THE ECONOMIES OF DEVELOPING COUNTRIES
AUTHORS MACGREGOR, J J
SOURCE BULL G B FOR COMM, 56: 1-7. REF.
PUBLICATION DATE 1976
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER 9A.9 G795
PRIMARY CATEGORY CODE 351000

105

-6-
ACCESSION NUMBER 769112889
TITLE MANAGING FOREST RESEARCH IN DEVELOPING COUNTRIES
AUTHORS IYAMABO, D E
SOURCE IN MANAGEMENT OF FORESTRY RESEARCH FOR RESULTS; PROCEEDINGS OF THE MEETING OF SUBJECT GROUP S6.06, 1ST: 57-66.
PUBLICATION DATE 1975
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER SO118.M4
PRIMARY CATEGORY CODE 351000

-7-
ACCESSION NUMBER 769055816
TITLE US TARIFF PREFERENCES FOR DEVELOPING COUNTRIES AFFECT FOREST PRODUCTS (IMPORTS)
AUTHORS SUNDERLAND, L B
SOURCE WORLD WOOD, 17 (5): 27.
PUBLICATION DATE 1976 MAY
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER 99. P W89
PRIMARY CATEGORY CODE 352000
INDEX TERM UNITED STATES

-8-
ACCESSION NUMBER 759101512
TITLE SCOPE FOR COOPERATION BETWEEN ISTA (INTERNATIONAL SEED TESTING ASSOCIATION) AND IUFRO (INTERNATIONAL UNION OF FOREST RESEARCH ORGANISATIONS) ON FORESTRY SEED PROBLEMS OF THE DEVELOPING COUNTRIES
AUTHORS KATRA, S K
SOURCE SEED SCI TECHNOL. 3 (2): 407-413. REF.
PUBLICATION DATE 1975
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER SB117.S455
PRIMARY CATEGORY CODE 351500

901

-9-
 ACCESSION NUMBER 750655985
 TITLE LOGGING AND LOG TRANSPORT IN MAN-MADE FORESTS
 IN DEVELOPING COUNTRIES
 ORGANIZATIONAL SOURCE FOOD AND AGRICULTURE ORGANIZATION OF THE
 UNITED NATIONS
 SOURCE ROME, 1 V. (VARIOUS PAGES) ILLUS.
 PUBLICATION DATE 1974
 NOTES SWEDISH FUNDS-IN-TRUST, TF-INT 74 (SWE)
 SERIES STATEMENT FOOD AND AGRICULTURE ORGANIZATION OF THE
 UNITED NATIONS, SFAO/SWE/TF 116
 DOCUMENT TYPE MONOGRAPH
 SOURCE NAME FAO
 LANGUAGE ENG
 NAL CALL NUMBER SDE 9.F6
 PRIMARY CATEGORY CODE 35000
 INDEX TERM LUMBER
 INDEX TERM TRANSPORTATION
 INDEX TERM UNDERDEVELOPED AREAS
 INDEX TERM FOREST POLICY

-10-
 ACCESSION NUMBER 749420272
 TITLE PULP AND PAPER IN DEVELOPING COUNTRIES /
 REPORT OF AN EXPERT GROUP MEETING, VIENNA,
 13-17 SEPTEMBER 1971
 ORGANIZATIONAL SOURCE UNITED NATIONS INDUSTRIAL DEVELOPMENT
 ORGANIZATION
 SOURCE (VIENNA, 67 P.
 PUBLICATION DATE 1973
 SERIES STATEMENT UNITED NATIONS, INDUSTRIAL DEVELOPMENT
 ORGANIZATION, 10/111
 DOCUMENT TYPE MONOGRAPH
 LANGUAGE ENG
 NAL CALL NUMBER T51175 US
 PRIMARY CATEGORY CODE 35200
 SECONDARY CATEGORY CODE 810500
 INDEX TERM PULPWOOD INDUSTRY
 INDEX TERM PAPER MAKING AND TRADE

-11-
 ACCESSION NUMBER 749079018
 TITLE DEVELOPING COUNTRIES AND THE NEW SCIENCE OF
 REMOTE SENSING. (FORESTRY)
 AUTHORS KIO, P R O
 SOURCE COMMONW FOR REV. 53 (2): 13-145. REF.
 PUBLICATION DATE 1974 JUN
 DOCUMENT TYPE ARTICLE
 LANGUAGE ENG
 NAL CALL NUMBER 99.8 2/72

107

PRIMARY CATEGORY CODE 351000

- 12 -
 ACCESSION NUMBER 749052654
 TITLE SEED PROBLEMS OF DEVELOPING COUNTRIES.
 (FOREST TREES)
 ORGANIZATIONAL SOURCE INTERNATIONAL SYMPOSIUM ON SEED PROCESSING,
 SOURCE BERGEN, NORWAY. 1973
 IN INTERNATIONAL SYMPOSIUM ON SEED PROCESSING
 SEED PROBLEMS INTERNATIONAL UNION OF FORESTRY
 RESEARCH ORGANIZATIONS. 2. 217 P. REF.
 PUBLICATION DATE 1973
 DOCUMENT TYPE ARTICLE
 LANGUAGE ENG
 NAL CALL NUMBER SB117.155 1973
 PRIMARY CATEGORY CODE 351500

- 13 -
 ACCESSION NUMBER 9119477
 TITLE WOOD IN HOUSING IN DEVELOPING COUNTRIES
 AUTHORS KOENIGSBERGER, O H
 ORGANIZATIONAL SOURCE FOOD AND AGRICULTURE ORGANIZATION OF THE
 UNITED NATIONS DIVISION OF FORESTRY AND
 SOURCE FOREST PRODUCTS
 PUBLICATION DATE UNASYLVA, 25 (101/103): 119-134. REF.
 1971
 DOCUMENT TYPE ARTICLE
 LANGUAGE ENG
 NAL CALL NUMBER 99.8 UN1
 PRIMARY CATEGORY CODE 352000

- 14 -
 ACCESSION NUMBER 9090185
 TITLE SOME CONSIDERATIONS ON FOREST UTILIZATION AND
 MANAGEMENT IN THE DEVELOPING COUNTRIES OF THE
 PACIFIC REGION
 AUTHORS SHIOYA, T
 SOURCE KYUSHU UNIV RES INST UNIV FORESTS BULL KYUSHU
 UNIV FORESTS, 45: 227-232.
 PUBLICATION DATE 1972 MAR
 DOCUMENT TYPE ARTICLE
 LANGUAGE ENG
 NAL CALL NUMBER 99.8 K99
 PRIMARY CATEGORY CODE 351000

108

THIS IS AN OFF-LINE CITATION LIST GENERATED BY
_ORBIT_IV
S.D.C.'S INTERNATIONAL SEARCH SERVICE

RENEWABLE ENERGY

NUMBER OF CITATIONS PRINTED = 14

FEBRUARY 15, 1979

THIS SEARCH WAS PERFORMED ON AGRICOLA

REQUESTED BY
VIGNONE

PLEASE SEND THIS LISTING TO

MARIA E. VIGNONE
AGENCY FOR INTERNATIONAL DEVELOPMENT 570 PP
WASHINGTON, D.C. 20523

109

178

-1-

ACCESSION NUMBER	789137242
TITLE	SORGO--MATERIA PRIMA RENOVAVEL PARA PRODUCAO DE ETANOL NA ESCALADA ENERGETICA NACIONAL / SODHUM, A RENEWABLE RAW MATERIAL FOR ETHAOL PRODUCTION ON A NATIONAL ENERGY SCALE (BRAZIL)
AUTHORS	ARAUJO, N DE O
SOURCE	BRAS AOUCAR, 90 (2): 23-41.
PUBLICATION DATE	1977 AUG
DOCUMENT TYPE	ARTICLE
LANGUAGE	POR
NAL CALL NUMBER	65.8 B73
PRIMARY CATEGORY CODE	202500
INDEX TERM	BRAZIL

-2-

ACCESSION NUMBER	789701152
TITLE	OCEAN ENERGY RESOURCES : / PRESENTED AT THE ENERGY TECHNOLOGY CONFERENCE, HOUSTON, TEXAS, SEPTEMBER 18-23, 1977 / SPONSORED BY THE OCEAN ENGINEERING DIVISION, ASME : EDITED BY NEIL T. MONNEY. --
AUTHORS	MONNEY, NEIL T
ORGANIZATIONAL SOURCE	ENERGY TECHNOLOGY CONFERENCE, HOUSTON, TEX., 1977.
ORGANIZATIONAL SOURCE	AMERICAN SOCIETY OF MECHANICAL ENGINEERS, OCEAN ENGINEERING DIVISION.
SOURCE	NEW YORK : AMERICAN SOCIETY OF MECHANICAL ENGINEERS., V. 104 P. : ILL. : 26 CM. --
PUBLICATION DATE	1977
NOTES	INCLUDES BIBLIOGRAPHICAL REFERENCES.
SERIES STATEMENT	AMERICAN SOCIETY OF MECHANICAL ENGINEERS, OCEAN ENGINEERING DIVISION, SOED : V. 4
DOCUMENT TYPE	MONOGRAPH
SOURCE NAME	US PUB
LANGUAGE	ENG
NAL CALL NUMBER	T-1163.2.E493 1977
PRIMARY CATEGORY CODE	850500
INDEX TERM	RENEWABLE ENERGY SOURCES
INDEX TERM	CONGRESSES.
INDEX TERM	OCEAN ENGINEERING
INDEX TERM	CONGRESSES.
INDEX TERM	MARINE RESOURCES
INDEX TERM	CONGRESSES.

-3-
ACCESSION NUMBER 789038863
TITLE RENEWABLE ENERGY SOURCES FOR THE FOREST
INDUSTRY
AUTHORS JANW. E C
SOURCE PROC SOC AM FOR, P. 57-59.
PUBLICATION DATE 1977
DOCUMENT TYPE ARTICLE
SOURCE NAME US PUB
LANGUAGE ENG
NAL CALL NUMBER 99.9 5013
PRIMARY CATEGORY CODE 352000

-4-
ACCESSION NUMBER 789038472
TITLE ENERGY FOR RURAL AFRICA: THE POTENTIAL OF
SMALL-SCALE RENEWABLE ENERGY TECHNIQUES
AUTHORS HOWE, J W
AUTHORS KNOWLAND, W E
SOURCE FOCUS TECH COOP, 3: 18-21.
PUBLICATION DATE 1977
DOCUMENT TYPE ARTICLE
SOURCE NAME US PUB
LANGUAGE ENG
NAL CALL NUMBER 99.9 F6
PRIMARY CATEGORY CODE 250500
INDEX TERM AFRICA

-5-
ACCESSION NUMBER 789033135
TITLE WATER HYACINTHS, EICHHORNIA CRASSIPES (MART.)
SOLMS, A RENEWABLE SOURCE OF ENERGY
AUTHORS WOLVERTON, B C
AUTHORS McDONALD, R C
SOURCE IN A CONFERENCE ON CAPTURING THE SUN THROUGH
BIOCONVERSION: PROCEEDINGS, P. 249-254.
PUBLICATION DATE 1976
DOCUMENT TYPE ARTICLE
SOURCE NAME US PUB
LANGUAGE ENG
NAL CALL NUMBER TP260.C66
PRIMARY CATEGORY CODE 403000

-6-
 ACCESSION NUMBER 789693414
 TITLE FUELS AND ENERGY FROM RENEWABLE RESOURCES / /
 SYMPOSIUM ON FUELS AND ENERGY FROM RENEWABLE
 RESOURCES, 174TH NATIONAL MEETING OF THE
 AMERICAN CHEMICAL SOCIETY, CHICAGO, AUGUST
 1977. EDITED BY DAVID A. TILLMAN, KYOSTI V.
 SAHANEN, LARRY L. ANDERSON. --
 TILLMAN, DAVID A
 SAHANEN, K V. 1921
 ANDERSON, LARRY LAVON
 ORGANIZATIONAL SOURCE SYMPOSIUM ON FUELS AND ENERGY FROM RENEWABLE
 RESOURCES, CHICAGO, 1977.
 ORGANIZATIONAL SOURCE AMERICAN CHEMICAL SOCIETY.
 SOURCE NEW YORK : ACADEMIC PRESS., X. 342 P. : ILL.
 PUBLICATION DATE 1977
 NOTES INCLUDES BIBLIOGRAPHICAL REFERENCES AND INDEX.
 DOCUMENT TYPE MONOGRAPH
 SOURCE NAME US PUB
 LANGUAGE ENG
 NAL CALL NUMBER TA163.Z.596 1977
 PRIMARY CATEGORY CODE BS0500
 INDEX TERM RENEWABLE ENERGY SOURCES
 INDEX TERM CONGRESSES.
 INDEX TERM FUEL
 INDEX TERM CONGRESSES.

-7-
 ACCESSION NUMBER 789012450
 TITLE INDUSTRIAL USES FOR AGRICULTURAL BYPRODUCTS
 (AND WASTES, SOURCE OF RENEWABLE ENERGY, U.S.)
 AUTHORS MILLER, D L
 SOURCE IN ECOLOGY AND AGRICULTURAL PRODUCTION;
 PROCEEDINGS OF A SYMPOSIUM, P. 157-162. MAPS.
 PUBLICATION DATE 1977
 DOCUMENT TYPE ARTICLE
 SOURCE NAME USDA
 LANGUAGE ENG
 NAL CALL NUMBER 5601.SB 1973
 PRIMARY CATEGORY CODE BS0500
 INDEX TERM UNITED STATES

-8-
 ACCESSION NUMBER 779116281
 TITLE WOOD: AN ENERGY AND PROFIT PRODUCER,
 ENDLESSLY RENEWABLE
 AUTHORS LASSOIE, J P
 SOURCE AG IMPACT, P. 14-15.
 PUBLICATION DATE 1977 OCT
 DOCUMENT TYPE ARTICLE

SOURCE NAME	US PUB
LANGUAGE	ENG
NAL CALL NUMBER	5544.3 N7A45
PRIMARY CATEGORY CODE	351000

-9-	
ACCESSION NUMBER	779115175
TITLE	ENERGY CRISIS AND NEED FOR DEVELOPMENT OF RENEWABLE ENERGY SOURCES
AUTHORS	MANIVANNAN, K
SOURCE	AGRIC AGROIND J. 10 (4): 38-40.
PUBLICATION DATE	1977 APR
DOCUMENT TYPE	ARTICLE
LANGUAGE	ENG
NAL CALL NUMBER	S19.A32
PRIMARY CATEGORY CODE	550500

-10-	
ACCESSION NUMBER	779107721
TITLE	RENEWABLE ENERGY SOURCES AND A CONSERVATION ECONOMY
AUTHORS	CLARK, W
SOURCE	ECOLOGIST, 7 (7): 283-293. REF.
PUBLICATION DATE	1977 SEP
DOCUMENT TYPE	ARTICLE
SOURCE NAME	US PUB
LANGUAGE	ENG
NAL CALL NUMBER	QH540.E2
PRIMARY CATEGORY CODE	650500

-11-	
ACCESSION NUMBER	779098311
TITLE	THE PROSPECTS FOR RENEWABLE (SOLAR) ENERGY SOURCES
AUTHORS	WITWER, J G
SOURCE	WATER AIR SOIL POLLUT, 7 (2): 175-180.
PUBLICATION DATE	1977 FEB
DOCUMENT TYPE	ARTICLE
LANGUAGE	ENG
NAL CALL NUMBER	TD172.W36
PRIMARY CATEGORY CODE	550500

113

-12-
 ACCESSION NUMBER 779682992
 TITLE ENERGY FOR RURAL DEVELOPMENT : / RENEWABLE
 RESOURCES AND ALTERNATIVE TECHNOLOGIES FOR
 DEVELOPING COUNTRIES. REPORT OF AN AD HOC
 PANEL OF THE ADVISORY COMMITTEE ON TECHNOLOGY
 INNOVATION. BOARD ON SCIENCE AND TECHNOLOGY
 FOR INTERNATIONAL DEVELOPMENT. COMMISSION ON
 INTERNATIONAL RELATIONS. --
 ORGANIZATIONAL SOURCE NATIONAL RESEARCH COUNCIL. PANEL ON RENEWABLE
 ENERGY RESOURCES.
 ORGANIZATIONAL SOURCE U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT.
 OFFICE OF SCIENCE AND TECHNOLOGY. BUREAU OF
 TECHNICAL ASSISTANCE.
 SOURCE WASHINGTON : NATIONAL ACADEMY OF SCIENCES..
 XII. 306 P. : ILL.
 PUBLICATION DATE 1976
 NOTES PREPARED FOR THE OFFICE OF SCIENCE AND
 TECHNOLOGY. AGENCY FOR INTERNATIONAL
 DEVELOPMENT UNDER CONTRACT AID/CSD25B4. TASK
 ORDER NO. 1. ADVISORY STUDIES AND SPECIAL
 REPORTS NO. 18. INCLUDES BIBLIOGRAPHIES.
 DOCUMENT TYPE MONOGRAPH
 SOURCE NAME US PUB
 LANGUAGE ENG
 NATIONAL CALL NUMBER 5494.5 I5N3
 PRIMARY CATEGORY CODE 103000
 INDEX TERM AGRICULTURE
 INDEX TERM ENERGY CONSUMPTION.
 INDEX TERM UNDERDEVELOPED AREAS
 INDEX TERM AGRICULTURE.
 INDEX TERM UNDERDEVELOPED AREAS
 INDEX TERM TECHNOLOGY.

-13-
 ACCESSION NUMBER 769677271
 TITLE RENEWABLE ENERGY BULLETIN. / <V.2, NO.1-
 JAN./MAR. 1975-
 SOURCE LONDON. MULTI-SCIENCE PUB. CO.
 DOCUMENT TYPE SERIAL
 LANGUAGE ENG
 NATIONAL CALL NUMBER Z5853.F83R46
 PRIMARY CATEGORY CODE 850500
 INDEX TERM POWER RESOURCES
 INDEX TERM BIBLIOGRAPHY
 INDEX TERM PERIODICALS.
 INDEX TERM POWER (MECHANICS)
 INDEX TERM BIBLIOGRAPHY
 INDEX TERM PERIODICALS.

-14-
ACCESSION NUMBER 01008959
TITLE GRAZING ANIMALS: RENEWABLE ENERGY SOURCE FOR
FOOD
AUTHORS ENSMINGER, M E
SOURCE LIVEST BREED J. 19 (7): 106-108.
PUBLICATION DATE 1976 JUL
DOCUMENT TYPE ARTICLE
LANGUAGE ENG
NAL CALL NUMBER 49 L75B
PRIMARY CATEGORY CODE 250500

..... END OF OFF-LINE PRINT

115