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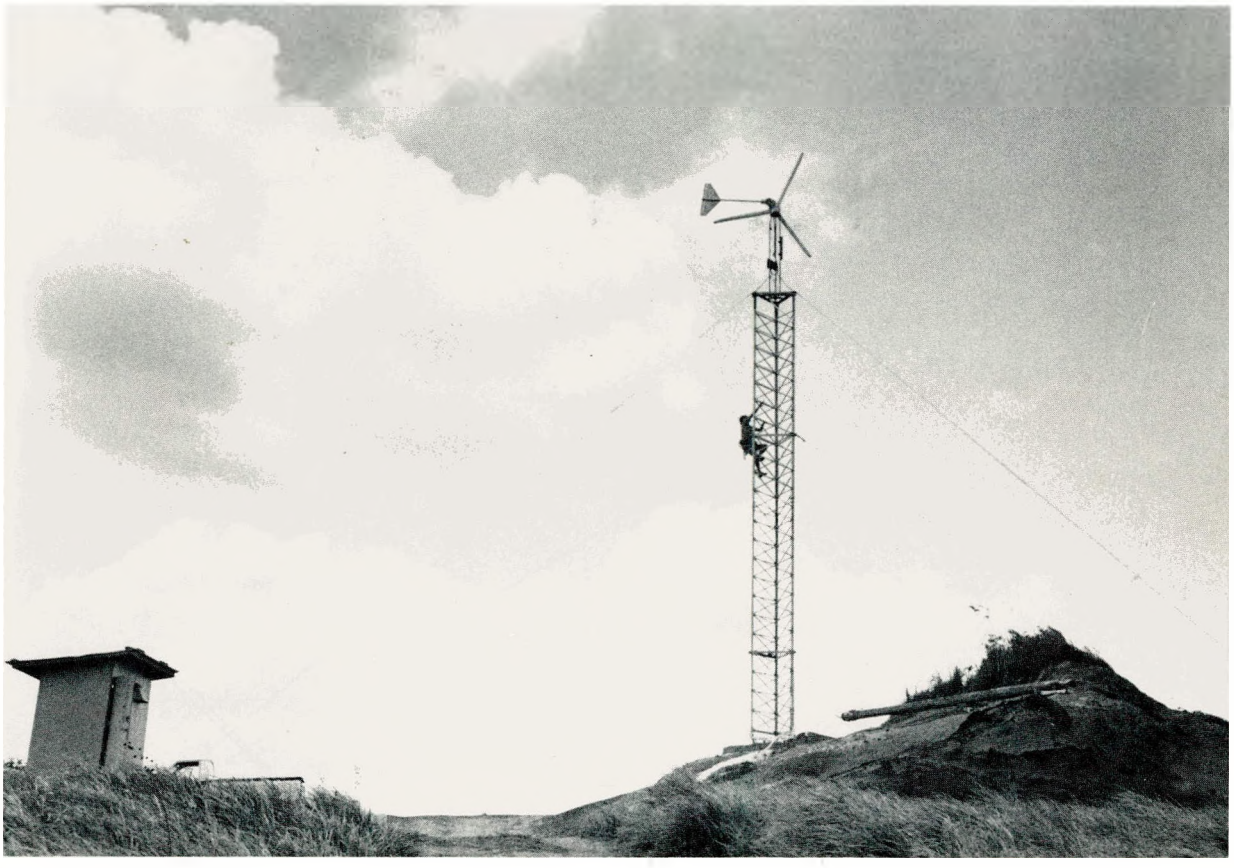
A Guidebook To Alternative Energy Projects on American Samoa, The Commonwealth of the Northern Mariana Islands, The Federated States of Micronesia, Guam, and The Republics of the Marshall Islands and Palau



Office of Capital Improvement Programs
Trust Territory of the Pacific Islands
Saipan, Commonwealth of the Northern Mariana Islands 96950
May, 1987

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A Guidebook to Alternative Energy Projects on American Samoa, the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia, Guam, and the Republics of the Marshall Islands and Palau

May, 1987

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Trust Territory of the Pacific Islands
Saipan, Commonwealth of the Northern Mariana Islands 96950

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(Cover photograph - wind electric system at Babulao, Guam, 1982, constructed by Bruce Best.)

PREFACE

The purpose of this book is to help transfer information concerning alternative energy projects that have been tried on the Pacific islands affiliated with the U.S. These islands include those in American Samoa, the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia (Kosrae, Pohnpei, Truk, and Yap), Guam, and the Republics of the Marshall Islands and Palau. Distances are long between islands and populations are sparse, making communication and the transfer of information particularly difficult. A project that works on American Samoa might be appropriate for Yap, but to get this information to the proper people on Yap in a reasonable period of time is extremely difficult.

This book attempts to help solve this problem by describing 100 alternative energy projects that have been tried on the islands since the mid- 1970's. This description and record of what has been done to date should be a source of ideas for energy workers, reduce duplication of work, and help encourage successes by describing other successes and failures.

Alternative energy projects are projects that use indigenous, renewable resources in order to reduce local dependency on imported petroleum for electricity or liquid fuels. The islands have an apparent abundance of natural resources for this purpose such as the sun, rivers, vegetation, the ocean, and wind; and, ideally, it should be relatively simple to convert these resources to electricity or fuel. However, there are problems unique to the remote, tropical Pacific that often appear insurmountable, and successes to date are the result of unusual persistence, hard work, and ingenuity of those on the islands.

The U.S. Department of Energy has been the most active sponsor of energy projects on the islands, and therefore the majority of projects in this book show their participation. The book attempts as much as possible to include all projects from the mid-1970's to the present and so locally and privately funded projects are also included. There are undoubtably omissions however, particularly in the private sector, and for these the author apologizes. As technology transfer includes the passing of complete information, projects that are not successful regardless of reason are included.

Projects are confined to those that actually develop or demonstrate hardware. For example, projects that use photovoltaic or hydroelectric systems are included, while those that use energy management systems to reduce petroleum consumption are not. These projects use the complete spectrum of alternative technologies such as biomass conversion, wind electric, solar water heating, photovoltaics, wind water pumping, hydroelectric, water desalination, and integrated systems. Because of the relatively low power demands, the systems are small with outputs usually between 1000 watts and 15 kilowatts. Costs of the projects are also low, and the projects attempt to be labor intensive and use local material and expertise whenever possible.

The book has three sections. Section I, Projects, gives a one page description for each of the 100 projects. The projects are grouped geographically by political entity. The information follows a format that includes location, cost, completion date, funding source, designer or supplier, contact office (contact names are not included as they often change), and a paragraph description of the project. A photograph is shown whenever possible. For each project there is also a list of literature for additional information. This literature keys to the entries in Section II.

Section II. Literature, lists 381 reports and studies that either describe the projects or have contributed to them in some fashion. Policy or general studies are grouped geographically while the rest are listed according to technology. Each one has a number that corresponds with numbers shown in the literature part of each project description. Section III. Appendices and Indexes, contains very brief descriptions of 21 new projects that the U.S. Department of Energy has just sponsored. This section also includes author and subject indexes, and sources for the literature described in Section II.

When the alternative energy work first started ten years ago there were only a handful of projects scattered across the islands. Most of these failed quickly, but they did lay the ground work for future endeavors. For those of us who were there at the beginning, the present accomplishments are truly amazing when compared to those early efforts. Now there are a network of well-run energy offices with rapidly developing expertise; periodic workshops to pass on this expertise; small, local businesses that distribute and maintain energy systems; individual workers who understand the technologies and island engineering problems; and the systems themselves such as the successful photovoltaic devices and biomass conversion systems. This book is an historical record of this work and a way of acknowledging the creativity and commitment of a diverse and dedicated group of energy workers.

Gathering material and preparing this book required the help of many people. The author would like to acknowledge and thank the following:

Cindy Bower-Camacho and Chuck Jordan, Office of Capital Improvement Programs, Trust Territory of the Pacific Islands;

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Elizabeth Udui, Juan Camacho, and the staff of the Commonwealth Energy Office, Commonwealth of the Northern Mariana Islands;

Tony Actouka, Office of Conservation and Resource Surveillance, Pohnpei State Government;

Regis Akitaya, Department of Public Works, Republic of Palau;

Banny deBrum, Energy Coordinator, Republic of the Marshall Islands;

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Bayard Shaver and the staff of Shaver and Co., Minneapolis, Minn. for production and printing

CONTENTS

SECTION I. PROJECTS

PART 1: AMERICAN SAMOA

Territorial Energy Office
Office of the Governor
Pago Pago, American Samoa 96799

PROJECT #1:
TERRITORIAL ENERGY OFFICE DEMONSTRATION HOUSE

(Front view of the American Samoa Territorial Energy House - 1982.)

LOCATION:
FAA Station (near airport)
Tutuila, American Samoa

COST: $25,000

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants and Energy
Extension Service Programs

COMPLETION DATE: 1982

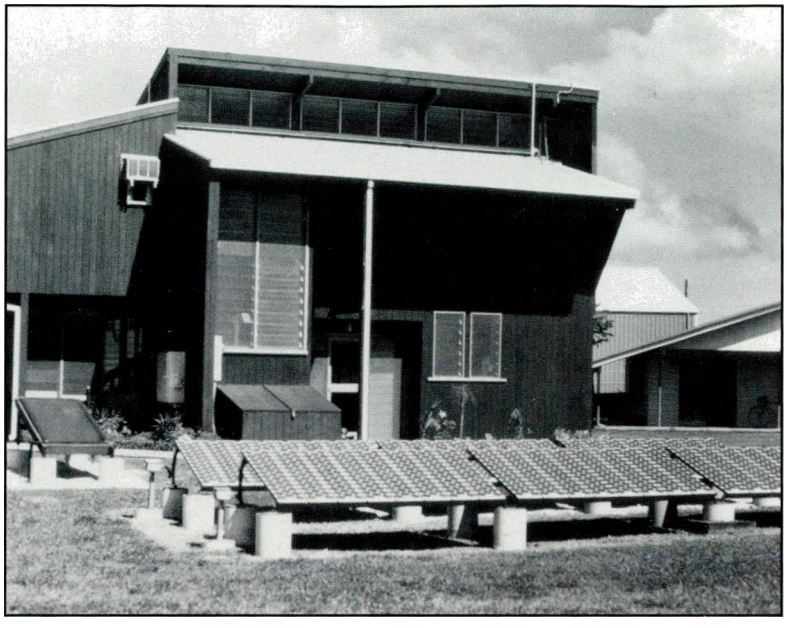
DESIGNER/SUPPLIER:
G.M. Meredeth & Associates
P.O. Box 2597
Pago Pago, American Samoa
96799

CONTACT:
Territorial Energy Office
Office of the Governor
Pago Pago, American Samoa
96799

COMMENTS: In 1981, the American Samoa Territorial Energy Office built an energy efficient home at a well-traveled location near the airport to demonstrate various energy saving ideas and energy conversion systems that use renewable resources. G.M. Meredeth & Associates of American and Western Samoa designed the home to combine traditional architecture with new energy conservation ideas and to use renewable energy systems for producing hot water and backup electricity. The Territorial Energy Office became the main occupant after construction was completed. Energy saving devices include fluorescent and natural lighting, natural ventilation, light colored roofing, and insulation. Energy systems include solar and heat pump water heating, and photovoltaic and wind electric systems with battery storage and an inverter. With the exception of the wind electric machine the systems are working as planned, and the house serves as a successful demonstration for conservation and energy devices. For additional information on the wind electric and photovoltaic systems see Projects #2 and #6.

LITERATURE: See references 2, 22, 34, 134, 138, 139, 140, 141, 155, 191, 192, and 205 for discussions of the Energy House, its place in American Samoa's energy plans, and energy conservation ideas.

PROJECT #2:
PHOTOVOLTAIC SYSTEM AT THE DEMONSTRATION HOUSE



(Photovoltaic array behind the Territorial Energy House - 1982.)

LOCATION:
FAA Station (near airport)
Tutuila, American Samoa

COST: $60,000

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants and Energy
Extension Service Programs

COMPLETION DATE: 1982

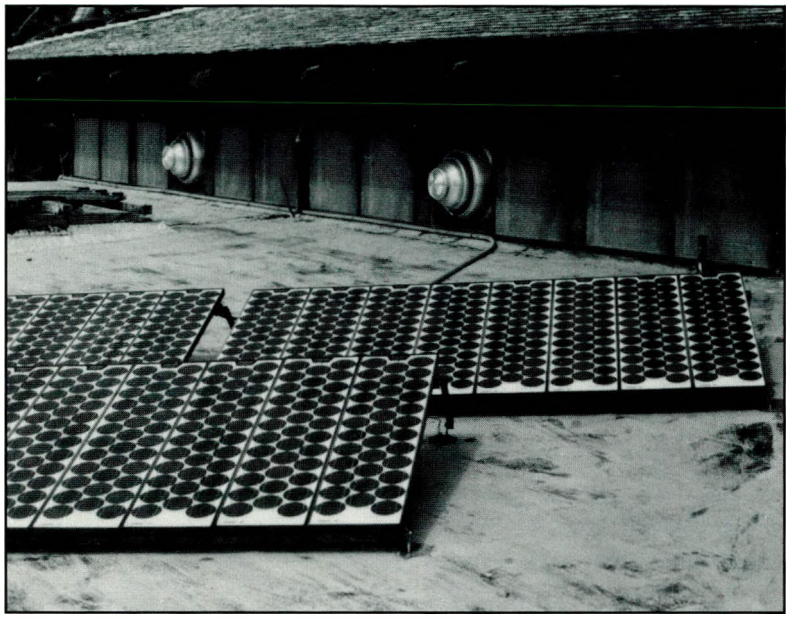
DESIGNER/SUPPLIER:
Solar Power Corp.
(out of business)

CONTACT:
Territorial Energy Office
Office of the Governor
Pago Pago, American Samoa
96799

COMMENTS: The American Samoa Territorial Energy Office installed a photovoltaic system as a backup source of electricity to utility power at the Territorial Energy House. The system complements other energy conversion and conservation systems at the house including a wind electric machine. Forty- eight Solar Power photovoltaic modules provide 1600 peak watts. The modules are in an array installed in a framework on the ground behind the house. A bank of deep-discharge batteries stores the electricity, and an Abacus inverter converts the power from DC to AC. The arrangement has been mostly successful, but there have been a few problems. These include repair work done to the inverter under warranty and inefficient operation due to a mismatch between system output and low power demands. See Projects #1 and #6 for information on the Energy House and the wind electric machine.

LITERATURE: References 2, 22, 34, 134, and 191 give brief, specific discussions on the system, and references 282 and 287 present general discussions on photovoltaic systems in American Samoa and throughout the Pacific.

PROJECT #3:
PHOTOVOLTAIC SYSTEMS AT THE POLOA AND LEONE SCHOOLS



(Photovoltaic array at the Poloa High School.)

LOCATION:
Poloa and Leone Schools
Tutuila, American Samoa

COST: $25,000 each

FUNDING SOURCE:
U.S. Department of Energy
Energy Extension Service
Program

COMPLETION DATE: Unknown

DESIGNER/SUPPLIER:
Solar Power Corp.
(out of business)

CONTACT:
Territorial Energy Office
Office of the Governor
Pago Pago, American Samoa
96799

COMMENTS: The American Samoa Territorial Energy Office has installed single photovoltaic-powered ventilation systems at Poloa and Leone Schools. Each system consists of a roof-mounted 24 module array and a bank of deep-discharge storage batteries to power four exhaust DC fans for removing hot air from the school buildings. Output from each system is about 800 peak watts. Originally, inverters converted the DC power to AC for AC fans. However, the inverters did not work so they were discarded, and DC fans were substituted. The systems are working properly now, but at each school vandals have broken a few of the modules with rocks.

LITERATURE: There are no references that have specific discussions on these systems. References 22, 34, 282, and 287 have general discussions on photovoltaics in American Samoa and throughout the Pacific.

PROJECT #4:
PHOTOVOLTAIC SYSTEM FOR A NOAA WEATHER STATION

LOCATION:
Cape Matatula
Tutuila, American Samoa

COST: Unknown

FUNDING SOURCE:
U.S. Department of Energy

COMPLETION DATE: 1983

DESIGNER/SUPPLIER:
Solarex Corp.
1335 Piccard Drive
Rockville, Maryland 20850

CONTACT:
Territorial Energy Office
Office of the Governor
Pago Pago, American Samoa
96799

COMMENTS: This photovoltaic system is the primary source of electricity for powering the National Oceanic and Atmospheric Administration (NOAA) geophysical monitoring station for climatic change at a remote site at Cape Matatula. The system has a peak output of about 3000 watts. It consists of ten interconnected arrays of ten Solarex modules per array, a bank of deep- discharge batteries, a 2000 watt Abacus inverter to convert DC power to AC, and a charger system for supplying 2000 watts of continuous power to the instruments. A diesel generator provides backup electricity. The photovoltaic system has been operating successfully to date and is a good application of a photovoltaic system supplying electricity reliably at a remote location.

LITERATURE: See references 11 and 13 for brief, specific discussions and references 270, 271, 282, 286, and 287 for general discussions on photovoltaic-powered communication systems.

PROJECT #5:
PHOTOVOLTAIC SYSTEM FOR AN ELECTRIC FENCE

(Photovoltaic equipment before a storm destroyed the fence - 1981.)

LOCATION:
Fitiuita, Ta'u
Manu'a Island
American Samoa

COST: $1,100

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1981

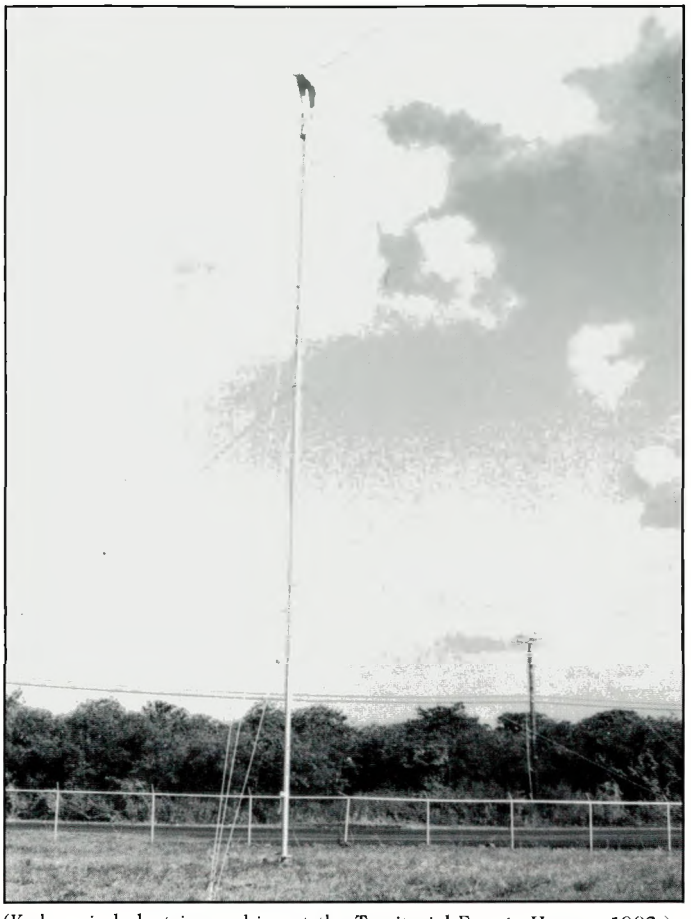
DESIGNER/SUPPLIER:
David A. Sleep, formerly
Department of Agriculture
Office of the Governor
Pago Pago, American Samoa
96799

CONTACT:
Territorial Energy Office
Office of the Governor
Pago Pago, American Samoa
96799

COMMENTS: Using a photovoltaic system to power an electric fence in 1981 was an unusual application for this part of the Pacific. Throughout the Pacific wild pigs cause considerable damage to root crops on rural farms. Pigs are difficult to control as they dig under ordinary fences, and most rural areas do not have electricity for electric fences. The purpose of this project was for the local Department of Agriculture to demonstrate a photovoltaic-powered, electric fence system that has been used successfully in New Zealand. A single photovoltaic panel provided 12 watts of electricity to power an electric fence that enclosed one acre of taro on a remote farm on Manu'a Island. Equipment consisted of a 12 watt Solar Pak photovoltaic unit, a Wakato electric fence power controller with battery pack, and nylon cord interwoven with copper strands as wire for the fence. The wire was at two heights, 4-8 inches and 16-18 inches off the ground. The system worked well for a few months and kept the pigs out of the taro. However, a storm blew trees over on the fence, and the fence has not been rebuilt.

LITERATURE: See reference 288 for a detailed discussion and references 175, 176, 191, 192, 282, and 287 for more general discussions.

PROJECT #6:
WIND ELECTRIC SYSTEM AT THE DEMONSTRATION HOUSE



(Kedco wind electric machine at the Territorial Energy House - 1982.)

LOCATION:
FAA Station (near airport)
Tutuila, American Samoa

COST: $10,000

FUNDING SOURCE:
U.S. Department of Energy

COMPLETION DATE: 1982

DESIGNER/SUPPLIER:
Kedco Wind Systems

EnerTech Wind Systems
P.O. Box 420
Norwich, Vermont 05055

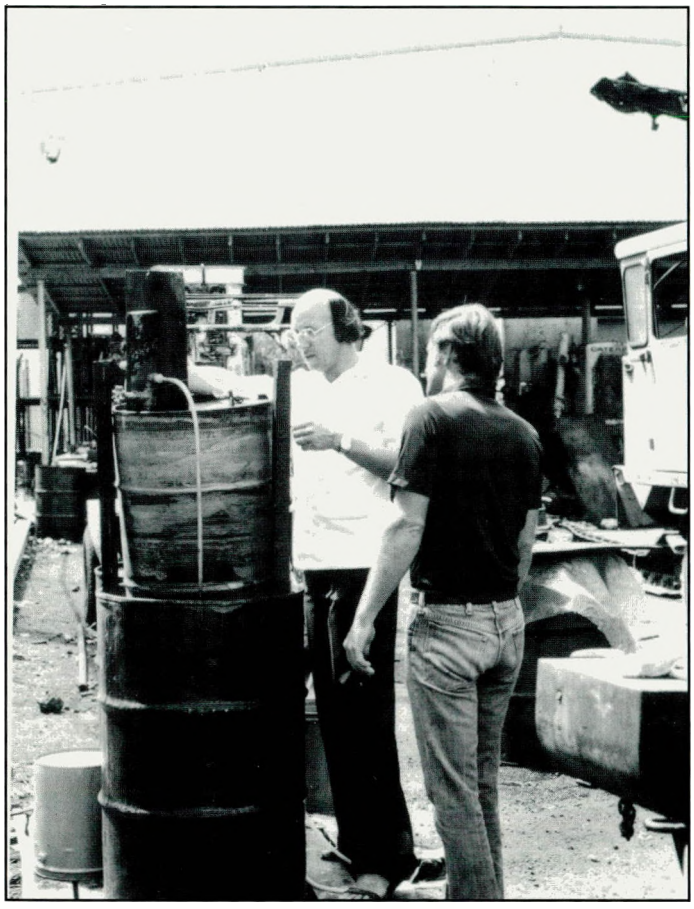
Rockwell International
Rocky Flats Plant Energy
Systems Group
Golden, Colorado 80401

CONTACT:
Territorial Energy Office
Office of the Governor
Pago Pago, American Somoa
96799

COMMENTS: This project is part of the U.S. Department of Energy's effort with Rockwell International to install wind electric machines on a number of the Pacific islands. The program has had mixed results on American Samoa. Technicians from Rockwell International installed a Kedco system at the Territorial Energy Office House as one of a number of energy conversion and conservation systems demonstrated there. The machine failed almost immediately. After being repaired, it failed again, and this time technicians replaced it with an EnerTech system. This system consists of an 1800 watt EnerTech downwind, wind electric machine on a Rohn tower. It has an AC induction generator and is connected to the island power grid. The machine has operated without problems until recently when a starter capacitor failed. A new capacitor has been ordered and should be installed by now. See Project #1 for additional information on the Energy House.

LITERATURE: See references 2, 134, 191, and 192 for brief, specific discussions, and references 22, 317, 321, 322, 325, 326, and 327 for general discussions of wind and the wind potential on American Samoa.

PROJECT #7
BIOGAS CONVERSION OF TUNA SLUDGE



(Experimental tuna sludge digester at the Marine Railway Authority - 1980.)

LOCATION:
Marine Railway Authority
Pago Pago, Tutuila
American Samoa

COST: $20,000

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1980

DESIGNER/SUPPLIER:
Action Resources, Inc.
1077 Bishop St., Suite 442
Honolulu, Hawaii 96813

CONTACT:
Territorial Energy Office
Office of the Governor
Pago Pago, American Samoa
96799

COMMENTS: The tuna fish canning industry in American Samoa produces large amounts of waste tuna sludge that must be disposed of in ways that do not harm the environment or are not energy consumptive. The purpose of this project was to build a prototype anaerobic digester to see if it would be economical to convert the tuna to methane gas. Action Resources, Inc., and the American Samoa Territorial Energy Office built and operated a small digester at the Marine Railway Authority near the canneries. Samples of the tuna sludge were sent to the University of Hawaii for chemical analysis in order to determine the best process for large-scale digestion. Biogas from the digester was also sent to the University for analysis of the gas content. A detailed final report showed that expanding the operation would be cost-effective and result in significant production of methane gas. However, at that time the canneries were encountering severe economic problems so they were not interested in expansion despite the economic promise.

LITERATURE: See reference 114 for a detailed report and references 2, 7, 191, and 192 for brief, specific accounts.

PROJECT #8
SOLAR AIR CONDITIONING FOR THE HOSPITAL

(Back of the Hospital where the solar air conditioner is located - 1980.)

LOCATION:
Lyndon B. Johnson Hospital
Tutuila, American Samoa

COST: $200,000

FUNDING SOURCE:
U.S. Department of Energy

U.S. Department of Housing and Urban Development

COMPLETION DATE: 1983

DESIGNER/SUPPLIER:
Dorvin Leis Company, Inc.
Maui, Hawaii 96708

CONTACT:
Territorial Energy Office
Office of the Governor
Pago Pago, American Samoa
96799

COMMENTS: The purpose of this project was to determine the technical and economic suitability of using a solar absorption cooling system to supplement a standard hospital air conditioning system in a remote, tropical setting. This is a unusual project being the only one of its kind in the South Pacific. Dorvin Leis Company, Inc., from Hawaii designed and installed a 40 ton supplemental cooling system for the hospital. The system includes three American Yazaki Corporation modular, water-fired, absorption chillers; 8,428 square feet of Yazaki solar collectors; an insulated 7,000 gallon hot water storage tank; circulating pumps; and controls. Originally, the system was to operate only during sunlight hours, but now it operates continually using waste heat from the hospital boilers at night. With a total hospital cooling load of 165 tons the new system was to provide significant energy savings and have a payback time of under seven years. Unfortunately, there have been a series of technical and design problems, and the system has been operating only occasionally. The technology seems to be too complex for a location such as this considering the complexity of the system and the difficulty in finding technical help and repair parts.

LITERATURE: Reference 300 is a brief account of the project. References 22 and 27 give general discussions.

PROJECT #9
BUTANE GAS CONVERSION FOR GOVERNMENT VEHICLES

LOCATION:
Pago Pago
Tutuila, American Samoa

COST: $10,000

FUNDING SOURCE:
U.S. Department of Energy
Technology Transfer Program

COMPLETION DATE: 1986

DESIGNER/SUPPLIER:
Territorial Energy Office
Office of the Governor
Pago Pago, American Samoa
96799

CONTACT:
Territorial Energy Office
Office of the Governor
Pago Pago, American Samoa
96799

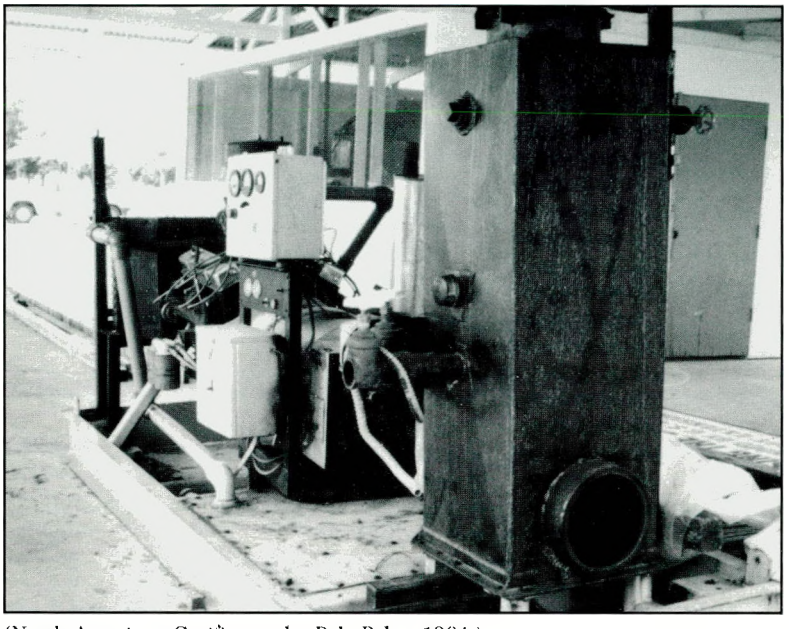
COMMENTS: The purpose of this project was to determine the economic and technical feasibility of converting American Samoa government vehicles to use butane gas. Originally, the Territorial Energy Office was to convert four vehicles, but because of unexpected expenses they were able to convert just one vehicle, an Isuzu pickup truck. They completed the conversion after considerable technical difficulties and then monitored the operation for a few months. A complete final report describes the conversion process and gives costs, comparative operating costs, and other pertinent information. The report shows that currently the economics of conversion and operation are not good because of falling gasoline prices. However, the conversion does work, and there may be opportunities in the future where it will make economic sense.

LITERATURE: See reference 329 for the project report and reference 376 for a brief description of the project.

PART 2: COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

Commonwealth Energy Office
P.O. Box 340
Commonwealth of the Northern Mariana Islands
Saipan, Mariana Islands 96950

PROJECT #10
GASIFIER DEMONSTRATION



(North American Gasifier at the Pala Pala - 1984.)

LOCATION:
Pala Pala, Civic Center
Susupe, Saipan
Commonwealth of the Northern
Mariana Islands

COST: $25,000

FUNDING SOURCE:
U.S. Department of Energy
Energy Extension Service Program

COMPLETION DATE: 1983

DESIGNER/SUPPLIER:
Hodam & Associates
North American Gasifier Co.
106 K Street, Suite #200
Sacramento, California 95814

CONTACT:
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern
Mariana Islands 96950

COMMENTS: The purpose of this project was to demonstrate producer gas as a source of energy for powering electricity generators. Producer gas is obtained when biomass is partially combusted in a gasifier where the air intake is controlled. By limiting air intake the biomass is partially burned yielding a combustible gas called producer gas. In turn, this gas can be burned to power things such as vehicles or electric generators. The technology is established but has certain problems, mostly environmental concerning by-products of the partial combustion. For this project, the Energy Office purchased a North American Gasifier with generator from Hodam & Associates. The unit was to produce up to 30 kilowatts of electricity by burning local tangantangan. Success has been mixed. The machine worked well at first but is broken now due to machine design problems and irregular maintenance. See Project #97 for a similar system.

LITERATURE: See references 122, 123, and 125 for specific discussions and references 22, 38, 39, 45, 115, and 347 for general policy discussions.

PROJECT #11
CHARCOAL KILN

(Charcoal kiln at the Cabrera business - 1986.)

LOCATION:
Gregorio Cabrera
Island Charcoal
Capitol Hill, Saipan
Commonwealth of the Northern
Mariana Islands

COST: $2,900

FUNDING SOURCE:
U.S. Department of Energy
Energy Extension Service Program

COMPLETION DATE: 1984

DESIGNER/SUPPLIER:
British Tropical Products Institute
London, United Kingdom

CONTACT:
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern
Mariana Islands 96950

COMMENTS: The purpose of this project was to demonstrate an efficient way to make charcoal. Charcoal is the solid residue from incomplete combustion of organic matter and has a higher energy content than wood. On the Mariana Islands, charcoal is made traditionally by burning wood in a dirt covered pit. People working on this project developed a more efficient and easily transported kiln for converting local tangantangan to charcoal. This kiln has two interlocking steel cylinders, four smokestacks, four inlets, and a conical cover. It produces up to 3/4 ton of charcoal per firing. The Energy Office demonstrated the kiln at the Kagman Agriculture Station and then gave it to a private entrepreneur, Gregorio Cabrera, to use in his local charcoal business. The U.S. Department of Energy awarded the Commonwealth Energy Office a 1985 National Award for Energy Innovation for developing the technology and transferring it successfully to a local business.

LITERATURE: References 119 and 129 give specific discussions of the project, and references 115 and 118 are of related interest. (Update: See **The Northern Marianas Charcoal Kiln Project**, by E.S. Udui, 1986, 22p.)

PROJECT #12
INTEGRATED DIGESTER PLANT

(Digester and aquaculture ponds at the integrated digester plant - As Lito Agriculture Station - 1985.)

LOCATION:
As Lito Agriculture Station
Saipan
Commonwealth of the Northern
Mariana Islands

COST: $28,000

FUNDING SOURCE:
U.S. Department of Energy
Energy Extension Service and
Appropriate Energy Technology
Grants Programs

COMPLETION DATE: 1984

DESIGNER/SUPPLIER:
George Chan, formerly
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern
Mariana Islands 96950

CONTACT:
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern
Mariana Islands, 96950

COMMENTS: The Commonwealth Energy Office won a U.S. Department of Energy 1984 National Award for Energy Innovation for this project. The project integrates a number of small systems into a plant for processing waste (sanitation), generating methane (fuel), and producing fertilizer. A biogas digester converts pig waste into methane gas by anaerobic digestion; the digester's effluent water goes to aquaculture ponds as a nutrient for fish and algae; and pond water and digester waste become crop fertilizer. The components of the system include a reinforced concrete digester that also stores the gas; a second fiberglass digester; fiberglass algae tanks; and a 2,000 square foot, plastic-lined fish pond. The Energy Office demonstrates the project at the As Lito Agriculture Station. Through their Rural Development Program they are encouraging rural farmers to build similar systems. See Projects #13, #14, #15, and #16 for additional information on these systems.

LITERATURE: For specific discussions see references 2, 3, 4, 7, 116, 117, 120, 121, 124, 126, 128, 133, 178, 191, 192, and 193. For general and policy discussions see references 11, 22, 35, 37, 38, 39, and 45.

PROJECT #13
BIOGAS CONVERSION AT A RURAL FARM - NO.1

(Digester and piggery at the Fina Sisu pig farm - 1985.)

LOCATION:
Fina Sisu Piggery
Saipan
Commonwealth of the Northern
Mariana Islands

COST: $13,000

FUNDING SOURCE:
U.S. Department of Energy
Energy Extension Service Program
Private funds

COMPLETION DATE: 1983

DESIGNER/SUPPLIER:
George Chan, formerly
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern
Mariana Islands 96950

CONTACT:
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern
Mariana Islands 96950

COMMENTS: This project is to construct a biogas digester system at a commercial pig farm. The design is similar to the one at the integrated digester plant at the As Lito Agriculture Station (Project #12) and is a good example of transferring a technology from the government to the private sector. The digester has been built with private funds and some support from the U.S. Department of Energy. It consists of a combination concrete digester and storage tank with piping leading to a small gas burner. Pig wastes are converted to methane gas by anaerobic digestion, and the gas is used for cooking hog food and heating water for the slaughter house. The system is working properly.

LITERATURE: No references specifically discuss this project. References 22, 38, 39, 44, 45, 120, 121, 124, 126, and 128 have general discussions.

PROJECT #14
BIOGAS CONVERSION AT A RURAL FARM - NO.2

(Digester and pond system at Beswick Businesses - 1986.)

LOCATION:
Beswick Businesses
Saipan
Commonwealth of the Northern
Mariana Islands

COST: Unknown

FUNDING SOURCE:
Private funds

COMPLETION DATE: 1985

DESIGNER/SUPPLIER:
Rodger N. Ludwick
Beswick Businesses
P.O. Box 303, Saipan
Commonwealth of the Northern
Mariana Islands 96950

CONTACT:
Rodger N. Ludwick
P.O. Box 303, Saipan
Commonwealth of the Northern
Mariana Islands 96950

COMMENTS: This project is a privately financed, integrated digester system. The design comes from the integrated digester plant at the As Lito Agriculture Station. In similar fashion to Projects #13, #15, and #16, it is an example of technology transfer from a government sponsored project to the private sector. A fiberglass digester converts pig wastes to methane gas for cooking pig feed; the digester's nutrient-rich effluent water goes to a fish and duck pond; and wastes from the pond and digester are fertilizer for a garden. The system has been operating successfully since completion date. For more information on the integrated digester plant at As Lito see Project #12.

LITERATURE: No references specifically discuss this project. References 22, 38, 39, 44, 45, 120, 121, 124, 126, and 128 have general discussions.

PROJECT #15
BIOGAS CONVERSION AT A RURAL FARM - NO.3

(Digester at the Jose Hocog farm - 1984.)

LOCATION:
Jose Hocog Farm
San Jose, Tinian
Commonwealth of the Northern
Mariana Islands

COST: $8,000

FUNDING SOURCE:
U.S. Department of Energy
Energy Extension Service Program

COMPLETION DATE: 1983

DESIGNER/SUPPLIER:
George Chan, formerly
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern
Mariana Islands 96950

CONTACT:
Jose Hocog
P.O. Box 98
San Jose, Tinian
Commonwealth of the Northern
Mariana Islands, 96952

COMMENTS: This project is similar to Projects #13, #14, and #16. The design for the digester comes from the Commonwealth Energy Office integrated digester plant at the As Lito Agriculture Station. A 200 cubic foot concrete digester and gas storage system converts pig wastes to methane gas by anaerobic digestion. Unlike the other projects this digester stands by itself and is not integrated into aquaculture and crop fertilizer systems. The digester is operating, but the owner has not been able to maintain it properly. See Project #12 for information on the As Lito integrated digester plant.

LITERATURE: No references specifically discuss this project. References 22, 38, 39, 44, 45, 120, 121, 124, 126, and 128 have general discussions.

PROJECT #16
BIOGAS CONVERSION AT A RURAL FARM - NO. 4

(Digester at the Pedro Sakisat farm.)

LOCATION:
Pedro Sakisat Farm
Rota
Commonwealth of the Northern
Mariana Islands

COST: $8,000

FUNDING SOURCE:
U.S. Department of Energy
Energy Extension Service Program

COMPLETION DATE: 1983

DESIGNER/SUPPLIER:
George Chan, formerly
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern
Mariana Islands 96950

CONTACT:
Pedro Sakisat
Rota
Commonwealth of the Northern
Mariana Islands 96951

COMMENTS: This is another biogas digester system with a design similar to the system at the Commonwealth Energy Office integrated digester plant at the As Lito Agriculture Station. The system includes a 200 cubic foot concrete digester and gas storage facility with an algae basin. The digester is producing biogas; and water hyacinth and other water plants are growing in the basin and are a protein supplement to the pig feed. For information on the integrated digester plant see Project #12, and for information on the other rural digesters see Projects #13, #14, and #15.

LITERATURE: No references specifically discuss this project. References 22, 38, 39, 44, 45, 120, 121, 124, 126, and 128 have general discussions.

PROJECT #17:
BIOMASS FARM

(Giant Leucaena at the first plantation - 1986.)

LOCATION:
Kagman Agriculture Station
Saipan
Commonwealth of the Northern
Mariana Islands

COST: $36,000

FUNDING SOURCES:
U.S. Department of Energy
U.S. Department of Agriculture

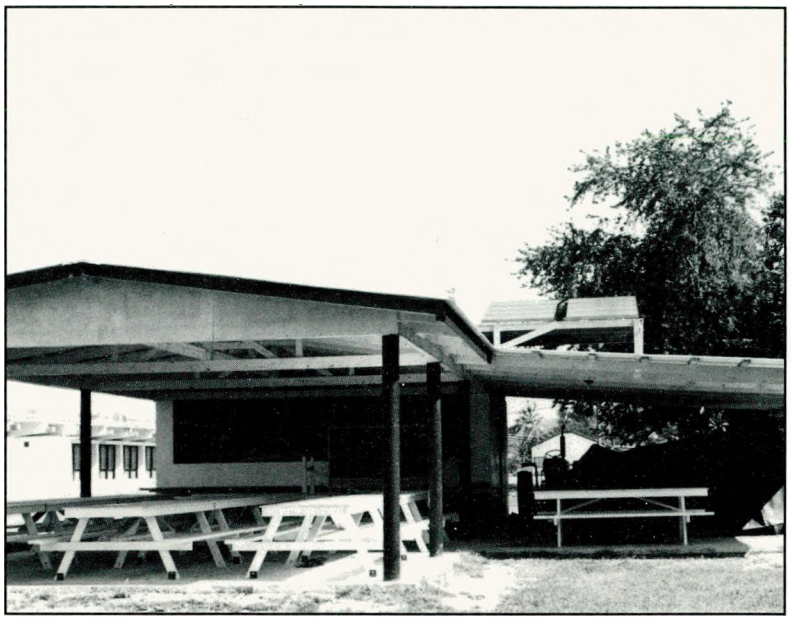
DESIGNER/SUPPLIER:
Kagman Agriculture Station
Saipan
Commonwealth of the Northern
Mariana Islands 96950

CONTACT:
James H. Culbert
Kagman Agriculture Station
P.O. Box 221, Saipan
Commonwealth of the Northern
Mariana Islands 96950

COMMENTS: Technicians from the Kagman Agriculture Station are experimenting on three small plantations with various crops that could be sources of energy for biomass systems. In 1980, they planted a crop of Giant Leucaena (tangantangan) on the first plantation. They are harvesting the crop now and have used over half of it to produce charcoal in Project #11. The crop has a faster growth rate and is more pest-resistant than common Leucaena; however, it produces less charcoal. On the second plantation they planted seven different varieties of Leucaena in two rows each. They have not harvested these yet. On the third plantation they planted 14 varieties of trees including Monkey Pod, Eucalyptus, and Acacia. They will harvest these trees in 1988. Future work includes studying the tree spacing and growth in other soils, and correlating their data with data from Hawaii. Problems to date include frequent changes in administration at the Agriculture Station with subsequent changes in program objectives and procedures. (Update: The typhoon of Dec. 3, 1986, destroyed most of the plantations.)

LITERATURE: There are no specific discussions of this project. See references 11, 13, 22, 38, 39, 40, and 45 for policy discussions and references 115, 131, and 347 for discussions of similar projects.

PROJECT #18
PHOTOVOLTAIC SYSTEM AT THE PALA PALA



(Photovoltaic system on the roof of the Pala Pala - 1986.)

LOCATION:
Pala Pala, Civic Center
Susupe, Saipan
Commonwealth of the Northern
Mariana Islands

COST: $55,800

FUNDING SOURCE:
U.S. Department of Energy
Energy Extension Service Program

COMPLETION DATE: 1984

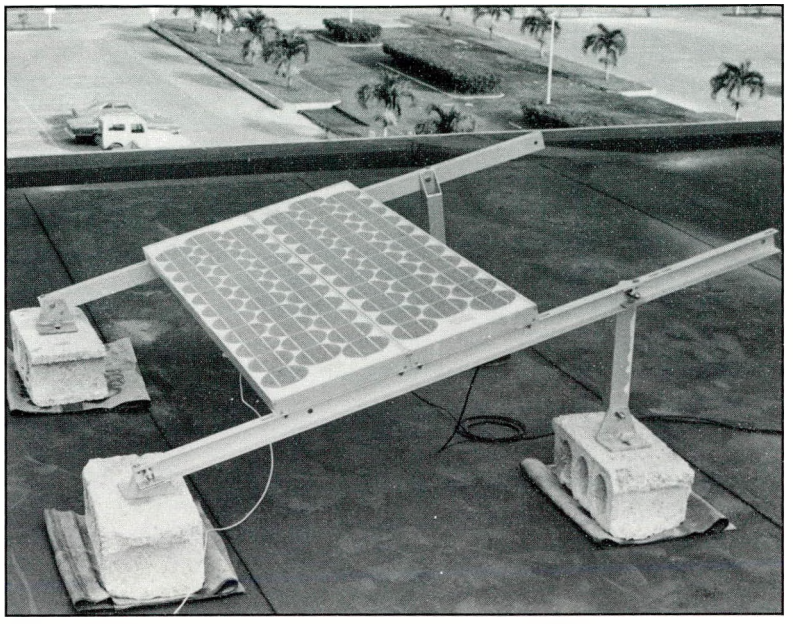
DESIGNER/SUPPLIER:
Solarex Corporation
1335 Piccard Drive
Rockville, Maryland 20850

CONTACT:
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern
Mariana Islands 96950

COMMENTS: This is part of a project to install photovoltaic systems at remote island locations in order to provide electricity for fans, fluorescent lights, refrigerators, and radios. Eventually, each household on Agrihan, Northern Mariana Islands, will receive a ceiling fan, a 40 watt fluorescent light, and a radio socket. The Commonwealth Energy Office is demonstrating one of the systems now at the Pala Pala near the Civic Center. The Pala Pala is a small shed and covered area that is used for exhibiting a number of energy systems such as the gasifier (see Project #10). The photovoltaic system consists of two Solarex photovoltaic modules, a controller, eight 6 volt batteries, a 40 watt fluorescent light, and a ceiling fan. The system is operating without problems except for the ceiling fan, which melted and has not been replaced. (Update: The system has been dismantled recently and shipped to the Northern Islands.)

LITERATURE: See references 272 and 273 for specific discussions; references 282, 286, and 287 for related discussions; and references 22, 38, 39, and 45 for policy discussions.

PROJECT #19
PHOTOVOLTAIC REFRIGERATOR DEMONSTRATION



(Photovoltaic panel on the roof of the Nauru Building - 1982.)

LOCATION:
Former Commonwealth Energy Office
Nauru Building, Saipan
Commonwealth of the Northern Mariana Islands

COST: $1,700

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy Technology Grants Program

COMPLETION DATE: 1982

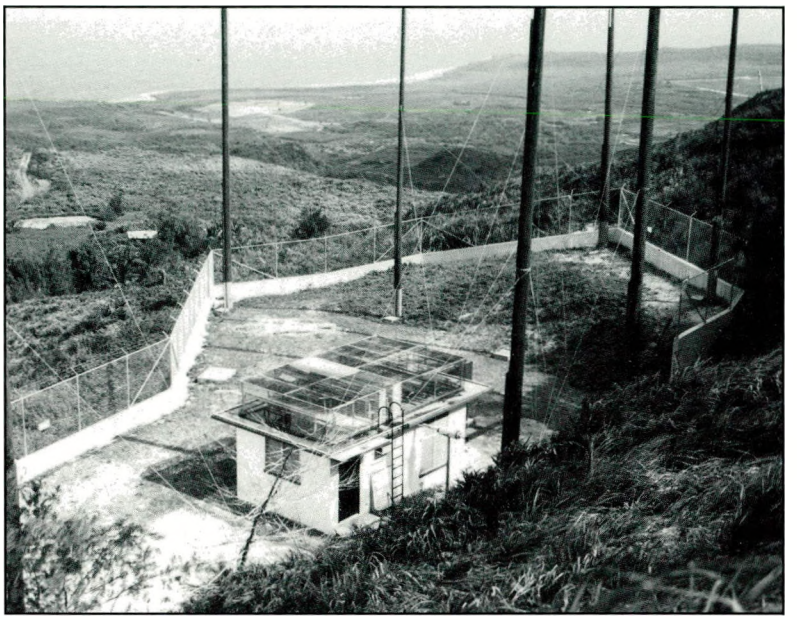
DESIGNER/SUPPLIER:
ARCO Solar, Inc.
P.O. Box 2105
Chatsworth, California 91311

CONTACT:
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern Mariana Islands 96950

COMMENTS: The U.S. Department of Energy sponsored this project in 1980 when photovoltaic systems were just being introduced to the Pacific islands. The purpose was to show how a simple photovoltaic system could power a small refrigerator intended for rural communities. Such systems are more common now so the Commonwealth Energy Office has dismantled the demonstration system and is using the components in the dispensary on Agrihan. The system consisted of two ARCO panels connected to a battery bank, a power control device, and a small refrigerator. The panels were placed in a frame on the roof of the Nauru Building and the refrigerator was in the Commonwealth Energy Office.

LITERATURE: See references 2, 191, 192, 272, and 273 for specific discussions; references 282, 286, and 287 for related material; and references 22, 38, 39, and 45 for policy discussions.

PROJECT #20
PHOTOVOLTAIC SYSTEMS AT THE COMMUNICATION STATIONS



(Photovoltaic array on the roof of the NOAA Communication Center, Mount Tapotchau - 1986.)

LOCATION:
NOAA Communication Station
Mount Tapotchau, Saipan
Commonwealth of the Northern
Mariana Islands

COST: Unknown

FUNDING SOURCE:
Economic Opportunity Commission

COMPLETION DATE: 1985

DESIGNER/SUPPLIER:
ARCO Solar, Inc.
P.O. Box 2105
Chatsworth, California 91311

CONTACT:
Vic Borja
NOAA Communication Center
Capital Hill, Saipan
Commonwealth of the Northern
Mariana Islands 96950

COMMENTS: For this project technicians from the Communication Center installed three photovoltaic systems as the primary source of electricity for the National Oceanic and Atmospheric Administration (NOAA) and the Commonwealth of the Northern Mariana Islands repeater stations on Mount Tapotchau. System #1 includes six ARCO Solavolt, 40 watt, roof-mounted photovoltaic panels; two voltage regulators; and eight Delco, 105 amp-hour, deep-cycle batteries. It powers five communication repeaters for the CNMI. System #2 includes 19 Solavolt, 40 watt roof-mounted panels; five voltage regulators; and 25 Delco 105 amp-hour batteries. It powers the NOAA communication repeaters. System #3 includes four Solarex 20 watt panels and powers lights at the NOAA station. System #1 has been operating for two years, and Systems #2 and #3 have been operating for one year. A diesel generator provides backup electricity. With the exception of some battery problems, the photovoltaic systems have been operating without problems since installation.

LITERATURE: References 270, 271, 273, 282, 286, and 287 for information on related projects and references 22, 38, 39 , and 45 for policy discussions.

PROJECT #21
PHOTOVOLTAIC SYSTEM FOR A PUBLIC CLOCK

(Photovoltaic panel above the clock, Susupe Shopping Center - 1982.)

LOCATION:
Susupe Shopping Center
Saipan
Commonwealth of the Northern
Mariana Islands

COST: Unknown

FUNDING SOURCE:
Manufacturer

COMPLETION DATE: 1982

DESIGNER/SUPPLIER:
Unknown

CONTACT:
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern
Mariana Islands 96950

COMMENTS: This project was another of the earlier photovoltaic demonstrations. A small solar panel powered the large public clock at the main shopping center in Susupe. The clock and single photovoltaic panel were on a pole in the center of the shopping center. For reasons unknown the clock and panel were dismantled in 1985.

LITERATURE: There are no specific references for this project. References 273, 282, and 287 discuss related topics, and references 22, 38, and 39 discuss some photovoltaic policy.

PROJECT #22
WIND ELECTRIC MACHINE DEMONSTRATION

(Kedco wind electric machine at Kagman Agriculture Station - 1982)

LOCATION:
Kagman Agriculture Station
Saipan
Commonwealth of the Northern
Mariana Islands

COST: $15,000

FUNDING SOURCE:
U.S. Department of Energy

COMPLETION DATE: 1982

DESIGNER/SUPPLIER:
Kedco Wind Systems

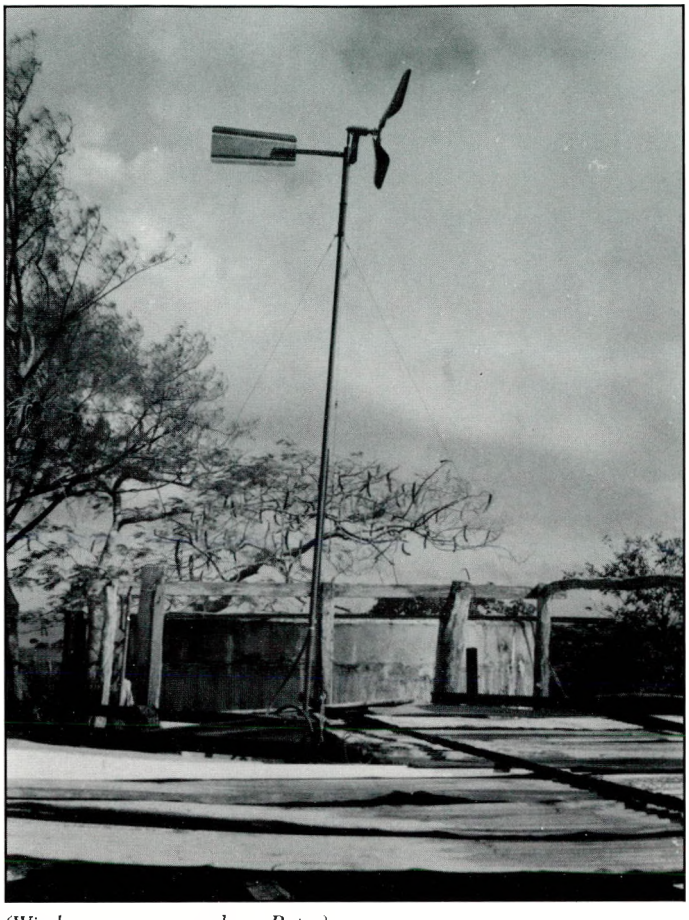
Rockwell International
Rocky Flats Plant Energy
Systems Group
Golden, Colorado 80401

CONTACT:
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern
Mariana Islands 96950

COMMENTS: During the early 1980's, the U.S. Department of Energy sponsored the installation of a number of Kedco and EnerTech wind electric machines throughout the Pacific. Only a few of the machines are operating now. In 1982, technicians from Rockwell International installed a 3000 watt Kedco wind electric machine at the Kagman Agriculture Station and connected the system to the central power grid. Despite the technicians' efforts it broke twice within six months. The Commonwealth Energy Office dismantled it and sent the parts to the Guam Energy Office. The reasons for failure both times were electrical problems with the inverter and field control circuit, possibly caused by large grid power fluctuations. These machines are complex and require access to parts and technical help to keep them running.

LITERATURE: See references 318, 321, 322, 325, 326, and 327 for specific reference to the project or to Pacific wind data. See references 22, 38, 39, and 45 for policy information.

PROJECT #23
WIND PUMPING AND SOLAR WATER HEATING DEMONSTRATION



(Wind pump on a ranch on Rota.)

LOCATION:
Aniceto Mundo Ranch
Dugi, Rota
Commonwealth of the Northern
Mariana Islands

COST: $1,200

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1983

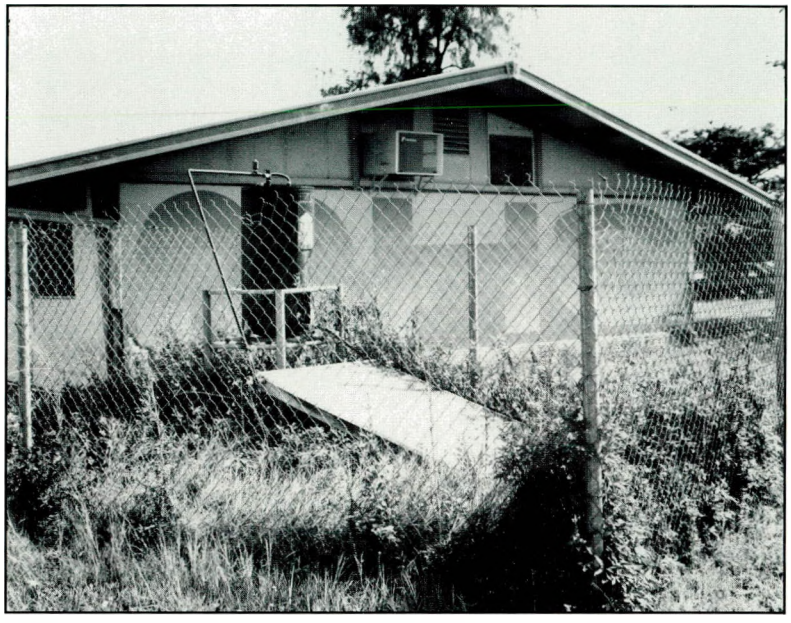
DESIGNER/SUPPLIER:
SPARCO Wind Pump

CONTACT:
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern
Mariana Islands 96950

COMMENTS: The purpose of this project was to install and demonstrate a wind water pump and a solar water heating system on a public bath house to be built at the American War Memorial Park on Saipan. The Commonwealth Energy Office purchased just the wind pump because of the increasing costs of equipment in the early 1980's. Then they did not receive permission to install the pump on the bath house so they stored the system for two years while looking for another suitable site. Eventually, they installed it on a ranch on Rota as part of their Rural Development Program. After some initial problems the pump worked properly until a wind storm destroyed it beyond repair. The pump does not seem to be designed for the Pacific environment.

LITERATURE: References 2, 3, 4, 7, 191, and 192 briefly discuss the project; references 322, 325, 326, and 327 discuss Pacific wind data; and references 22, 37, 38, and 45 discuss policy matters.

PROJECT #24
SOLAR WATER HEATING WORKSHOP



(Solar water heating system at the Marianas High School - not operating - 1986.)

LOCATION:
Marianas High School
Susupe, Saipan
Commonwealth of the Northern
Mariana Islands

COSTS: $1,000

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1981

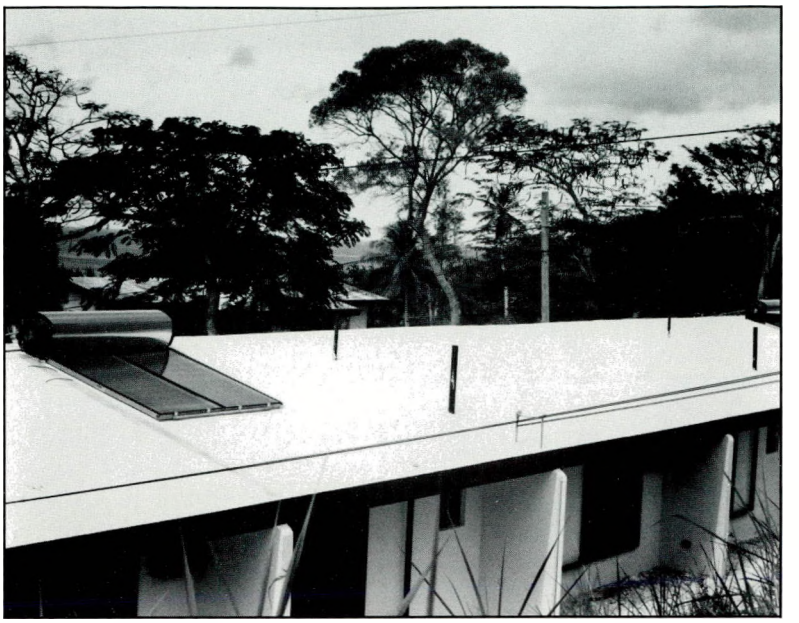
DESIGNER/SUPPLIER:
John Morgan and Tlaloc Tokuda,
formerly
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern
Mariana Islands 96950

CONTACT:
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern
Mariana Islands 96950

COMMENTS: In 1980, the U.S. Department of Energy sponsored the Commonwealth Energy Office to conduct a small workshop for building a solar water heating system at the Marianas High School in Susupe. The purpose was to design a simple, inexpensive system for the outer islands and to train high school students to build such a system. The students and technicians from the Energy Office built the system at the school during a two day workshop. The design came from the University of Hawaii Energy Education Project. The system consists of a solar collector and hot water tank in a small fenced area outside the school. Water circulates through the collector and tank by natural convection. The system was not connected to the school and is not operating now.

LITERATURE: Reference 302 is a detailed description; references 2, 3, 4, 7, 191, and 192 give brief descriptions; references 22, 38, 39, and 45 discuss policy.

PROJECT #25
SOLAR BANK PROJECT



(SolaHart collectors and tanks on a multi-family dwelling, Capitol Hill - 1986.)

LOCATION:
Saipan
Commonwealth of the Northern Mariana Islands

COST: $100,000 in 1984
$129,000 in 1985

FUNDING SOURCE:
U.S. Department of Housing and Urban Development

COMPLETION DATE: Program in progress

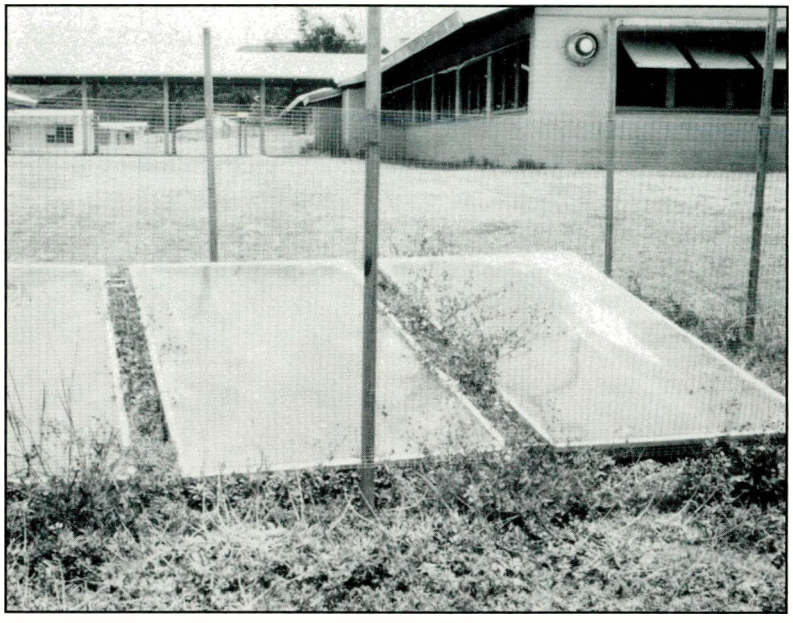
DESIGNER/SUPPLIER:
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern Mariana Islands 96950

CONTACT:
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern Mariana Islands 96950

COMMENTS: The Commonwealth Energy Office Solar Bank Program is a financial assistance program sponsored by two grants from the U.S. Department of Housing and Urban Development. Financial assistance is available to individuals obtaining loans for domestic solar hot water or space cooling systems and for certain energy conservation measures. The Solar Bank funds are used to reduce the outstanding principal on loans for such equipment. Maximum financial assistance on a solar system for one to four family residences is up to 40% of the costs or $1,000, whichever is less. However, these systems must satisfy certain warranty requirements. The Program has been successful so far with 19 Australian SolaHart systems installed on four multi-family dwellings and 15 private homes.

LITERATURE: Reference 301 gives a detailed description of the Program; references 22, 37, 38, and 45 discuss policy.

PROJECT #26
SOLAR WATER HEATING FOR A HOSPITAL



(SolaRoll solar collectors at the Hospital - 1983.)

LOCATION:
Dr. Torres Hospital
Saipan
Commonwealth of the Northern
Mariana Islands

COST: $4,000

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1983

DESIGNER/SUPPLIER:
SolaRoll
Bio-Energy Systems, Inc.
Ellenville, New York 12933

CONTACT:
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern
Mariana Islands 96950

COMMENTS: The purpose of this project was to test the suitability of a new type of solar collector, SolaRoll, for Pacific islands. SolaRoll is a thin mat of rubber/plastic with tubes that are an integral part of the backing. The material comes in a roll, and is inexpensive and easy to install. Technicians from the Commonwealth Energy Office installed the material in three 18 square foot frames on the ground near one of the hospital kitchens. They connected the collectors to two hot water tanks and used an electric pump to circulate the water. This latter part of the system was not designed properly and was replaced by a simple thermosiphon system that circulates the water by natural convection. The system worked successfully for awhile but was eventually dismantled in favor of a standard hot water system. The SolaRoll equipment performed satisfactorily.

LITERATURE: References 2, 7, 191, and 192 discuss the project briefly; references 22, 38, 39, and 45 contain discussions on solar policy.

PROJECT #27
SOLAR WATER HEATING AT THE AGRICULTURE STATION

(Solar collector at the Kagman Agriculture Station - 1978.)

LOCATION:
Kagman Agriculture Station
Saipan
Commonwealth of the Northern Mariana Islands

COST: Unknown

FUNDING SOURCE:

U.S. Department of Energy

COMPLETION DATE: 1978

DESIGNER/SUPPLIER:
Department of Natural Resources
Kagman Agriculture Station
Saipan
Commonwealth of the Northern Mariana Islands 96950

CONTACT:
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern Mariana Islands 96950

COMMENTS: Energy technicians from the Commonwealth Energy Office built a small solar water heating system at the Kagman Agriculture Station in the late 1970's. They installed the single collector in a framework on the ground about 100 feet from the main building. The system supplied hot water to a tank on a stand near the collector by natural water circulation. It was dismantled in 1983.

LITERATURE: There are no references that discuss this project. References 302, 303, 305, 307, 308, and 309 discuss similar projects. References 22, 38, 39, and 45 discuss solar policy.

PART 3: FEDERATED STATES OF MICRONESIA - KOSRAE

Energy Planner
P.O. Box AD
State of Kosrae
Federated States of Micronesia
96944

PROJECT #28
HYDROELECTRIC SYSTEM ON THE MALEM RIVER

LOCATION:
Malem River
Malem, Kosrae
Federated States of Micronesia

COST: $110,000

FUNDING SOURCE:
U.S. Department of Interior

Office of Capital Improvement
Programs,
Trust Territory of the
Pacific Islands

COMPLETION DATE: 1987

DESIGNER/SUPPLIER:
National Rural Electrification
Cooperative Association
1800 Massachusetts Ave., N.W.
Washington, D.C. 20036

CONTACT:
Bruce Howell, CIP Office
State of Kosrae
Federated States of Micronesia
96944

COMMENTS: Kosrae has four major rivers near populated areas; the Mutante, the Pukussuk, the Malem, and the Finkol. Preliminary engineering surveys by the U.S. Army Corps of Engineers and private consultants show that Kosrae can produce small amounts of electricity by building small hydroelectric systems on these rivers. Three of them already have water intakes near supply diversion dams. The National Rural Electrification Cooperative Association has completed a detailed engineering report for a system on the Malem River that will produce roughly 38 kilowatts of electricity. The project is under construction now, and the system should be operating by 1987.

LITERATURE: See references 22, 47, and 50 for a general discussion of Kosrae's plans for hydroelectric development. References 212, 214, 216, 219, 222, and 229 assess the hydroelectric potential.

PROJECT #29
PHOTOVOLTAIC-POWERED REEF BEACON LIGHTS

LOCATION:
Various harbors
Kosrae and Pohnpei
Federated States of Micronesia

COSTS: Unknown

FUNDING SOURCE:
Pohnpei State Economic
Development Authority

COMPLETION DATE: 1986

DESIGNER/SUPPLIER:
El's Enterprises
Kolonia, Pohnpei
Federated States of Micronesia
96941

CONTACT:
Energy Planner
Department of Resources and
Development
Federated States of Micronesia
Kolonia, Pohnpei 96941

COMMENTS: Returning from fishing at night on many of the outer Pacific islands is hazardous because of the lack of beacons marking the channels through the reefs to the harbors. El's Enterprises of Pohnpei is installing towers with rotating beacon lights to mark some of these channels on Kosrae and Pohnpei. To date, they have installed two of ten towers on Pohnpei. Two six volt batteries charged by a small photovoltaic panel power each beacon.

LITERATURE: There are no references that specifically discuss these beacons. References 282, 286, and 287 discuss Pacific applications of photovoltaic systems.

PROJECT #30
SOLAR WATER HEATING FOR THE HOSPITAL

LOCATION:
Hospital
Lelu, Kosrae
Federated States of Micronesia

COST: $13,000

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1982

DESIGNER/SUPPLIER:
Joe LoBosso, formerly
Kosrae Community Development
Agency

El Camino Solar Systems
5330 Debbie Lane
Santa Barbara, California
93111

CONTACT:
Energy Planner, P.O. Box AD
State of Kosrae
Federated States of Micronesia
96944

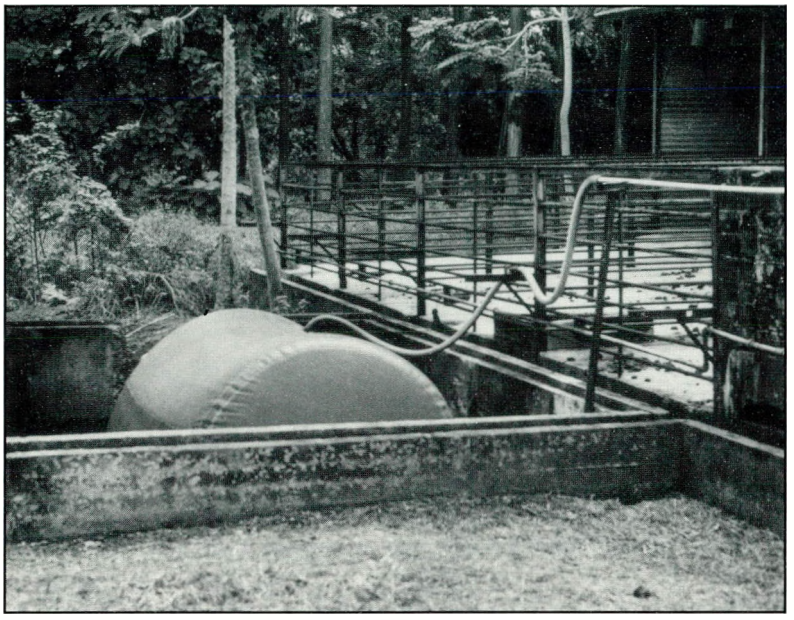
COMMENTS: The U.S. Department of Energy gave financial support to a Peace Corps volunteer to install and demonstrate a solar water heating system at the new hospital on Kosrae. At the time, this was one of the first packaged solar systems in Micronesia with collector and storage tank part of the same unit. The project was delayed two years because of a change in Peace Corps volunteers and because of problems receiving the supplies. Mr. LoBosso of the Kosrae Community Development Agency completed the project for the Peace Corps and wrote a short pamphlet in the language of Kosrae explaining the system. The system consists of six, 24 square foot Sunspot collectors and related pumps, storage tanks, and hardware.

REFERENCES: Reference 310 is for the short instruction pamphlet. See references 2, 191, 192, and 310 for discussions of the system during installation.

PART 4: FEDERATED STATES OF MICRONESIA - POHNPEI

Chief, Division of Energy
Department of Conservation and Resource Surveillance
State of Pohnpei
Kolonia, Pohnpei
Federated States of Micronesia 96941

PROJECT #31
BIOGAS CONVERSION AT THE AGRICULTURE STATION



(Digester at the Agriculture Station - 1978.)

LOCATION:
Agriculture Station
Kolonia, Pohnpei
Federated States of Micronesia

COST: $400

FUNDING SOURCE:
Pohnpei State Government

COMPLETION DATE: 1977

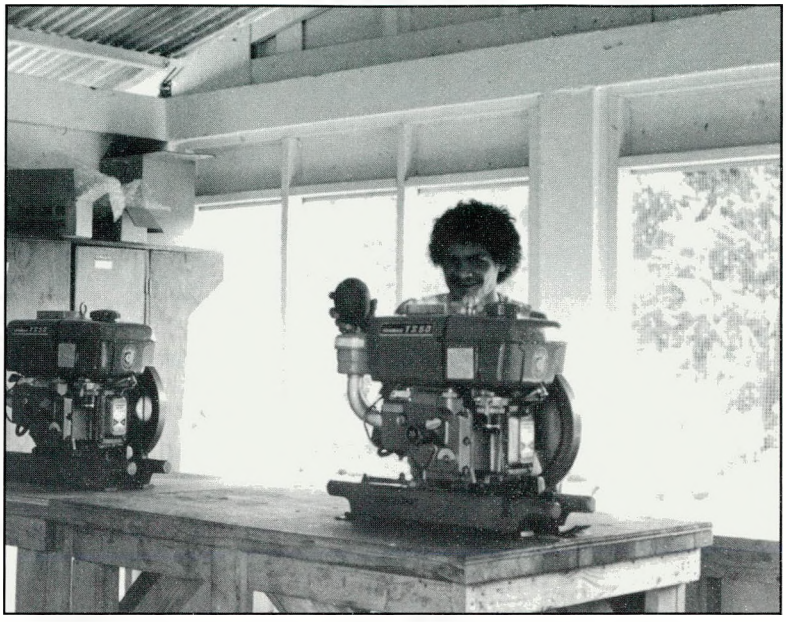
DESIGNER/SUPPLIER:
James Hiyane, formerly
Agriculture Station
Kolonia, Pohnpei
Federated States of Micronesia
96941

CONTACT:
Division of Energy
Department of Conservation and
Resource Surveillance
Kolonia, Pohnpei
Federated States of Micronesia
96941

COMMENTS: Employees of the Agriculture Station built this biogas digester at their piggery to demonstrate to rural farmers how pig wastes can be converted to methane gas for cooking pig food. The system consisted of a clay digester chamber and a rubberized bag for storing the gas. This project was unique as it was the first digester in this part of the Pacific and had an unusual design featuring the rubberized bag. The digester worked for a few years, but it has been dismantled now.

LITERATURE: There are no references that refer directly to this system. For general discussions of Pohnpei's policy on biomass see references 22, 47, 54, 57, 61, and 115.

PROJECT #32
COCONUT OIL/DIESEL ENGINE TEST



(Diesel engines being run on diesel fuel and coconut oil, PATS - 1983.)

LOCATION:
Pohnpei Agriculture & Trade School
Pohnpei
Federated States of Micronesia

COST: $10,000

FUNDING SOURCE:
Federated States of Micronesia
Congress of Micronesia

COMPLETION DATE: 1983

DESIGNER/SUPPLIER:
John Gridley
Pohnpei Agriculture & Trade School
Pohnpei
Federated States of Micronesia
96941

CONTACT:
Pohnpei Agriculture & Trade School
Pohnpei
Federated States of Micronesia
96941

COMMENTS: Many of the outer islands depend on imported petroleum to operate small engine/generator sets for producing electricity. The purpose of this project was to determine if these small diesel engines could operate on unrefined, local coconut oil. Instructors and students from Pohnpei Agriculture & Trade School (PATS) operated two new, identical, small diesel engines (Yanmar Model TS-50), one with diesel fuel and the other with coconut oil, side-by-side for 1000 hours. During this time they ran various tests and periodically dismantled and inspected the engines. Results show that the coconut oil engine generated slightly higher horsepower, ran at a lower temperature, consumed less fuel, ran more smoothly, and had less wear than the diesel fuel engine.

LITERATURE: Reference 338 discusses the test and presents the results. For general policy discussion on coconut oil see references 22, 47, 57, and 61.

PROJECT #33
PHOTOVOLTAIC SYSTEM AT MICRONESIA BOUND

(Photovoltaic array on the roof of Micronesia Bound - 1983.)

LOCATION:
Micronesia Bound, Inc.
Nett Point, Pohnpei
Federated States of Micronesia

COST: $1,500

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1981

DESIGNER/SUPPLIER:
Ted Glenn, Venansio Alphons,
and Larry Slominski
Micronesia Bound, Inc.

ARCO Solar Inc.
P.O. Box 2105
Chatsworth, California 91311

CONTACT:
Micronesia Bound, Inc.
P.O. Box 326
Kolonia, Pohnpei
Federated States of Micronesia
96941

COMMENTS: This small photovoltaic system is one of a number of energy devices assembled and demonstrated by Micronesia Bound, Inc., at their school at Nett Point. (See Project #36.) Micronesia Bound (Aramas Kapw Program) is a school similar to the Outward Bound Schools of the U.S. Mainland that teach young adults practical skills and give them confidence. The school is not connected to the utility grid and uses these systems as their only supply of electricity. During some workshops a technician from the U.S. helped the students install three ARCO roof-mounted panels for producing about 100 watts of electricity at 12 volts. This array charges a battery bank that uses a wind electric machine as its primary source of electricity. (See Project #35.) An inverter converts the power to AC for running some appliances. The system worked properly for a few years, with the exception of some problems with the inverter and appliances, but has been dismantled temporarily while the school's new management changes their curriculum.

LITERATURE: For specific discussions see references 2, 5, 6, 176, 189, 191, and 192. For discussions on photovoltaic policy or instruction see references 22, 47, 54, 57, 282, and 287.

PROJECT #34
PHOTOVOLTAIC SYSTEM FOR AN ELECTRIC FENCE

(Photovoltaic system for powering the electric fence at PATS - 1983.)

LOCATION:
Pohnpei Agriculture & Trade School
Pohnpei
Federated States of Micronesia

COST: $1,100

FUNDING SOURCE:
Pohnpei Agriculture & Trade School

COMPLETION DATE: 1982

DESIGNER/SUPPLIER:
Wallace Industries, Ltd.
76 Delta Avenue
Auckland, New Zealand

CONTACT:
Pohnpei Agriculture & Trade School
Pohnpei
Federated States of Micronesia
96941

COMMENTS: This project illustrates the successful transfer of a technology from American Samoa to Pohnpei. The Pohnpei Agriculture & Trade School (PATS) uses a number of alternative energy systems as part of their educational program. After corresponding with the American Samoan Department of Agriculture, they installed a photovoltaic system similar to the one in American Samoa for electrifying one of their fences. (See Project #5.) Like many of the remote areas on Pacific islands, wild pigs do extensive damage to root crops; standard fences do not keep them out; and there is no electricity for electric fences. This simple 12 watt photovoltaic panel with battery and power control provides electricity for a fence and prevents pigs from entering the farm. PATS installed the system in 1982, and it has been working effectively since then.

LITERATURE: No references discuss this system directly. See reference 288 for the system in American Samoa; references 175 and 176 for information on technology transfer; and references 282 and 287 on photovoltaic instruction.

PROJECT #35
WIND ELECTRIC MACHINE AT MICRONESIA BOUND

(Aeropower wind electric system at Micronesia Bound - not operating - 1986.)

LOCATION:
Micronesia Bound, Inc.
Nett Point, Pohnpei
Federated States of Micronesia

COST: $10,000

SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1981

DESIGNER/SUPPLIER:
Ted Glenn, Venansio Alphons,
and Larry Slominski
Micronesia Bound, Inc.

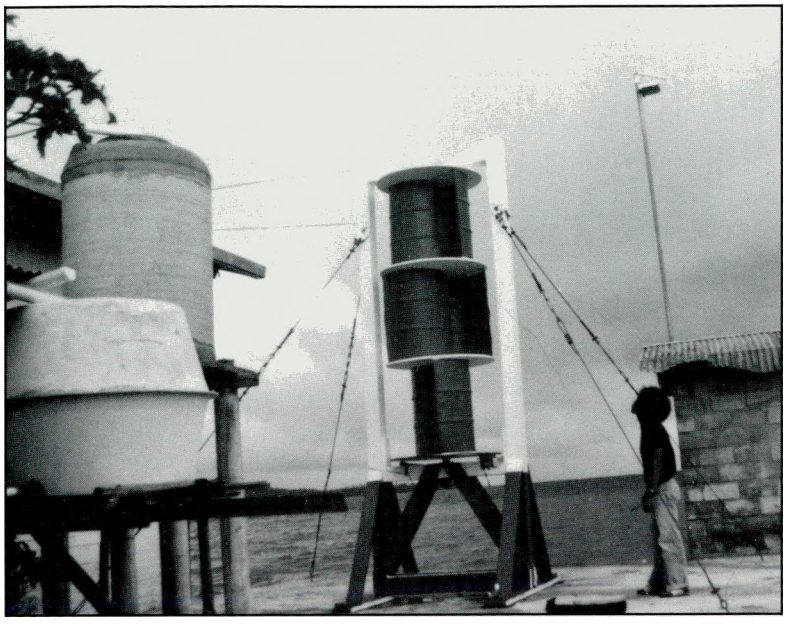
Aeropower, Inc.
Berkeley, California
(out of business)

CONTACT:
Micronesia Bound, Inc.
P.O. Box 326
Kolonia, Pohnpei
Federated States of Micronesia
96941

COMMENTS: The U.S. Department of Energy gave financial support to Micronesia Bound, Inc., for a number of energy training and demonstration projects as part of the school's technical training curriculum. (See Projects #33 and #36.) This wind system is the school's primary source of electricity. It includes an Aeropower Starlite 1500 watt stand-alone machine; a 60 foot, three-leg Rohn tower; six, 6 volt deep-cycle Trojan batteries; a Best inverter to convert power from 12 volt DC to 120 volt AC; and a control panel. A small photovoltaic array provides backup power. Mr. Slominski, a technician from the U.S. Mainland, did a good job installing the system with help from school staff and students. The machine worked well for awhile, but there were problems with the inverter and appliances, and Aeropower is out of business now so it is difficult to find repair parts. The system has been temporarily dismantled while the school changes program emphasis under new management.

LITERATURE: See references 2, 5, 6, 176, 189, 191, and 192 for specific discussions and references 22, 52, 57, 61, 322, 325, 326, and 327 for general discussions on policy and wind potential in Pohnpei.

PROJECT #36:
DEMONSTRATION PROJECTS AT MICRONESIA BOUND



(Savonious Rotor and water catchment system at Micronesia Bound - 1983.)

LOCATION:
Micronesia Bound, Inc.
Nett Point, Pohnpei
Federated States of Micronesia

COST: $5,000

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1981

DESIGNER/SUPPLIER:
Ted Glenn, Venansio Alphons,
and Larry Slominski
Micronesia Bound, Inc.
P.O. Box 326
Kolonia, Pohnpei
Federated States of Micronesia
96941

CONTACT:
Micronesia Bound, Inc.
P.O. Box 326
Kolonia, Pohnpei
Federated States of Micronesia
96941

COMMENTS: The U.S. Department of Energy sponsored Micronesia Bound, Inc., to build and demonstrate a number of simple energy devices that could be used on the outer islands. Over two years the school staff, students, and a technician from the U.S. Mainland built a Savonious Rotor vertical axis wind machine producing 100 watts of electricity; installed a small commercial wind electric machine producing 100 watts of electricity; built some simple solar dryers; improved their water catchment system; and built a horizontal axis wind water pump. The school has taken the systems apart now while new management redesigns their curriculum. At the time these were some of the best demonstration projects in this part of the Pacific. See Projects #33 and #35 for information on their photovoltaic and wind electric systems.

LITERATURE: References 2, 5, 6, 176, 189, 191, and 192 present specific discussions; and references 22, 47, 54, 57, and 61 give general policy discussions for these systems.

PROJECT #37
SOUTH PACIFIC MOBILE TRAINING UNIT

(Photovoltaic demonstration system at the School - 1983.)

LOCATION:
Kolonia, Pohnpei
Federated States of Micronesia

COST: Unknown

FUNDING SOURCE:
South Pacific Commission
Noumea, New Caledonia

COMPLETION DATE: 1983

DESIGNER/SUPPLIER:
South Pacific Commission
P.O. Box D5
Noumea, New Caledonia

CONTACT:
Division of Energy
Department of Convervation and Surveillance
Kolonia, Pohnpei
Federated States of Micronesia
96941

COMMENTS: The South Pacific Commission sponsored the South Pacific Mobile Training Unit in the early 1980's as a traveling school to introduce young adults to simple technologies designed for their localities. The school traveled throughout the Pacific usually remaining in one place for three to six months. Students came from throughout the area, including the outer islands and other districts. The staff presented a curriculum emphasizing energy systems and built these systems with help from the students. At the Pohnpei site students from Pohnpei, Yap, Truk, and Kosrae built solar dryers, solar water heaters, water desalination devices, and photovoltaic devices. The school remained on Pohnpei for about three months, and its work seemed to be successful.

LITERATURE: See references 175, 176, 187, 189, and 352 for discussions of systems similar to ones built at the School. None of these references discuss the school specifically.

PROJECT #38
ENERGY EFFICIENT DEMONSTRATION HOME

(Early construction of the energy efficient home - 1986.)

LOCATION:
Kolonia, Pohnpei
Federated States of Micronesia

COST: $24,000

FUNDING SOURCE:
U.S. Department of Energy
Technology Transfer Program
Pohnpei State Government
Department of Conservation and
Surveillance

COMPLETION DATE: 1986

DESIGNER/SUPPLIER:
Office of Planning & Statistics
Federated States of Micronesia
Kolonia, Pohnpei
96941

CONTACT:
Division of Energy
Department of Convervation and
Surveillance
Kolonia, Pohnpei
Federated States of Micronesia
96941

COMMENTS: This project is a collaborative effort to build and demonstrate an energy efficient house as an alternative to the concrete houses that have become widespread after World War II. The U.S. Department of Energy and the Pohnpei Department of Resources and Development are funding the design and construction of a 30 foot by 24 foot home built mostly from local materials. The structure is being built and oriented to take advantage of natural ventilation and shading. The design includes a high-pitched tropical hip roof, gable vents, substantial roof overhangs, natural planting, and the use of local lumber. Eventually the house will have a photovoltaic electrical system. The Pohnpei State Energy Planner may keep an office in the building or a local family may live in it. A brochure will describe the design and construction.

LITERATURE: There are no references yet that give a detailed account of the project; references 134, 155, 205, and 376 discuss similar projects; references 22, 47, 54, 57, and 61 discuss conservation policy on Pohnpei.

PROJECT #39
HYDROELECTRIC SYSTEM ON THE NANPIL RIVER

LOCATION:
Nanpil River
Pohnpei
Federated States of Micronesia

COST: $8,000,000

FUNDING SOURCE:
U.S. Army Corps of Engineers

COMPLETION DATE: 1988

DESIGNER/SUPPLIER:
U.S. Army Corps of Engineers
Building 230, Fort Shafter
Honolulu, Hawaii 96858

E.E. Black Construction
Honolulu, Hawaii

CONTACT:
U.S. Army Corps of Engineers
Building 230, Fort Shafter
Honolulu, Hawaii 96858

COMMENTS: The people of Pohnpei should be able to generate a significant amount of their electricity by hydroelectric systems on their rivers. During the last few years the U.S. Army Corps of Engineers and others have made surveys and preliminary design studies in order to select the best sites. The Army Corps of Engineers selected a site on the Nanpil River as the most suitable for a major installation and designed a 1.8 megawatt hydropower plant. They have awarded the construction contract to E.E. Black Construction of Hawaii and construction has just started. It will take about two years to build a road to the site, build the dam, install the turbine/generator sets, and connect the system to the power grid. This project is the most significant use of renewable resources in this part of the Pacific and should help solve some of Pohnpei's power problems. See Projects #28, #40, #41, and #42 for smaller hydroelectric projects on Pohnpei and Kosrae.

LITERATURE: See references 208, 213, 214, 216, 218, 220, 224, 225, 226, 228, 230, 232, and 233 for specific information. See references 21, 22, 47, 54, 57, and 61 for policy discussions of hydroelectric on Pohnpei.

PROJECT #40
HYDROELECTRIC SYSTEM ON THE MAND RIVER

(Mand River at Mand Village - 1986.)

LOCATION:
Mand Village, Pohnpei
Federated States of Micronesia

COST: $77,000

SOURCE:
Pohnpei State Legislature
Community Development
Block Grant Program
U.S. Department of Energy

COMPLETION DATE: late 1980's

DESIGNER/SUPPLIER:
Department of Public Works
Pohnpei State Government
Kolonia, Pohnpei
Federated States of Micronesia
96941

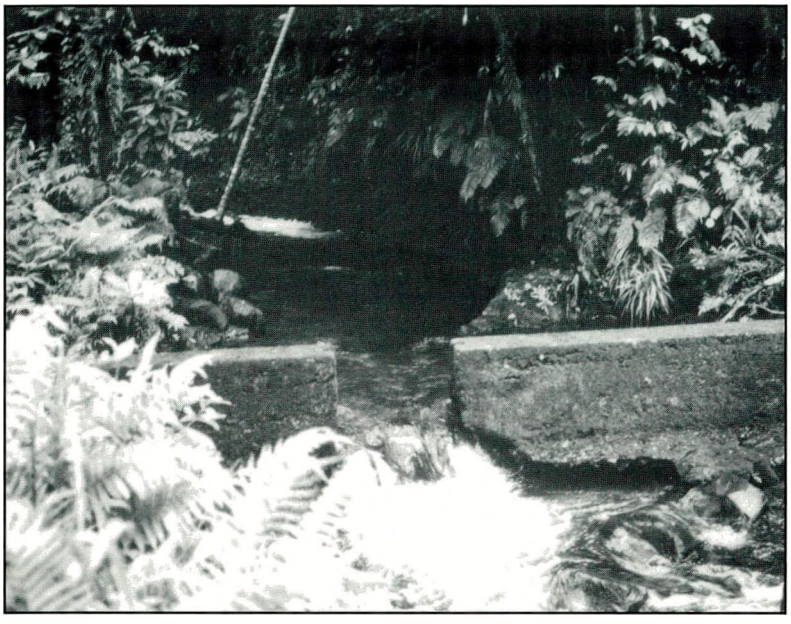
National Rural Electrification
Cooperative Association
1800 Massachusetts Ave., N.W.
Washington, D.C. 20036

CONTACT:
Division of Energy
Department of Conservation and
Surveillance
Kolonia, Pohnpei
Federated States of Micronesia
96941

COMMENTS: Pohnpei Island has high rainfall, mountainous terrain, and numerous rivers offering some excellent sites for hydroelectric installations of various sizes. The Japanese built some systems prior to World War II, and for the last decade there has been great interest in building some again. For the last few years there have been plans to build a small hydroelectric system on the Mand River to supply power to the village of Mand. Preliminary surveys and design studies have been completed for a 15 kilowatt system. A contractor and starting date have not been determined, but the people at Mand hope work will start soon. See Projects #28, #39, #41, and #42 for other hydroelectric projects on Pohnpei and Kosrae. See Appendix B for additional information.

LITERATURE: References 212, 213, 214, 216, 218, 224, 225, 228, 230, and 233 are for hydroelectric surveys on Pohnpei. References 22, 47, 54, 57, and 61 are for general policy reports concerning hydroelectric development.

PROJECT #41
HYDROELECTRIC SYSTEM ON THE KRICTILANG STREAM



(Old dam at the Krictilang Stream near Palikir Village - 1983.)

LOCATION:
Palikir Village
Krictilang Stream
Pohnpei
Federated States of Micronesia

COST: $31,500

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program
Private funds

COMPLETION DATE: 1984

DESIGNER/SUPPLIER:
Fred Ramp, formerly
Pohnpei
Federated States of Micronesia
96941

CONTACT:
Division of Energy
Department of Conservation and
Surveillance
Kolonia, Pohnpei
Federated States of Micronesia
96941

COMMENTS: This project illustrates the problem the U.S. Department of Energy had during the early 1980's with the rapidly escalating costs of equipment for small energy projects. They gave Fred Ramp and the Palikir Power Corporation a small grant to meet half the costs for constructing a 25 kilowatt hydroelectric plant on the Krictilang Stream. The project was to include a small concrete dam, penstock, power shack, cross-flow turbine, and AC power controlling equipment. A consultant made a feasibility study, and the site and design were satisfactory. However, there were problems with the grant paperwork and funds, and almost two years passed before the Department of Energy sent the money to the Corporation. By that time costs had almost doubled. Also, the surrounding community had little interest in the project. For these two reasons the project was not completed, and the funds were returned to the Department of Energy.

LITERATURE: Reference 211 is a detailed discussion; references 2, 191, and 192 give brief discussions; and references 212, 213, 214, 216, 218, 224, 225, 228, 230, and 233 are for hydroelectric surveys on Pohnpei.

PROJECT #42
HYDROELECTRIC SYSTEM AT PICS

(Penstock for transporting water to the turbine - PICS - 1982.)

LOCATION:
Tawannu Stream
Pohnpei Island Central
High School
Kolonia, Pohnpei
Federated States of Micronesia

COST: $12,000

FUNDING SOURCE:
U.S. Department of Energy
Pohnpei State Government

COMPLETION DATE: 1981

DESIGNER/SUPPLIER:
John Harder
P.O. Box 542, Kappa
Kauai, Hawaii 96746

CONTACT:
Division of Energy
Department of Conservation and
Surveillance
Kolonia, Pohnpei
Federated States of Micronesia
96941

COMMENTS: The purpose of this project was to train students at Pohnpei Island Central High School (PICS) and to provide a backup supply of electricity for their dormitory. Students, instructors, and a visiting technician installed a 1500 watt cross-flow turbine and generator at Tawannu Stream during a workshop. The system consisted of a Canyon Industries turbine and generator, a battery bank, DC to AC inverter, 8 inch concrete pipe for about 200 feet of penstock, and a power shack. The system operated successfully, but debris down the penstock ruined the turbine, which they had not protected with a trash rack. Then a flood washed away the penstock supports. Despite their considerable initial investment of work and capital, the system was only a backup source of electricity, and there was no interest in rebuilding it.

LITERATURE: There are no specific references for the project. References 212, 213, 214, 216, 218, 224, 225, 228, 230, and 233 are for hydroelectric surveys on Pohnpei, and references 22, 47, 54, 57, and 61 are for policy studies pertaining to hydroelectric development.

PROJECT #43
RAM WATER PUMPING

(Ram water pump near Ipwal Village - 1986.)

LOCATION:
Ipwal Village
Pohnpei
Federated States of Micronesia

COST: $7,000

FUNDING SOURCE:
U.S. Department of Energy
Technology Transfer Program

COMPLETION DATE: 1985

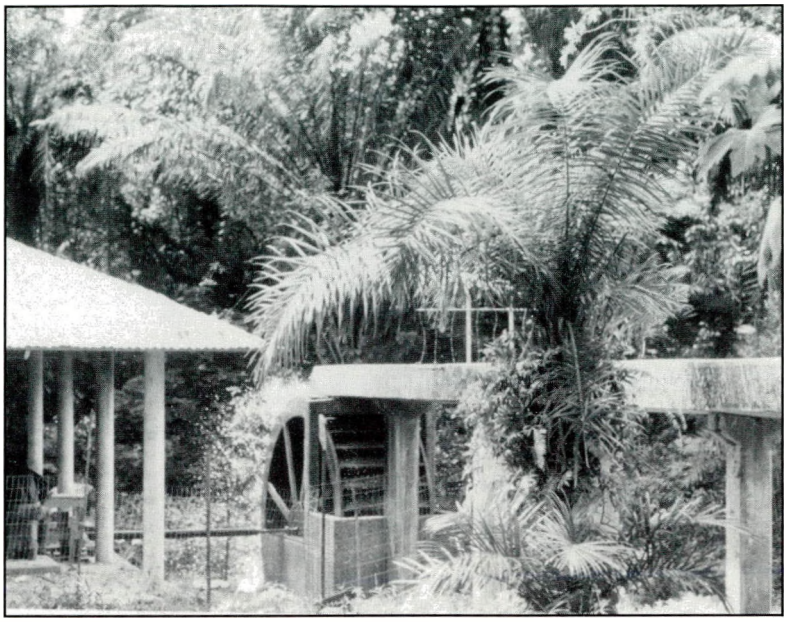
DESIGNER/SUPPLIER:
Water & Energy Research Institute
University of Guam
UOG Station
Mangilao, Guam 96913

CONTACT:
Department of Community Services
Pohnpei State Government
Kolonia, Pohnpei
Federated States of Micronesia
96941

COMMENTS: Ram water pumping is a simple and reliable way to pump water. However, many people in the Pacific are not familiar with this technology. The purpose of this project is to demonstrate such a system in a remote setting. A ram pump is simply a device that makes moving water pump itself. It pumps only a small percentage of the water moving through it but can do so to levels that are much higher than the source. The pump will work with any volume of water moving at any speed. The Water & Energy Research Institute installed a ram pump on a remote stream near Ipwal Village. Before this, people there hand carried water a few hundred yards up a steep path to the village. The system consists of a Hercules ram pump, a small dam to serve as a feed tank, and PVC piping for delivering the water to a storage tank at the village. The pump is working well and is delivering over 50 gallons of water per hour to the village.

LITERATURE: Reference 351 is a detailed report on the project; reference 376 gives a brief description of the project; reference 331 is a general discussion of ram pumps; and reference 228 describes water supply on Pohnpei.

PROJECT #44
MECHANICAL WATER WHEEL POWER



(Water wheel, penstock, and sawmill - 1980.)

LOCATION:
Museum, Tawannu Stream
Kolonia, Pohnpei
Federated States of Micronesia

COST: About $1,000

FUNDING SOURCE:
Pohnpei State Government
Small Industries Office

COMPLETION DATE: 1979

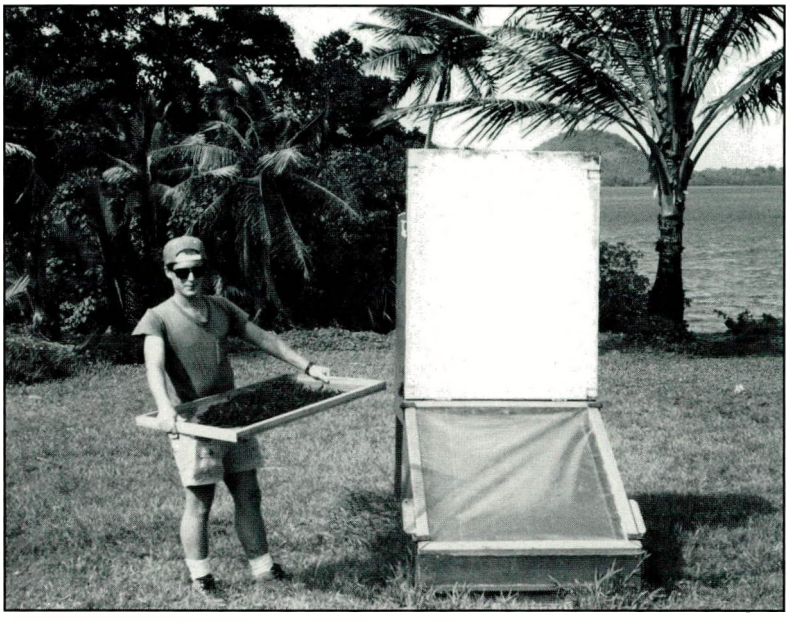
DESIGNER/SUPPLIER:
Daniel Graham
Pohnpei State Government
Kolonia, Pohnpei
Federated States of Micronesia
96941

CONTACT:
Division of Energy
Department of Conervation and Surveillance
Kolonia, Pohnpei
Federated States of Micronesia
96941

COMMENTS: In the late 1970's, a penstock and overshot water wheel were built at an old Japanese dam on Tawannu stream through great individual effort. The wheel powered a small sawmill for making bamboo containers to ship Pohnpei pepper. Water came from the dam to the wheel through a 75 foot open concrete penstock. The wooden wheel was 10 feet in diameter and made locally. Power conversion equipment included salvaged items such as an old truck axle and transmission. The system worked well for a year or so. However, they could not make the repairs when necessary, and they abandoned the project. This is another example of a project that worked well mostly through the efforts of one person. Once he left, other people did not maintain the project. Nevertheless, for awhile it was an interesting and aesthetically pleasing use of water power.

LITERATURE: There are no specific references for this project. References on water power on Pohnpei include 228 and 230.

PROJECT #45
PEPPER DRYER



(Collector and tray with pepper - PATS - 1986.)

LOCATION:
Pohnpei Agriculture & Trade School
Pohnpei
Federated States of Micronesia

COST: $50

FUNDING SOURCE:
Pohnpei Agriculture & Trade School

COMPLETION: 1985

DESIGNER/SUPPLIER:
Pohnpei Agriculture & Trade School
Pohnpei
Federated States of Micronesia
96941

CONTACT:
Pohnpei Agriculture & Trade School
Pohnpei
Federated States of Micronesia
96941

COMMENTS: During the last few years the staff and students of the Pohnpei Agriculture & Trade School (PATS) have built and tested a number of energy systems as part of their regular curriculum. This solar dryer is typical of the simple systems they instruct the students to build and hope they will duplicate when they return to their homes. The dryer is a design that uses rocks to store the heat from the collector. Pepper drys on trays inside the drying box. The dryer can be built for less than $50 using salvaged materials such as old plywood and refrigerator insulation. See Projects #32 and #34 for information on the PATS coconut oil/diesel test and photovoltaic-powered electric fence.

LITERATURE: No references specifically discuss this project. References 313 and 352 discuss similar projects.

PART 5: FEDERATED STATES OF MICRONESIA - TRUK

Energy Planner
State Planning Office, P.O. Box 189
State of Truk
Moen, Truk
Federated States of Micronesia
96942

PROJECT #46
PHOTOVOLTAIC WATER PUMP - NO.1

(Photovoltaic panel on stand with pump on ground - 1985.)

LOCATION:
Various locations
Truk State
Federated States of Micronesia

COST: $250,000

FUNDING SOURCE:
U.S. Department of Housing and Urban Development

COMPLETION DATE: Continuing

DESIGNER/SUPPLIER:
Water & Energy Research Institute
University of Guam
UOG Station
Mangilao, Guam 96913

CONTACT:
Rural Sanitation Program
P.O. Box 819
Moen, Truk
Federated States of Micronesia
96942

COMMENTS: The Water & Energy Research Institute (WERI) has designed a photovoltaic system to pump groundwater from shallow wells on low atoll islands or the flat, sandy coastal areas of high islands. This system described here is similar to over 150 other family-size systems installed throughout the Truk islands. The major components include one or two 30 watt photovoltaic panels depending upon how much pumping power is needed, a Rule 400 bilge pump, a 10 foot galvanized pipe to mount the panels on, electrical wiring, and PVC piping. The systems are working well so far supplementing rainwater catchment systems. The match of power supply to end use and resource to demand, the program design, and the quality of work are excellent and contribute to a successful program. See Project #47 for a village-size system on Truk; Project #78 for another family-size system on the Marshall Islands; and Appendix B for an irrigation project on Truk.

LITERATURE: References 295, 296, 297, and 298 are excellent, detailed reports of the project; references 282, 286, and 287 are more general discussions of photovoltaics; references 22, 46, 47, 62, 63, and 64 contain policy discussions.

PROJECT #47
PHOTOVOLTAIC WATER PUMP - NO.2

(Photovoltaic water pumping system - 1985.)

LOCATION:
Moen, Truk
Federated States of Micronesia

COST: $10,000

FUNDING SOURCE:
U.S. Geological Survey

COMPLETION DATE: 1985

DESIGNER/SUPPLIER:
Water & Energy Research Institute
University of Guam
UOG Station
Mangilao, Guam 96913

CONTACT:
Rural Sanitation Program
P.O. Box 819
Moen, Truk
Federated States of Micronesia
96942

COMMENTS: The Water & Energy Research Institute (WERI) has been installing photovoltaic water pumping systems on islands throughout the Pacific. This system is designed to supplement village water catchment systems by pumping water from shallow wells on low atolls or sandy, coastal areas of high islands. This project has a different sponsor, the U.S. Geological Survey, and different components than Project #46. Components include an A.Y. McDonald, 36 volt DC centrifugal pump, 12 Solar Power Corporation 30 watt photovoltaic modules, a water-proof on-off switch, electrical wiring, and PVC pipe. The system is operating well and demonstrates the suitability of photovoltaics as a power source for pumping water on remote islands. See Project #46 for information on family-size photovoltaic water pumps on Truk; Project #78 for a photovoltaic pump on the Marshall Islands; and Appendix B for an irrigation project on Truk.

LITERATURE: References 295, 296, 297, and 298 are excellent, detailed reports of the project; references 282, 286, and 287 are more general discussions of photovoltaics; references 22, 46, 47, 62, 63, and 64 contain policy discussions.

PROJECT #48
WIND ELECTRIC MACHINE AT XAVIER HIGH SCHOOL

(Jacobs wind electric system at Xavier - 1984.)

LOCATION:
Xavier High School
Moen, Truk
Federated States of Micronesia

COST: $48,000

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1983

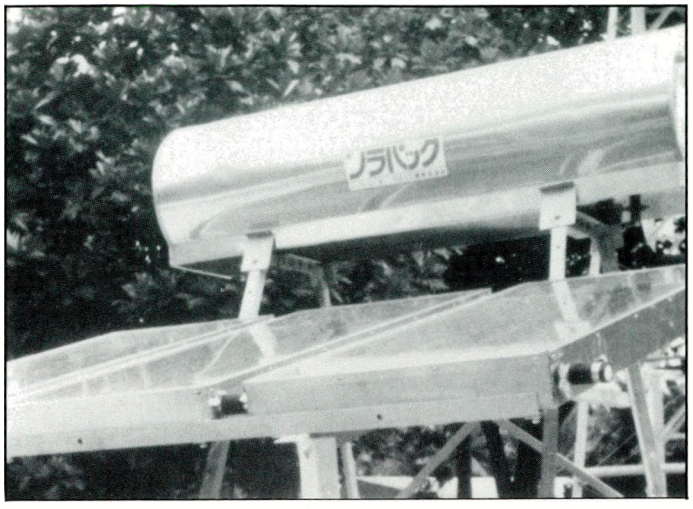
DESIGNER/SUPPLIER:
Jacobs Wind Electric Company
2720 Fernbrook Lane
Minneapolis, Minnesota
55441

CONTACT:
Xavier High School
P.O. Box 220
Moen, Truk
Federated States of Micronesia
96942

COMMENTS: Xavier High School is one of the outstanding schools of the Pacific. When the school applied for this grant they did not have utility power. They planned to install a wind electric machine as part of their vocational program and to use it as their principal source of electricity. After receiving the grant, the school acquired utility power so they replaced the original stand-alone machine with a grid-connected machine. The system now includes a Jacobs 12 kilowatt machine on an 80 foot tower, a single phase inverter, and power control equipment. The system operated properly at first despite barely adequate wind speeds and generated between one and five kilowatt-hours/day. Large fluctuations in the utility power supply caused the machine to behave in an erratic fashion, and a stand-alone system was not worth the expense of battery storage so they are not operating the machine now.

LITERATURE: References 2, 191, and 192 have brief discussions; reference 324 has wind speed data; references 322, 325, 326, and 327 present additional wind data; and references 22, 46, 47, 62, and 63 contain policy discussions.

PROJECT #49
WIND PUMPING AND SOLAR WATER HEATING FOR A HOSPITAL



(Solar equipment at the Satawan health dispensary - 1982)

LOCATION:
Health Dispensary
Satawan Island
Lower Mortlocks, Truk
Federated States of Micronesia

COST: $8,750

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1981

DESIGNER/SUPPLIER:
SolarPak Solar Systems
Southern Cross Windmills

CONTACT:
Energy Planner
State Planning Office
P.O. Box 189
Moen, Truk
Federated States of Micronesia
96942

COMMENTS: A common problem for health dispensaries on remote islands is a lack of hot water. In the late 1970's, the U.S. Department of Energy sponsored the new Satawan dispensary to acquire equipment for pumping and heating water. After long delays typical for such a remote location they installed the systems in 1981. The system includes solar water heating and wind water pumping equipment. The solar part includes two package units by SolarPak that have the stainless steel storage tanks attached directly to 24 square feet of collectors. Water circulates by natural convection. The wind component includes a Southern Cross windmill, a 40 foot tower, and plumbing. The solar system is working, but the water pump is not connected now because the breadfruit trees are higher than the windmill.

LITERATURE: References 2, 7, 191, and 192 give brief discussions of the project; references 322, 325, 326, and 327 have wind data for the Pacific.

PROJECT #50
SOLAR DRYER FOR AN OUTER ISLAND

(Proposed site of the solar dryers and grinder, Romanum Island - 1978.)

LOCATION:
Romanum Island
Truk Lagoon
Federated States of Micronesia

COST: $12,000

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1979

DESIGNER/SUPPLIER:
Peace Corps
Truk State
Federated States of Micronesia
96942

CONTACT:
Energy Planner
State Planning Office
P.O. Box 189
Moen, Truk
Federated States of Micronesia
96942

COMMENTS: The purpose of this project was to help people on Romanum Island establish a small fishmeal business. Two Peace Corps volunteers and some local people planned to build various types of solar dryers, select the best one, and build a number of them to dry fish by-products. They planned to build a mill for grinding the by-products into fishmeal for chicken feed and hoped to sell the feed to farmers on neighboring islands. The idea was good, but for a number reasons including lack of community support they never started the project.

LITERATURE: References 2, 5, 6, 7, 176, 191, and 192 discuss the project in some detail.

PROJECT #51
DEMONSTRATION HOME AT AN OUTER ISLAND

(The demonstration home - 1986.)

LOCATION:
Truk Lagoon
Federated States of Micronesia

COST: $10,000

FUNDING SOURCE:
Charles Lindbergh Foundation
Summit, New Jersey

COMPLETION DATE: 1986

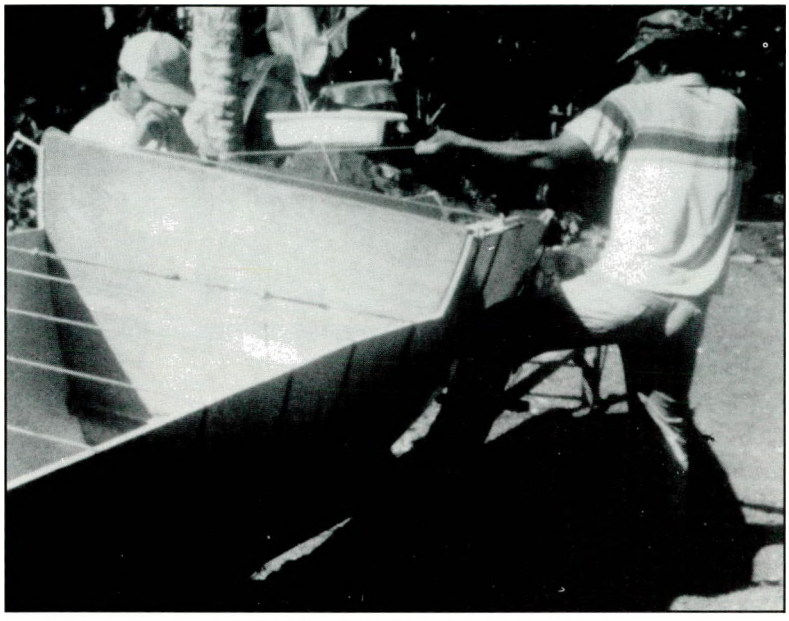
DESIGNER/SUPPLIER:
Steve Winter
P.O. Box 607
Moen, Truk
Federated States of Micronesia
96942

CONTACT:
Steve Winter
P.O. Box 607
Moen, Truk
Federated States of Micronesia
96942

COMMENTS: The Lindbergh Foundation offers financial support up to $10,000 for projects that contribute toward technological advancement and the preservation of the natural environment. Steve Winter is the former director of the Water & Energy Research Institute at the University of Guam, and during his tenure he installed photovoltaic pumps throughout the Pacific. See Projects #46, #47, and #78 for descriptions of his work. He has designed and built a cottage on a small island in the Truk Lagoon. The Lindbergh Foundation is sponsoring him there to use and demonstrate tropical, energy efficient construction and conservation systems. The cottage uses photovoltaic modules as the power source, and rainwater and groundwater are water sources.

LITERATURE: No references discuss this project. References 134, 155, 205, and 376 discuss other energy efficient projects.

PROJECT #52
SAIL-ASSIST FOR FISHING AND TRANSPORTATION



(Workers on Romanum Island building the tacking proa - 1983.)

LOCATION:
Romanum Island
Truk Lagoon
Federated States of Micronesia

COST: $11,000

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1983

DESIGNER/SUPPLIER:
Steve Dosh
Romanum Island

Chris White
S.T.B. Associates
Mathews, Virginia 23109

CONTACT:
Energy Planner
State Planning Office
P.O. Box 189
Moen, Truk
Federated States of Micronesia
96942

COMMENTS: Over the years plywood boats and outboard motors have replaced traditional ways of sailing for fishing and transportation. Outboards are proving expensive to run and repair, but it is difficult to return to the old ways. For this project Steve Dosh, a former Peace Corps volunteer who lives on Romanum Island, built and demonstrated an efficient 26 foot sailing boat (tacking proa) with single outrigger. The boat is suitable for fishing or transporting about six people plus cargo. Dosh and local boat builders used a design by Chris White that includes a constant camber fiberglass hull, simple and inexpensive construction, shallow draft, stability, and ease of sailing. The boat has sailed successfully throughout the Truk Lagoon, but other people have not built one yet.

LITERATURE: Reference 336 discusses the project in detail; references 2, 191, 192 give brief descriptions; and references 333 and 341 discuss similar projects.

PART 6: FEDERATED STATES OF MICRONESIA - YAP

Office of Planning, Budget, and Statistics
P.O. Box 471
Colonia, Yap
State of Yap
Federated States of Micronesia
96943

PROJECT #53
BIOGAS DIGESTER

LOCATION:
Colonia, Yap
Federated States of Micronesia

COST: $10,000

FUNDING SOURCE:
U.S. Department of Energy
Energy Extension Service Program

COMPLETION: 1985

DESIGNER/SUPPLIER:
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern
Mariana Islands 96950

CONTACT:
Energy Planner; Planning,
Budget, and Statistics
P.O. Box 471; Colonia, Yap
Federated States of Micronesia
96943

COMMENTS: The U.S. Department of Energy has been trying to encourage the Pacific governments to transfer technologies amongst each other and to take advantage of each other's local expertise. The Energy Office from the Commonwealth of the Northern Mariana Islands has been the leader in developing biogas digesters as part of their integrated digester plant demonstration. The purpose of this project is to see if a biogas digester similar to theirs can be built and demonstrated on Yap. Hopefully, farmers on Yap will build these digesters like the farmers are starting to on the Mariana Islands. The digester is part of an integrated system that converts animal wastes to methane gas; uses the effluent water as nutrients for fish and algae in aquaculture ponds; and uses the digester wastes for garden fertilizer. See Projects #12, #13, #14, #15, #16, and #62 for details on similar systems, and Appendix B for additional support of this technology on Yap.

LITERATURE: References 120, 121, 124, 126, and 128 discuss the integrated digester plant and biomass workshops; references 22, 47, 51, 60, 65, and 67 discuss biomass policy on Yap.

PROJECT #54
PHOTOVOLTAIC SYSTEMS FOR REFRIGERATORS

LOCATION:
Outer islands
Yap State
Federated States of Micronesia

COST: $65,000

FUNDING SOURCE:
U.S. Department of Energy

U.S. Department of Housing and
Urban Development

COMPLETION DATE: 1981

DESIGNER/SUPPLIER:
Solavolt International
P.O. Box 2934
Phoenix, Arizona 85062

CONTACT:
Energy Planner; Planning,
Budget, and Statistics
P.O. Box 471; Colonia, Yap
Federated States of Micronesia
96943

COMMENTS: This project is part of Project #99 in which 33 photovoltaic-powered refrigeration/lighting systems are being installed on outer islands throughout the Trust Territory of the Pacific Islands. For this project, the Yap Office of Planning, Budget, and Statistics is installing 13 such systems on the outer islands of Yap to power lights and refrigerators at health dispensaries. Each system has five, 40 watt Solavolt photovoltaic modules; a Polar refrigerator (Model RR-2); three Delco 2000, deep-cycle batteries; two, 20 watt fluorescent lights, two Sun Charger voltage regulators, and a set of module mounts. They replaced the Western Solar refrigerators with Polar refrigerators because of faulty electronic thermostats and they corrected a problem with the batteries discharging due to no low voltage disconnects. Still, the systems are not working properly so additional funds are being spent to upgrade them and to train local people to make repairs. See Appendix B for more information.

LITERATURE: References 282, 286, 287, 291, 292, and 299 discuss these and similar systems; references 22, 47, 51, 60, 65, and 67 discuss photovoltaics and Yap's energy policy.

PROJECT #55
PHOTOVOLTAIC REFRIGERATOR DEMONSTRATION

LOCATION:
Colonia, Yap
Federated States of Micronesia

COST: $2,900

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1982

DESIGNER/SUPPLIER:
Sam Falanruw
Colonia, Yap 96943

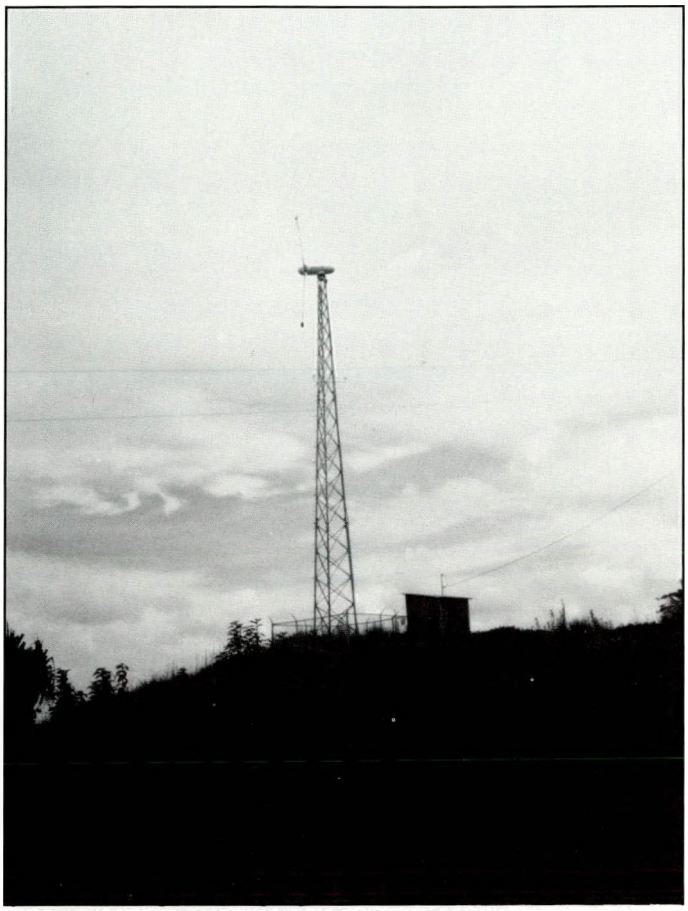
Solavolt International
P.O. Box 2934
Phoenix, Arizona 85062

CONTACT:
Energy Planner; Planning,
Budget, and Statistics
P.O. Box 471; Colonia, Yap
Federated States of Micronesia
96943

COMMENTS: This was one of the first U.S. Department of Energy projects for testing the suitability of photovoltaics to power refrigerators on remote islands. Originally, Mr. Falanruw, Director of the Department of Resources and Development, was to purchase two photovoltaic systems with refrigerators and put them on the outer islands of Ulithi and Falalop. By the time he received the grant, costs had increased and he could only afford one. He combined this project with Project #54 and purchased a Solavolt photovoltaic system and a Western Solar refrigerator. There were problems with the thermostat on the refrigerator, and so he replaced it with a Polar refrigerator. Otherwise, the project has been successful.

LITERATURE: References 2, 191, and 192 give brief, specific discussions; references 282, 286, 287, 291, 292, and 299 discuss similar systems; and references 22, 47, 51, 60, 65, and 67 discuss photovoltaics and Yap's energy policy.

PROJECT #56
WIND ELECTRIC MACHINE ON MAP



(EnerTech wind electric machine on Map - 1985.)

LOCATION:
Map Island, Yap State
Federated States of Micronesia

COST: $26,300

FUNDING SOURCE:
U.S. Department of Housing
and Urban Development

COMPLETION DATE: 1982

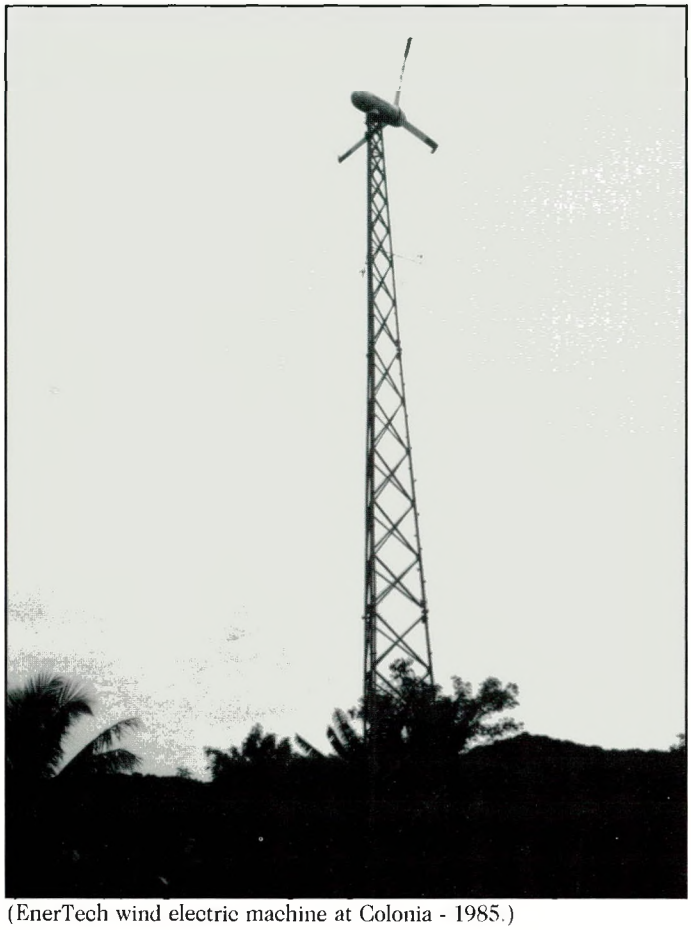
DESIGNER/SUPPLIER:
EnerTech Corporation
P.O. Box 420
Norwich, Vermont 05055

CONTACT:
Energy Planner; Planning,
Budget, and Statistics
P.O. Box 471; Colonia, Yap
Federated States of Micronesia
96943

COMMENTS: Until recently, Map Island was not connected to the central utility grid. The purpose of this project was to use a wind electric machine to produce electricity for the community center there. The machine was to be a stand-alone type with a bank of batteries storing the electricity. The grid goes to Map now so they redesigned the system for a machine connected to the grid without battery storage. The system includes an EnerTech down-wind turbine producing 4000 watts of electricity, a 60 foot Rohn tower, and an EnerTech control panel. The system has been performing satisfactorily. However, it is presently shut down awaiting a new transformer in the island grid system. This is one of the few wind electric machines operating in the Western Pacific now. See Project #57 for a similar project.

LITERATURE: References 321, 322, 325, 326, and 327 are for similar systems or wind data; references 22, 47, 51, 60, 65, and 67 are for Yap's energy policy concerning wind.

PROJECT #57
WIND ELECTRIC MACHINE AT COLONIA



(EnerTech wind electric machine at Colonia - 1985.)

LOCATION:
Colonia, Yap
Federated States of Micronesia

COST: $20,000

FUNDING SOURCE:
U.S. Department of Energy

COMPLETION DATE: 1982

DESIGNER/SUPPLIER:
EnerTech Wind Systems
P.O. Box 420
Norwich, Vermont 05055

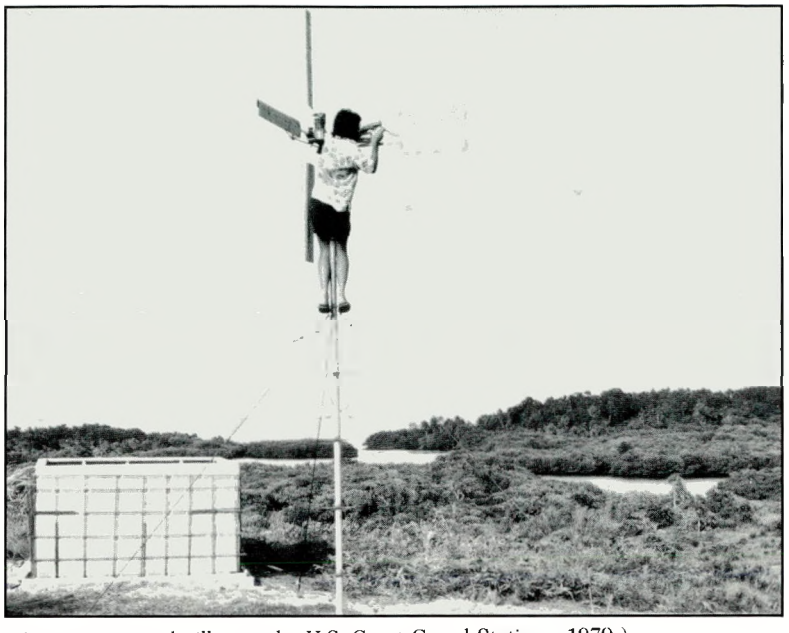
Rockwell International
Rocky Flats Plant Energy
Systems Group
Golden, Colorado 80401

CONTACT:
Energy Planner; Planning,
Budget, and Statistics
P.O. Box 471; Colonia, Yap
Federated States of Micronesia
96943

COMMENTS: This project is part of the joint effort between the U.S. Department of Energy and Rockwell International to install wind electric machines at central locations throughout the Pacific Islands. Machines were installed on American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, the Marshall Islands, Palau, and Yap; but this one is the only one that is operating now. Problems include corrosion, wind damage, lack of repair parts, lack of technical training, electrical malfunctions, power fluctuations from the utility grid, and lack of community interest. This system consists of an EnerTech down-wind turbine, a 60 foot Rohn tower, and an EnerTech control panel. The machine generates 1500 watts of electricity that goes into the utility grid. Technicians from Rockwell International did the installation and trained local people to do the maintenance and minor repairs. To date they have been able to keep it running. See Projects #6, #22, #67, #87, and #96 for information on similar projects.

LITERATURE: Reference 321 gives a detailed description; references 322, 325, 326, and 327 are for similar systems or wind data; references 22, 47, 51, 60, 65, and 67 are for Yap's energy policy concerning wind.

PROJECT #58
WIND WATER PUMP



(The Bowjon windmill near the U.S. Coast Guard Station - 1979.)

LOCATION:
U.S. Coast Guard Station
Colonia, Yap
Federated States of Micronesia

COST: $10,000

FUNDING SOURCE:
National Center for
Appropriate Technology

COMPLETION DATE: 1979

DESIGNER/SUPPLIER:
Bowjon Company
2829 Burton Avenue
Burbank, California 91504

CONTACT:
Energy Planner; Planning,
Budget, and Statistics
P.O. Box 471; Colonia, Yap
Federated States of Micronesia
96943

COMMENTS: In the late 1970's, the National Center for Appropriate Technology (NCAT) offered a small grants program for appropriate technology projects. This is the only project they funded in this part of the Pacific. The purpose of the project was to see if a Bowjon windmill would be suitable for pumping water to a small village. The Bowjon windmill or air lift pump is an unusual machine. A four-bladed, 7 foot diameter windmill compresses air for an air injection pump that can pump up to 5 gallons of water per minute. It does not need to be placed at the well and is cheaper with fewer moving parts than the standard windmill. The local U.S. Civic Action Team erected the machine on a 12 foot tower near the Coast Guard station. It worked for a few months lifting water about 90 feet and transporting it 300 feet to a gravity-feed storage tank. The pump was too far from the village for anyone to take responsibility for it, and after the guy wires failed and the blades were bent it was not repaired.

LITERATURE: There are no specific references on this project. References 322, 325, 326, and 327 present general wind data and references 22, 47, 51, 60, 65, and 67 discuss Yap's policy toward wind development.

PROJECT #59
YAP INSTITUTE OF NATURAL SCIENCE

(Solar drying and cooking systems at the Yap Institute of Natural Science - 1980.)

LOCATION:
Yap Institute of Natural Science
Colonia, Yap
Federated States of Micronesia

COST: $4,500

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1980

DESIGNER/SUPPLIER:
Yap Institute of Natural Science
Colonia, Yap
Federated States of Micronesia
96943

CONTACT:
Yap Institute of Natural Science
Colonia, Yap
Federated States of Micronesia
96943

COMMENTS: The Yap Institute of Natural Science does local environmental research and encourages people to use appropriate technologies that will not conflict with their traditional culture. The U.S. Department of Energy sponsored the Institute to build and demonstrate three simple systems: a solar crop dryer, an efficient wood cooking stove, and a solar ventilator. The Institute experimented with three types of dryers, and the best design was used in another Department of Energy project that placed 12 dryers in communities throughout Yap. They found that the stove worked best when it was built from cast sections of concrete. Coral and local soil do not work as they contain too much salt and do not tolerate heat well. The stove worked properly except for some cracking. A few of the stoves are being used around Yap now. The solar ventilator cooled a building by enhancing natural air circulation. Although it worked fairly well no others were built. See Project #60 for more information on the solar dryers.

LITERATURE: Reference 352 is their final report; reference 313 discusses the solar dryer project; and references 2, 5, 6, 175, 176, 191, and 192 contain brief, specific discussions.

PROJECT #60
SOLAR DRYER DEMONSTRATION

(A solar dryer being installed at a community on Yap - 1982.)

LOCATION:
Various communities
Yap State
Federated States of Micronesia

COST: $8,600

FUNDING SOURCE:
U.S Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1982

DESIGNER/SUPPLIER:
South Pacific Commission
P.O. Box D5
Noumea, New Caledonia

CONTACT:
Energy Planner; Planning,
Budget, and Statistics
P.O. Box 471; Colonia, Yap
Federated States of Micronesia
96943

COMMENTS: Traditionally, people on Pacific islands preserve their fish, fruit, and copra by drying them in the sun or in smoke houses. However, they encounter problems with rain, insects, and smoke damage. Solar dryers work well instead. This project uses a design that comes from the South Pacific Commission and was tried successfully by the Yap Institute of Natural Science. (See Project #59.) The idea is simple: the commodity to be dried is placed in a bin; the sun heats the bin up to 180 degrees F; and the drying is complete in a few hours. One unique feature is that the heat is controlled by varying the ventilation. The dryer consists of a metal drum with its exterior painted black; wire mesh for trays; a sheet of thin, clear plastic around the drum to enhance the sun's heat; and pieces of plywood for the dryer's base. The cost is about $100 per unit excluding labor. The Yap Office of Planning, Budget, and Statistics built 12 of these dryers and placed them in communities throughout Yap. At most places the dryers are used daily and work well.

LITERATURE: Reference 313 is the final report; reference 352 discusses a similar project; and references 2, 191, and 192 give brief, specific discussions.

PROJECT #61
VARIOUS SYSTEMS AT A PRIVATE HOME

(Water storage and heating systems - 1980.)

LOCATION:
Colonia, Yap
Federated States of Micronesia

COST: Unknown

FUNDING SOURCE:
Private funds

COMPLETION DATE: 1982

DESIGNER/SUPPLIER:
Various

CONTACT:
Energy Planner; Planning
Budget, and Statistics
P.O. Box 471; Colonia, Yap
Federated States of Micronesia
96943

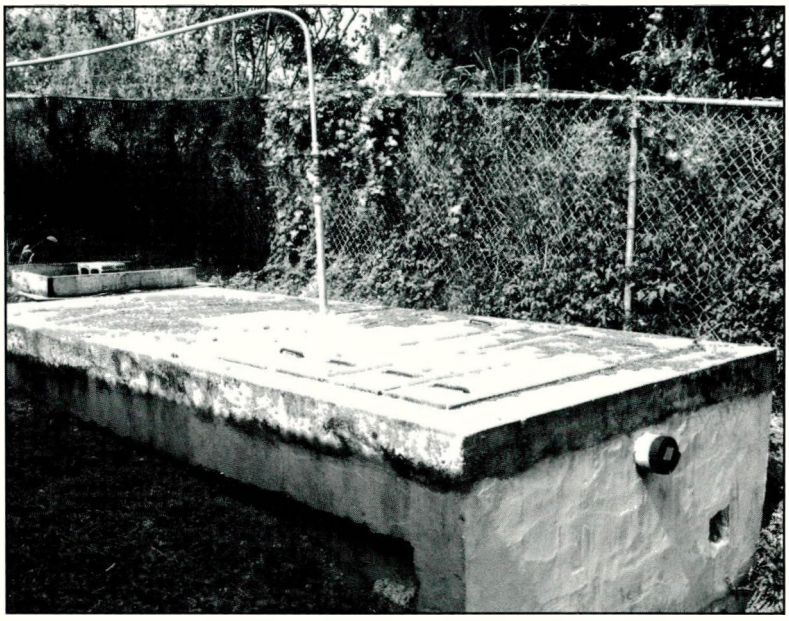
COMMENTS: This is a private home in Colonia, Yap, that has a variety of energy systems including a small wind electric machine, a solar water heating system, a small photovoltaic array, and a number of 12 volt DC appliances including ventilating fans. The house design has a number of energy efficient features including natural shading, natural ventilation, and roof overhangs. All of this was done with private funding.

LITERATURE: No references specifically discuss this project. References 134, 155, and 205 discuss similar projects.

PART 7: GUAM

Guam Energy Office
Office of the Governor
P.O. Box 2950
Agana, Guam 96910

PROJECT #62
BIOGAS CONVERSION AT THE AGRICULTURE STATION



(Biogas digester at the Experimental Station - not operating - 1986.)

LOCATION:
Experimental Station
College of Agriculture and
Life Science
Mangilao, Guam

COST: $6,500

FUNDING SOURCE:
U.S. Department of Energy
Technology Transfer Program
Guam Energy Office

COMPLETION DATE: 1985

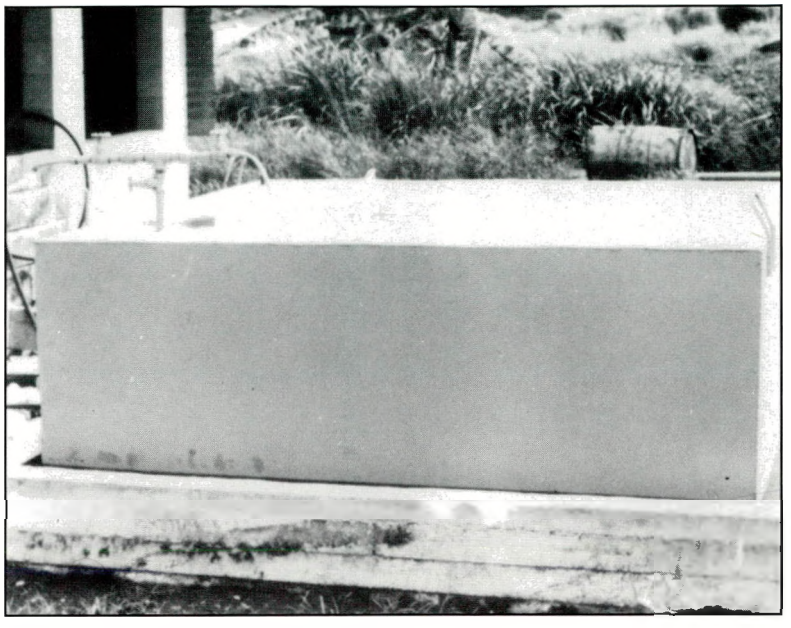
DESIGNER/SUPPLIER:
George Chan, formerly
Commonwealth Energy Office
P.O. Box 340, Saipan
Commonwealth of the Northern
Mariana Islands 96950

CONTACT:
Guam Energy Office
Office of the Governor
P.O. Box 2950
Agana, Guam 96910

COMMENTS: The U.S. Department of Energy and the Guam Energy Office sponsored the construction of a biogas digester at the Experimental Station run by the University of Guam College of Agriculture and Life Science. This is part of the Department of Energy's effort to transfer the biogas technology developed by the Commonwealth Energy Office on Saipan and to take advantage of their expertise. This digester is similar to the one being demonstrated by the Commonwealth Energy Office as part of their integrated digester plant. At the Experimental Station they built only the digester in order to generate methane gas to fuel an engine/generator set. They have had trouble getting the right mix in the digester to generate methane: too much water and too few animals. The digester is not set up to operate now, but eventually they hope to have it running properly. They never have run the generator, and the program funds have been reprogrammed for a photovoltaic educational project. See Project #12 for more information on the integrated digester plant.

LITERATURE: Reference 376 gives a brief description of the project; references 117, 120, 121, 124, 125, 126, and 128 discuss the integrated plant.

PROJECT #63
BIOGAS CONVERSION AT A COMMERCIAL FARM



(Biogas digester at Pedro's Farm - 1979.)

LOCATION:
Pedro's Farm
Agana, Guam

COST: $7,500

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1979

DESIGNER/SUPPLIER:
Pedro's Farm
Agana, Guam
96910

CONTACT:
Guam Energy Office
Office of the Governor
P.O. Box 2950
Agana, Guam 96910

COMMENTS: This was the first, small biogas digester sponsored by the U.S. Department of Energy, and its interest is mostly of historic value. Pedro's Farm is one of the largest commercial farms on Guam. During the 1970's, they built and operated a conventional biogas digester for converting animal wastes to biogas at their farm. A typhoon destroyed it though, and they used this grant to rebuild it. Workers at the farm completed the project, and the digester has been operating successfully. However, the farm is not accessible, and the project has had no demonstration or technology transfer value. It did show the Department of Energy that digesters are a suitable technology for Pacific farms.

LITERATURE: References 2, 3, 4, 7, 191, and 192 give brief specific discussions of the project; references 22, 72, 73, 75, 76, and 77 discuss Guam's energy policy concerning biomass.

PROJECT #64
PHOTOVOLTAIC SYSTEM AT THE GUAM ENERGY OFFICE

(ARCO photovoltaic panels on the roof of the Guam Energy Office - 1986.)

LOCATION:
Guam Energy Office
Mangilao, Guam

COST: $9,900

FUNDING SOURCE:
U.S. Department of Energy
Technology Transfer Program

Guam Energy Office

COMPLETION DATE: 1985

DESIGNER/SUPPLIER:
Bruce Best
Marianas Electronics
130 Marine Drive, Suite #103
Agana, Guam 96910

CONTACT:
Guam Energy Office
Office of the Governor
P.O. Box 2950
Agana, Guam 96910

COMMENTS: This is a joint project between the U.S. Department of Energy and the Guam Energy Office. The purpose is to demonstrate at the Guam Energy Office the potential of photovoltaic systems for several applications. The system consists of twelve, 35 watt ARCO photovoltaic panels (Model M-700) mounted in a frame on the roof; a charge controller; fourteen, 217 amp-hour Trojan batteries; a 1000 DC to AC inverter; and electronic equipment for monitoring the system and collecting data. Peak electrical output from the panels is about 400 watts at 12 volts DC; peak output from the batteries is 3000 watts. The system is connected to a number of appliances including three, 12 volt ceiling fans; four, 12 volt fluorescent lights; an incandescent spotlight; and an Apple II computer. The Guam Energy Office is publishing an information brochure describing the system and its applications. The system is operating properly, but the demonstration value would increase if more people were aware of the project.

LITERATURE: Reference 275 is for the brochure the Guam Energy Office is publishing; references 270, 271, 276, 277, 282, 287, and 376 describe similar systems on Guam.

PROJECT #65
PHOTOVOLTAIC SYSTEM FOR SATELLITE COMMUNICATION

LOCATION:
Guam Energy Office
Mangilao, Guam

COST: $8,100

FUNDING SOURCE:
U.S. Department of Energy
Technology Transfer Program

Department of Education
Trust Territory of the Pacific
Islands

COMPLETION DATE: 1985

DESIGNER/SUPPLIER:
Bruce Best
Marianas Electronics
130 Marine Drive, Suite #103
Agana, Guam 96910

CONTACT:
Guam Energy Office
Office of the Governor
P.O. Box 2950
Agana, Guam 96910

COMMENTS: Communication throughout the Pacific is usually done by high frequency (HF) radio transmission. Very high frequency (VHF) communication using satellites and high-gain antennas has less atmospheric interference, less distortion, and requires less power. This project demonstrates the effectiveness of small photovoltaic-powered VHF systems by setting up a number of such systems on the Pacific islands. A successful VHF communication package using the ATS-1 satellite has been installed at 14 Pacific island locations. The package includes a single, ARCO M73 40 watt panel; two, 6 volt 220 amp- hour batteries; a VHF receiver; amplifier; phone patch; and speaker. The package can also power an Apple II computer requiring either 12 volt DC or 110 volt AC. The systems provided good communication from Guam throughout the Pacific, but the satellite has dropped below the horizon now so it is no longer useful. These systems have excellent potential if another satellite is launched, and they are also useful for powering computers.

LITERATURE: References 270, 271, 276, and 376 describe the system in detail; references 275, 277, and 287 describe other Pacific photovoltaic systems.

PROJECT #66
WIND ELECTRIC MACHINE FOR AQUACULTURE

(Bruce Best inspecting the Sencenbaugh wind electric machine at Babulao - 1983.)

LOCATION:
Joe Roberto Farm
Talofofo River Valley
Babulao, Guam

COST: $8000

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1983

DESIGNER/SUPPLIER:
Bruce Best
Marianas Electronics
130 Marine Drive, Suite #103
Agana, Guam 96910

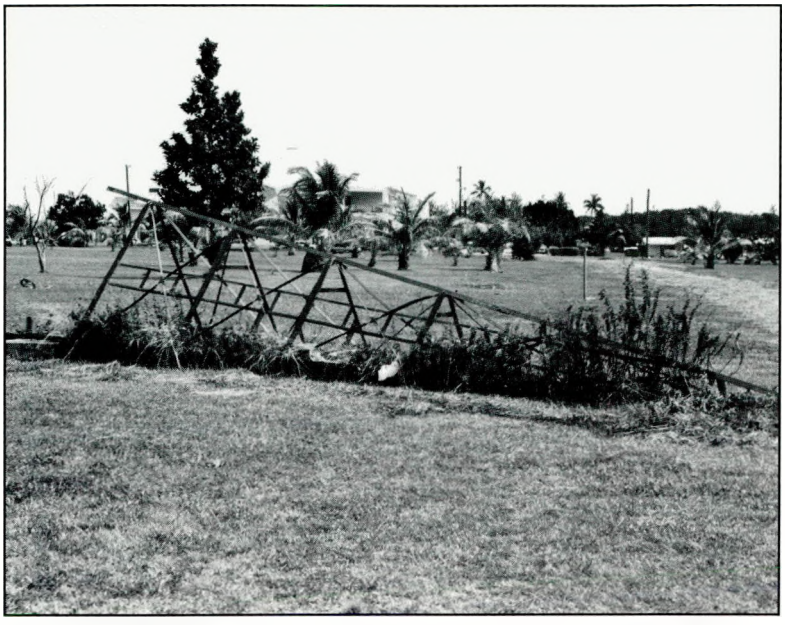
Sencenbaugh Wind Electric
P.O. Box 11174
Palo Alto, California 94306

CONTACT:
Guam Energy Office
Office of the Governor
P.O. Box 2950
Agana, Guam 96910

COMMENTS: The U.S. Department of Energy gave financial support to Mr. Best to install a wind electric system for circulating water at an aquaculture farm in a remote part of the Guam interior. This is the primary source of electricity at the farm; a photovoltaic system provides backup power. The wind electric system consists of a 1000 watt Sencenbaugh, 12 volt DC wind generator; power regulating equipment; twenty-four, 270 amp-hour Century batteries; and a 120 volt, AC 300 VA Topaz inverter. The machine is mounted on a 55 foot tower salvaged from typhoon-damaged sections of a Navy communication antenna. With the exception of minor problems the machine operated successfully until the aquaculture operation was abandoned last year in favor of a pineapple farm. At the time this was one of the few successful wind electric projects in the Western Pacific, mostly because of the crew's efforts installing and maintaining this system under difficult conditions.

LITERATURE: Reference 316 is for a detailed final report; references 2, 175, 191, 192, and 314 give brief descriptions; and references 315, 319, 322, 323, 325, 326, and 327 have wind data on Guam.

PROJECT #67
WIND ELECTRIC MACHINE AT THE GUAM ENERGY OFFICE



(The tower is all that remains of the wind electric machine project - Mangilao, Guam - 1986.)

LOCATION:
Guam Energy Office
Mangilao, Guam

COST: $10,000

FUNDING SOURCE:
U.S. Department of Energy

COMPLETION DATE: 1983

DESIGNER/SUPPLIER:
Rockwell International
Rocky Flats Plant Energy
Systems Group
Golden, Colorado 80401

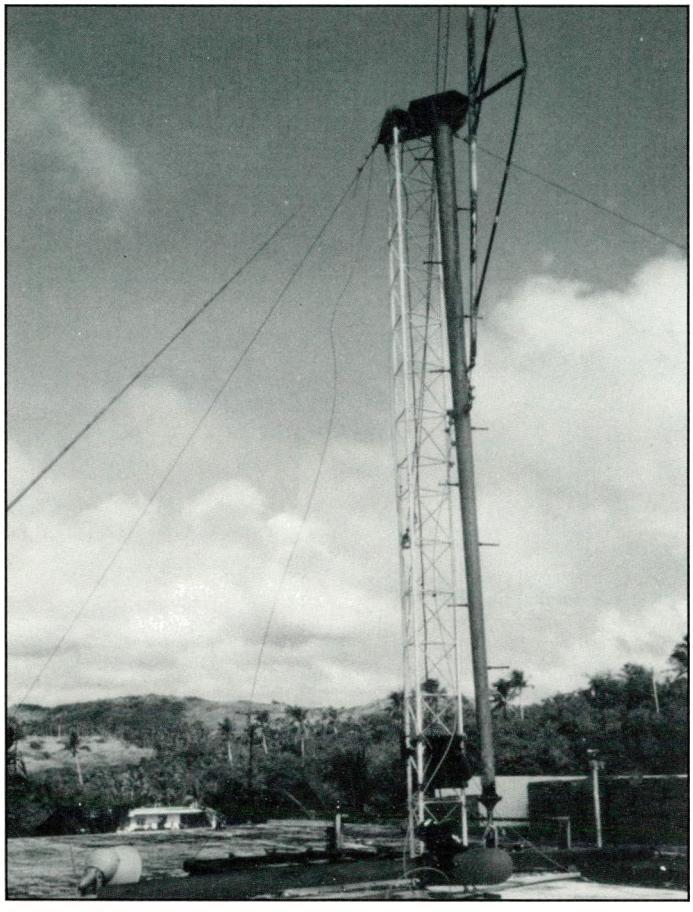
Kedco International
Inglewood, California 90306

CONTACT:
Guam Energy Office
Office of the Governor
P.O. Box 2950
Mangilao, Guam 96910

COMMENTS: This is another of the joint projects between the U.S. Department of Energy and Rockwell International to install wind electric machines at central locations throughout the Pacific. Other sites include American Samoa, the Commonwealth of the Northern Mariana Islands, the Marshall Islands, Palau, and Yap. The purpose of the program was to test and demonstrate wind electric machines at these locations. Only the machine at Yap is running now. Causes of failure include corrosion, storm damage, lack of local repair parts and skills, poor system design, problems with the utility grid, inadequate winds, and lack of community interest. The system on Guam included a Kedco 2500 watt wind generator, a Gemini DC to AC synchronous inverter, and a 60 foot tower. Technicians from Rockwell International installed the machine at the Guam Energy Office, and it ran at first despite inadequate winds. The machine was permanently damaged raising it after a storm and has been dismantled. See Projects #6, #22, #57, #87, and #96 for information on the other wind machines.

LITERATURE: Reference 321 discusses this project; references 22, 72, 75, 76, 77, 314, 316, 319, 322, 323, 325, and 326 discuss wind development on Guam.

PROJECT #68:
DOMESTIC WIND ELECTRIC MACHINE - NO.1



(Wind electric machine - 1985.)

LOCATION:
Inarajan, Guam

COST: $3,000

FUNDING SOURCE:
Private funds

COMPLETION DATE: 1982

DESIGNER/SUPPLIER:
Whirlwind Power Co.
207 1/2 E. Superior St
Duluth, Minnesota 55802

CONTACT:
Stan McKinnon
P.O. Box 4818
Inarajan, Guam 96916

COMMENTS: This is a privately financed project to provide a wind electric machine to generate electricity for domestic use at the owner's home. The main components include a grid-connected, 4000 watt Whirlwind, wind electric machine (Model 4120I) with 3 phase alternator; a 20 foot tower; and a control box. The machine is not operating because of inadequate wind speeds. This is a common problem throughout the Pacific where wind systems have been installed without first collecting wind data at specific sites over an adequate period of time. See Project #69 for a similar system.

LITERATURE: There are no specific references for this project. References 314, 316, 319, 321, 322, 323, 325, 326, and 327 discuss wind machines or include wind data for Guam.

PROJECT #69
DOMESTIC WIND ELECTRIC MACHINE - NO.2

(Wind electric machine - 1985.)

LOCATION:
Barrigada Heights
Guam

COST: $6,000

FUNDING SOURCE:
Private funds

COMPLETION DATE: 1981

DESIGNER/SUPPLIER:
Whirlwind Power Co.
207 1/2 E. Superior St.
Duluth, Minnesota 55802

CONTACT:
Harry Walker
201 K & F Building
Dededo, Guam 96912

COMMENTS: This is another privately financed project for producing electricity for domestic use at the owner's home. The system includes a grid-connected, 4000 Whirlwind, wind electric machine; a 40 foot tower; and a Gemini synchronous inverter. The machine is operating, but the wind speeds are not adequate to make the system useful. See Project #68 for a similar system.

LITERATURE: There are no specific references for this project. References 314, 316, 319, 321, 322, 323, 325, 326, and 327 discuss wind machines or include wind data for Guam.

PROJECT #70
SOLAR WATER HEATING FOR UNIVERSITY DORMITORIES

(SolaHart collectors at a University of Guam dormitory - 1986.)

LOCATION:
Dormitories
University of Guam
Mangilao, Guam

COST: $30,000

FUNDING SOURCE:
U.S. Department of Energy
Energy Extension Service Program

COMPLETION DATE: 1985

DESIGNER/SUPPLIER:
George J. Viegas
Office of Administrative Affairs - Plant Management
University of Guam
Mangilao, Guam 96913

SolaHart
3560 Dunhill Street
San Diego, California 92121

CONTACT:
Guam Energy Office
Office of the Governor
P.O. Box 2950
Agana, Guam 96910

COMMENTS: For this project the Guam Energy Office and the University of Guam plant engineers have installed 15 SolaHart packaged, solar water heating systems on two dormitories at the University of Guam. These are complete units with an 80 gallon storage tank attached to the top of two, 21 square foot collectors. These systems are the only source of hot water at the dormitories, and, with the exception of vandalism to one, have operated without problems. Installation and maintenance are done properly, and this is one of the best solar hot water projects in the Western Pacific.

LITERATURE: No references discuss this project specifically. Reference 303 discusses solar water heating on Guam; references 22, 72, 76, and 79 discuss Guam's energy policy on solar water heating.

PROJECT #71
SOLAR WATER HEATING AT A DETENTION HOME

(Frank Jaquette inspecting his solar collectors on a youth detention home - 1981.)

LOCATION:
Youth detention home
Mangilao, Guam

COST: $12,000

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1979

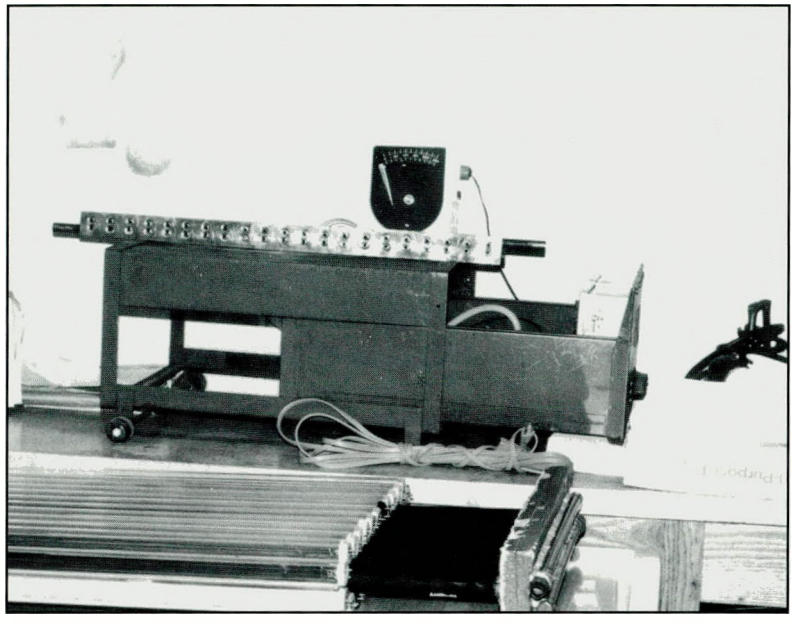
DESIGNER/SUPPLIER:
Frank Jaquette
Mathematics Department
University of Guam
UOG Station
Mangilao, Guam 96913

CONTACT:
Guam Energy Office
Office of the Governor
P.O. Box 2950
Agana, Guam 96910

COMMENTS: Mr. Jaquette is a mathematics professor at the University of Guam, and for sometime he has been experimenting with simple, home-built solar water heating systems designed for Pacific islands. In 1978, such systems were still unusual. The U.S. Department of Energy gave him a grant to encourage his work and to help him refine and demonstrate his most recent designs. In addition, he was to conduct three workshops to build and install these systems and to write a series of brochures describing them. After refining the design he held the workshops and installed the systems at the Guam penitentiary, a firehouse, and a youth detention home. All the systems worked properly, especially the one at the detention home, which has been operating for a number of years despite a complete lack of maintenance. He wrote the brochures, and for awhile there was a small supply at the Guam Energy Office. See Project #72 for a description of his other solar water heating project.

LITERATURE: References 307, 308, and 309 are for the brochures; references 2, 3, 4, 7, 191, and 192 briefly describe the project.

PROJECT #72
SOLAR COLLECTOR FROM FLUORESCENT TUBES



(Fluorescent tubes being evacuated for a solar collector in Frank Jaquette's workshop - 1981.)

LOCATION:
Mathematics Department
University of Guam
Mangilao, Guam

COST: $14,600

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1981

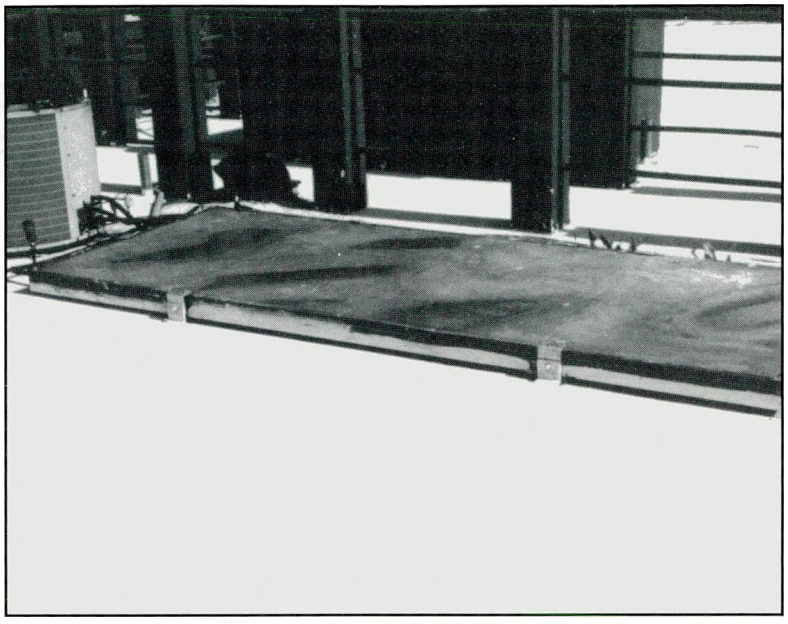
DESIGNER/SUPPLIER:
Frank Jaquette
Mathematics Department
University of Guam
UOG Station
Mangilao, Guam 96913

CONTACT:
Guam Energy Office
Office of the Governor
P.O. Box 2950
Agana, Guam 96910

COMMENTS: The U.S. Department of Energy gave two grants to Mr. Jaquette to support him in developing and demonstrating a unique solar system that would use burned out fluorescent light tubes as part of the collector. Mr. Jaquette evacuated the tubes; inserted small, interconnected copper tubes; and resealed them. In this way, the fluorescent tubes would serve as glazing and help retain the heat. He was hoping that the collector could be built by the homeowners and would be as efficient as commercial ones. He experimented with the system at his University workshop and built a series of prototype collectors. He ran some inconclusive tests comparing these collectors with his more conventional home-built models. (See Project #71.) The fluorescent tube model proved impractical because it was difficult to construct, and the fluorescent tubes kept breaking during the evacuation process.

LITERATURE: Reference 306 specifically describes the project; references 2, 3, 4, 7, 191, and 192 give brief descriptions.

PROJECT #73
DOMESTIC SOLAR WATER HEATING - NO.1



(Solar water heating system - 1985.)

LOCATION:
Barrigada Heights
Guam

COST: $1000

FUNDING SOURCE:
Private funds

COMPLETION DATE: 1980

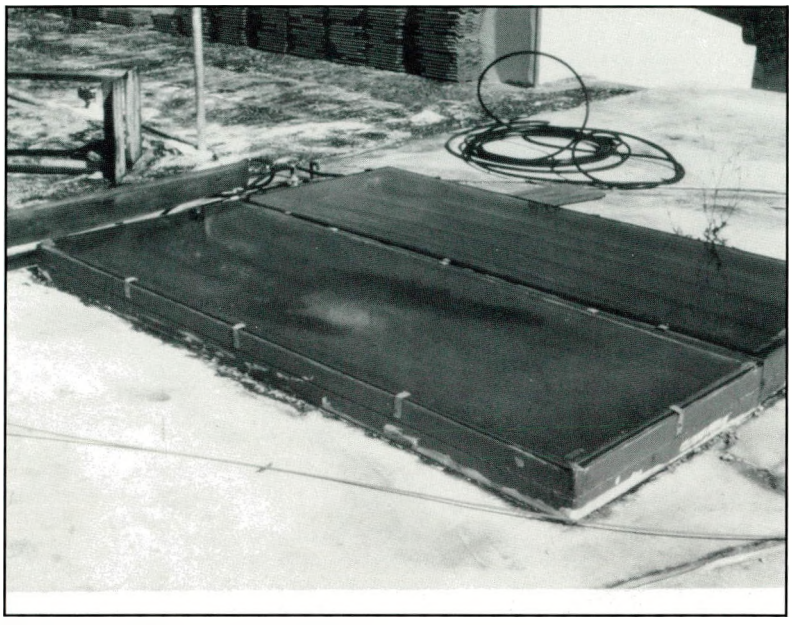
DESIGNER/SUPPLIER:
Silo Guam
Agana, Guam 96910

CONTACT:
Harry Walker
201 K & F Building
Dededo, Guam 96912

COMMENTS: This is a simple, domestic solar hot water system similar to ones that are appearing on Guam. The system includes a 24 square foot commercially-built solar collector and two small storage tanks. the System is Dr. Walker's only source of hot water. See Project #69 for information on a wind electric machine at the same location.

LITERATURE: No references specifically discuss this project. References 301, 302, 303, 305, 306, 307, 308, 309, and 310 discuss solar water heating systems throughout the Pacific.

PROJECT #74
DOMESTIC SOLAR WATER HEATING - NO.2



(Solar water heating system - 1985.)

LOCATION:
Inarajan
Guam

COST: $200

FUNDING SOURCE:
Private funds

COMPLETION DATE: 1977

DESIGNER/SUPPLIER:
Stan McKinnon
P.O. Box 4818
Inarajan, Guam 96916

CONTACT:
Stan McKinnon
P.O. Box 4818
Inarajan, Guam 96916

COMMENTS: This is a good example of a successful, home-built, domestic solar water heating system. It consists of two solar collectors, piping, and an existing 80 gallon water heater tank. The system is still working well, and the owner has reduced his monthly power bill by almost 50%. See Project #68 for information on a wind electric machine at the same location.

LITERATURE: No references specifically discuss this project. References 301, 302, 303, 305, 306, 307, 308, 309, 310 discuss solar water heating systems throughout the Pacific.

PROJECT #75
ENERGY MANAGEMENT AT THE UNIVERSITY GYMNASIUM

(University of Guam gymnasium - solar collector is on the far left - 1986.)

LOCATION:
Gymnasium
University of Guam
Mangilao, Guam

COST: Unknown

FUNDING SOURCE:
U.S. Department of Energy

COMPLETION DATE: 1985

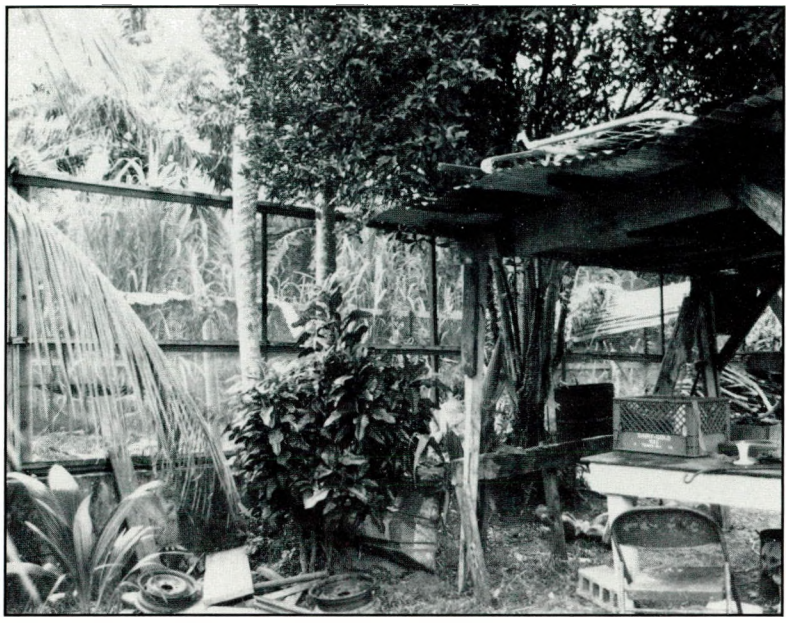
DESIGNER/SUPPLIER:
George Viegas
Office of Administrative
Affairs - Plant Management
University of Guam
Mangilao, Guam 96913

CONTACT:
Guam Energy Office
Office of the Governor
P.O. Box 2950
Agana, Guam 96910

COMMENTS: This is a two part project to install roof insulation and a solar water heating system at the University of Guam's new gymnasium. The roof insulation part won a U.S. Department of Energy National Award for Energy Innovation in 1985. The insulation consists of pre-cast concrete panels with foam inside. A reflective coating is fixed to the outside of them. Exhaust fans remove hot air from the gymnasium. The insulation and fans are able to cool the gymnasium to a comfortable temperature so air conditioning is necessary only when there are large crowds. The solar water heating system supplements a standard gas water heater for hot water for the showers. The water circulating pump is broken right now so the system is not operating.

LITERATURE: No references specifically discuss this project. References 148, 149, 151, 152, 153, 154, 155, 162, 164, 169, and 170 discuss energy management on Guam.

PROJECT #76
TYPHOON-PROOF GREENHOUSE



(The typhoon-proof greenhouse at Merizo - 1981.)

LOCATION:
Merizo, Guam

COST: $3,000

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1981

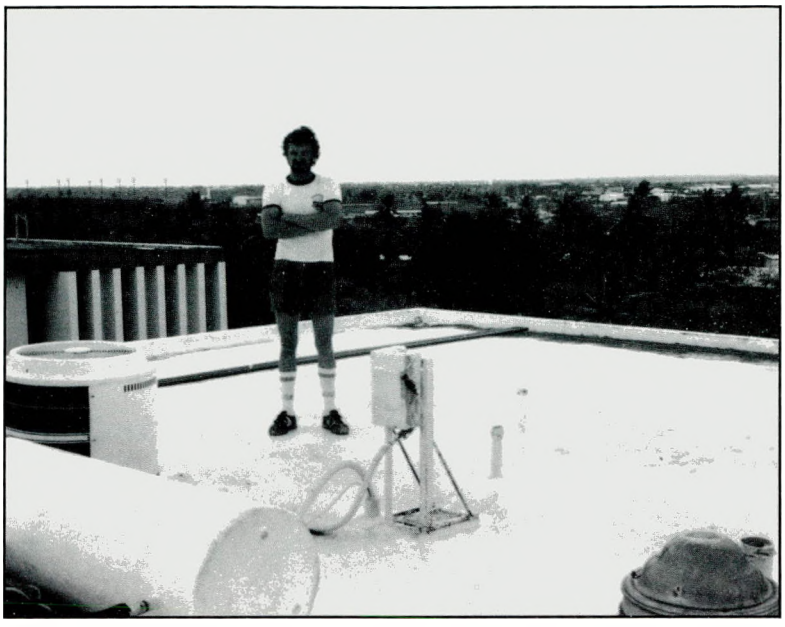
DESIGNER/SUPPLIER:
Eugene LeRoy, formerly
Merizo, Guam 96916

CONTACT:
Guam Energy Office
Office of the Governor
P.O. Box 2950
Agana, Guam 96910

COMMENTS: The U.S. Department of Energy gave a grant to Mr. LeRoy to build a small, typhoon-proof greenhouse. The purpose of the project was to demonstrate a unique greenhouse on a small rural farm. The greenhouse was to include simple, inexpensive construction using some scrap material; raised-bed, French-intensive gardening to increase productivity; screening to keep out insects; and draw-down shutters to prevent damage from typhoon winds and salt spray. This project did not work out well. Mr. LeRoy lost interest in the work, and others in the community did not support it. He finally completed the greenhouse, but it did not include many of the important features such as the shutters and the raised gardening beds. The owner of the farm did use the greenhouse for growing an unusual strain of spinach.

LITERATURE: References 2, 3, 4, 6, 191, and 192 discuss this project briefly.

PROJECT #77
EVAPORATIVE COOLING SYSTEM



(The water holding tank and equipment on the roof of the apartment building - 1983.)

LOCATION:
Apartment house
Tamuning, Guam

COST: $11,800

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1983

DESIGNER/SUPPLIER:
Geoffrey Burke
P.O. Box 7233
Tamuning, Guam 96911

CONTACT:
Guam Energy Office
Office of the Governor
P.O. Box 2950
Agana, Guam 96910

COMMENTS: The purpose of this project was to determine if evaporative cooling could partially cool a building, thereby reducing air conditioning costs. The idea was to spray a fine mist of water on the outside of the apartment building Mr. Burke lived in. As the water evaporated the building would be cooled. Mr. Burke installed a holding tank and spray mechanism on the roof of the building. He placed thermistors in the walls of his apartment in order to get comparative temperature measurements. He planned to monitor the system for a year to see if it worked; to build a catchment system so that the water could be continually recycled through the system; and to prepare a detailed final report for wide circulation. These tasks were never done, and the project generally was not successful. Mr. Burke seemed to lose interest in the project as work progressed and the idea was not working. Nevertheless, a final report explaining the project and its flaws would have been useful.

LITERATURE: References 2, 191, and 192 discuss this project briefly.

PART 8: REPUBLIC OF THE MARSHALL ISLANDS

Energy Coordinator
Republic of the Marshall Islands
Majuro, Marshall Islands 96960

PROJECT #78
PHOTOVOLTAIC WATER PUMP

(Photovoltaic pumping system on Majuro - 1986.)

LOCATION:
Majuro Atoll
Marshall Islands

COST: $4,000

FUNDING SOURCE:
U.S. Geological Survey
Trust Territory of the Pacific Islands

COMPLETION DATE: 1985

DESIGNER/SUPPLIER:
Water & Energy Research Institute
University of Guam
UOG Station
Mangilao, Guam 96913

A.Y. McDonald Company
Dubuque, Iowa 52001

CONTACT:
Energy Coordinator
Republic of the Marshall Islands
Majuro, Marshall Islands 96960

COMMENTS: This photovoltaic water pumping system is installed at a private home on Majuro Atoll. The purpose is to demonstrate how photovoltaic-powered, family-size pumps can extract groundwater from shallow lense wells on atolls in order to supplement rainwater catchment systems. The major components of the system are four, ARCO 35 watt photovoltaic modules; an A.Y. McDonald pump; an aluminum support structure; electrical wiring; and PVC piping. The Water & Energy Research Institute (WERI) of the University of Guam did the installation work. The system works well; however, it has not been connected to a water storage tank. Eventually, it should pump about 3 gallons of water per minute to a tank for washing clothes and showering. This project is similar to other WERI Projects #46, #47, and #95.

LITERATURE: References 294, 295, 296, 297, and 298 specifically discuss photovoltaic-powered pumps; references 280, 282, 286, and 287 discuss photovoltaics generally on the Marshall Islands.

PROJECT #79
VILLAGE PHOTOVOLTAIC SYSTEM FOR UTIRIK ATOLL

LOCATION:
Utirik Atoll
Marshall Islands

COST: $327,000

FUNDING SOURCE:
U.S. Department of Energy
Republic of the Marshall Islands
Utirik Municipal Council

COMPLETION DATE: 1984

DESIGNER/SUPPLIER:
Hughes Aircraft
National Aeronautics and Space Administration

CONTACT:
Energy Coordinator
Republic of the Marshall Islands
Majuro, Marshall Islands 96960

COMMENTS: The Utirik Municipal Council decided to use their thermonuclear compensation money from the U.S. to purchase a central, hard-wired photovoltaic system to provide electricity for their village. This decision was based on their successful experience with a photovoltaic-powered communication system. In order to purchase an appropriate village-size system they pooled their money with additional money from the U.S. Department of Energy. National Aeronautics and Space Administration (NASA) engineers designed the system, and technicians from Hughes Aircraft did the installation. The main components of the system include 120 Photowatt International and Solec, Inc. solar modules producing 66 watts each; a power controller; power output panel; DC to AC inverter; 120 C&D #3KCPSA-5 225 amp- hour, six volt batteries; ballasted planter structures; 76 night lights; 95 fluorescent lights at 24 watts each; six medical refrigerators; one medical exam light; seven ventilation fans and a battery charger. Total peak output is 8000 watts. The Marshall Islands Energy Programme is sponsoring a technical, social, and economic evaluation of the system.

LITERATURE: References 274, 278, 279, 281, 285, 289, and 293 specifically discuss this project; references 280, 282, 286, and 287 have general discussions; references 22, 82, 84, 85, and 86 discuss policy.

PROJECT #80
PHOTOVOLTAIC LIGHTING FOR OUTER ISLANDS

LOCATION:
Various Islands
Marshall Islands

COST: $1,700 per system

FUNDING SOURCE:
U.S. Department of Housing
and Urban Development

COMPLETION DATE: 1986

DESIGNER/SUPPLIER:
Servco International
211 Wilcox Lane
Honolulu, Hawaii 96819

CONTACT:
Energy Coordinator
Republic of the Marshall
Islands
Majuro, Marshall Islands 96960

COMMENTS: The purpose of this project is to use small photovoltaic systems to provide lighting for atoll dispensaries and community halls on remote islands throughout the Marshall Islands. There are a number of projects in the Western Pacific similar to this where small photovoltaic lighting, refrigeration, or communication systems are distributed to villages on remote islands that either do not have electricity or depend on small, conventional generators. Generally, these projects have been successful. (See Projects #18, #46, #54, #65, #81, #98, and #99.) So far 29 systems have been installed throughout the Marshall Islands. Although the systems have worked fairly well, the batteries continually have low voltages. Each system consists of two ARCO 35 watt, M-61 modules; module support structures; two, 20 watt stainless steel fluorescent lights; and two Delco 2000 batteries.

LITERATURE: References 280, 282, and 287 discuss this project generally; references 22, 82, 84, 85, 86, 284, 285, 286, 289, and 292 are some of the many that discuss energy policy and photovoltaics on the Marshall Islands.

PROJECT #81
PHOTOVOLTAIC REFRIGERATORS FOR OUTER ISLANDS

(Four photovoltaic panels on the roof of the dispensary at Laura, Majuro - 1986.)

LOCATION:
Various islands
Marshall Islands

COST: $7,000 each

FUNDING SOURCE:
U.S. Department of Energy
Energy Extension Service Program

COMPLETION DATE: 1983

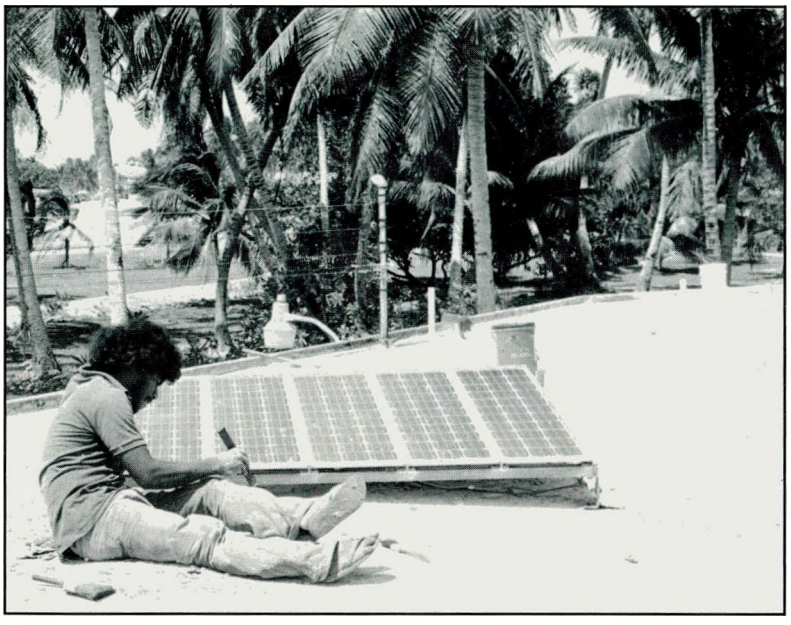
DESIGNER/SUPPLIER:
Solavolt International
P.O. Box 2934
Phoenix, Arizona 85062

CONTACT:
Energy Coordinator
Republic of the Marshall Islands
Majuro, Marshall Islands 96960

COMMENTS: This project is part of Project #99 in which 33 photovoltaic- powered refrigeration/lighting systems are being installed on outer islands throughout the Pacific. Seven such systems have been installed at health dispensaries for outer island communities in the Marshall Islands. Each system consists of four or five, 40 watt Solavolt photovoltaic modules; three Delco 2000, deep-cycle batteries; a voltage regulator; module support structures; wiring harness; a Western Solar refrigerator Model 12-1; and two, 20 watt fluorescent lights. Of the seven systems, only the one on Lae Atolls is working. The other six systems have had problems with the refrigerators or the batteries. The one shown in the photograph is at a dispensary on Laura Island, Marjuro Atoll, and vandals have destroyed the wiring. See Projects #18, #54, #65, #80, #98, and #99 for similar systems.

LITERATURE: References 280, 282, and 287 discuss this project generally; references 22, 82, 84, 85, 86, 284, 285, 286, 289, and 292 are some of the many that discuss energy policy and photovoltaics on the Marshall Islands.

PROJECT #82
PHOTOVOLTAIC DEMONSTRATION



(Solavolt system mounted on the roof of the President's house - 1983.)

LOCATION:
President's house
Majuro Atoll
Marshall Islands

COST: $7,000

FUNDING SOURCE:
U.S. Department of Energy
Energy Extension Service Program

COMPLETION DATE: 1983

DESIGNER/SUPPLIER:
Solavolt International
P.O. Box 2934
Phoenix, Arizona 85062

CONTACT:
Energy Coordinator
Republic of the Marshall Islands
Majuro, Marshall Islands 96960

COMMENTS: This photovoltaic system is being demonstrated at the house of the President of the Republic of the Marshall Islands, and it is used for refrigeration and lighting. It is at a central location in the main part of Majuro. The system is the same as the ones described in Project #81, and like most of these, it has not been working properly.

LITERATURE: References 280, 282, and 287 discuss this project generally; references 22, 82, 84, 85, 86, 284, 285, 286, 289, and 292 are some of the many that discuss energy policy and photovoltaics on the Marshall Islands.

PROJECT #83
DOMESTIC PHOTOVOLTAIC SYSTEM

(This is the photovoltaic system in 1983 - it has now been moved to another house.)

LOCATION:
Uliga
Majuro Atoll
Marshall Islands

COST: Unknown

FUNDING SOURCE:
Unknown

COMPLETION DATE: 1983

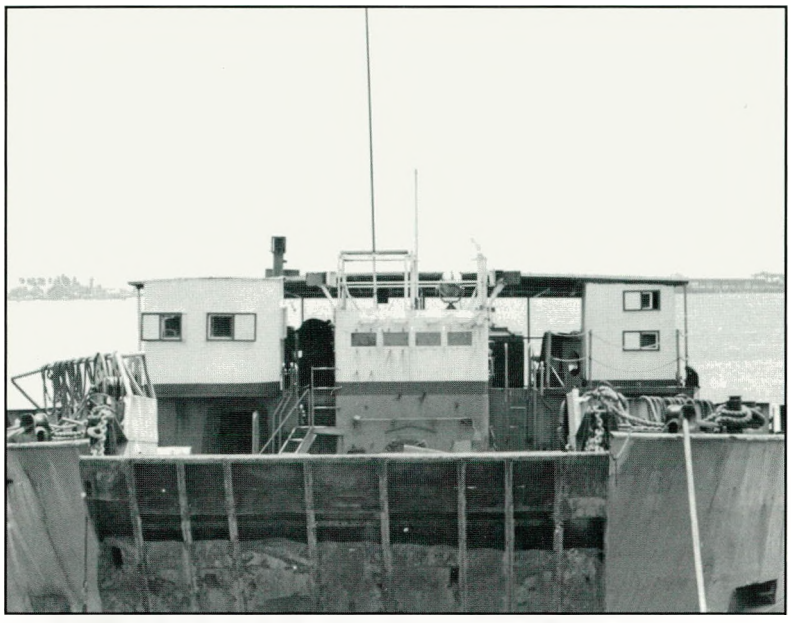
DESIGNER/SUPPLIER:
ARCO Solar, Inc.
P.O. Box 2105
Chatsworth, California 91311

CONTACT:
Energy Coordinator
Republic of the Marshall Islands
Majuro, Marshall Islands 96960

COMMENTS: This is a privately owned system for domestic use on Chief Secretary DeBrum's home at Uliga, Majuro Atoll. The system includes 24 roof- mounted ARCO panels producing about 33 watts each, battery storage, a power regulator, and a DC to AC inverter. Peak output is about 800 watts.

LITERATURE: References 280, 282, and 287 discuss this type of project; references 22, 82, 84, 85, 86, 284, 285, 286, 289, and 292 are some of the many that discuss energy policy and photovoltaics on the Marshall Islands.

PROJECT #84
PHOTOVOLTAIC SYSTEM FOR A LANDING BARGE



(Photovoltaic panels mounted on the roof of the center cabin - LCT - 1980.)

LOCATION:
Landing craft
Majuro, Marshall Islands

COST: $1,500 each

FUNDING SOURCE:
U.S. Department of the Interior

COMPLETION DATE: 1980

DESIGNER/SUPPLIER:
Manufacturer unknown

CONTACT:
Energy Coordinator
Republic of the Marshall Islands
Majuro, Marshall Islands 96960

COMMENTS: In the late 1970's, a number of small photovoltaic-powered communication systems were installed on LCTs (Landing Craft, Tank) in the Marshall Islands. The details of the project are few, but it was probably the first effort by the Trust Territory of the Pacific Islands to use photovoltaic systems to power communication sets. Originally, the systems were to include ARCO panels but other panels, most likely Solavolt, were substituted for unknown reasons. The system had two panels with an output of around 30 watts each, battery storage, and power controls. The systems worked as expected but have been dismantled now as the LCTs are no longer in use.

LITERATURE: References 280, 282, and 287 discuss this type of project; references 22, 82, 84, 85, 86, 284, 285, 286, 289, and 292 are some of the many that discuss energy policy and photovoltaics on the Marshall Islands.

PROJECT #85
PHOTOVOLTAIC SYSTEMS ON KILI

LOCATION:
Kili Island
Marshall Islands

COST: Unknown

FUNDING SOURCE:
Kili Council Trust Fund

COMPLETION DATE: 1984

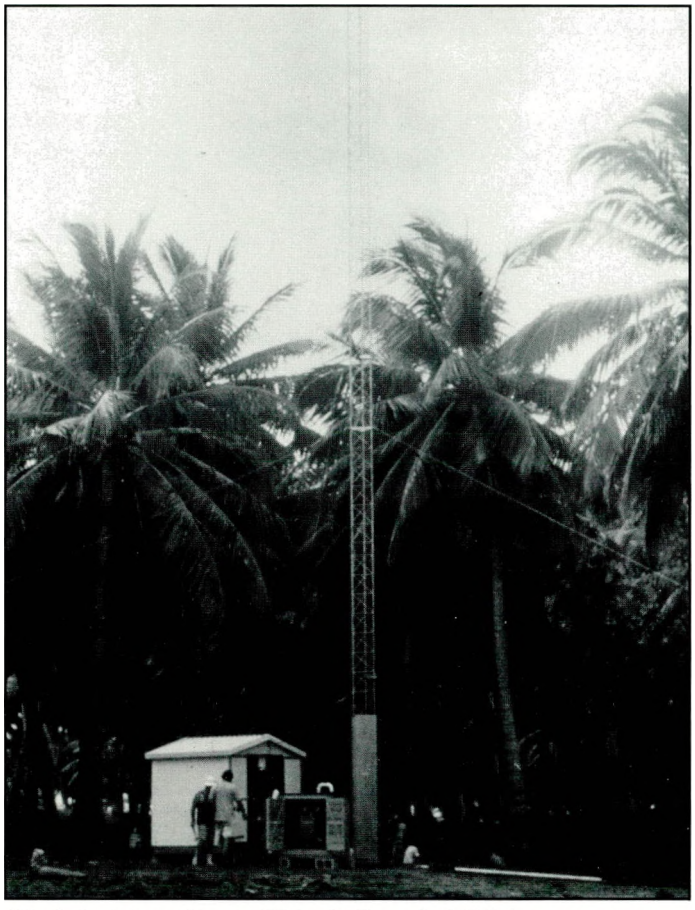
DESIGNER/SUPPLIER:
Ron Richmond
Solar Electric Company
Honolulu, Hawaii 96820

CONTACT:
Energy Coordinator
Republic of the Marshall Islands
Majuro, Marshall Islands 96960

COMMENTS: The Kili Municipal Council voted to spend part of their thermonuclear compensation money (Trust Fund) from the U.S. to provide some of their electricity by a series of photovoltaic systems. Mr. Richmond helped them design an overall system that is made up of seven smaller, independent systems. These systems produce electricity for the village school, the health clinic, the church, and ten low-pressure sodium street lights. Total combined peak power is 4300 watts. For example, the system for one street light includes two, 40 watt ARCO panels; two, 6 volt Trojan batteries connected in series; and power controlling equipment. Other appliances include interior and exterior lights, refrigerators, and ventilation fans. Part of the project included operation and maintenance training for two people from Kili. The people from Kili also purchased 30, 5000 watt gasoline generators to supplement the photovoltaic system and provide electricity for the 90 houses.

LITERATURE: Reference 284 describes the systems; references 280, 282, 285, 286, 287, 289, and 292 are some of the many that discuss other photovoltaic systems on the Marshall Islands.

PROJECT #86
WIND ELECTRIC MACHINE ON BIKINI ATOLL



(Wind electric machine at Bikini Atoll - early 1970's.)

LOCATION:
Bikini Atoll
Marshall Islands

COST: Unknown

FUNDING SOURCE:
U.S. Atomic Energy Commission

COMPLETION DATE: 1974

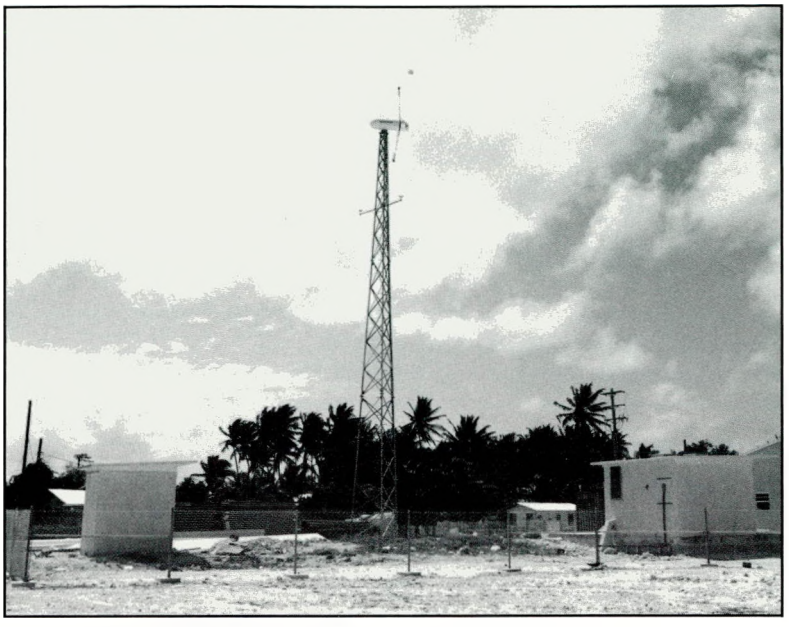
DESIGNER/SUPPLIER:
Unknown

CONTACT:
Energy Coordinator
Republic of the Marshall Islands
Majuro, Marshall Islands 96960

COMMENTS: This is another of the early energy projects for which it is difficult to find information. This wind electric machine was installed at Bikini Atoll in order to power some of the equipment being used for radiation tests in the early 1970's. The U.S. military originally used the tower for making radiation measurements of wind-carried particles during the thermonuclear tests. Manufacturer and fate of the wind machine is unknown.

LITERATURE: There is no known specific literature on this project. See references 320, 321, 322, 325, 326, and 327 for information on other wind systems and general wind data in the Marshall Islands.

PROJECT #87
WIND ELECTRIC MACHINE AT THE HOSPITAL



(EnerTech wind electric machine at the new hospital - 1986.)

LOCATION:
New hospital
Majuro Atoll, Marshall Islands

COST: $10,000

FUNDING SOURCE:
U.S. Department of Energy

COMPLETION DATE: 1983

DESIGNER/SUPPLIER:
Rockwell International
Rocky Flats Plant Energy Systems Group
Golden, Colorado 80401

EnerTech Wind Systems
P.O. Box 420
Norwich Vermont 05055

CONTACT:
Energy Coordinator
Republic of the Marshall Islands
Majuro, Marshall Islands 96960

COMMENTS: This is another of the joint effort wind electric projects with the U.S. Department of Energy and Rockwell International installing a series of wind electric machines throughout the Western Pacific. The program has not been very successful, and, with the exception of Yap, none of the machines are operating now. Problems include damage from corrosion and winds, lack of local training and community interest, lack of repair parts, erratic behavior caused by grid power fluctuations, and inadequate wind speeds. The project on Majuro was for installing a 1500 watt EnerTech grid-connected machine at the new hospital. Despite a number of obstacles, technicians from Rockwell International were able to erect the tower, install the machine, and provide some training to local workers. They left Majuro before the machine could be connected to the grid, and for unknown reasons it still remains unconnected. See Projects #6, #22, #57, #67, and #96 for information on the other wind projects.

LITERATURE: Reference 321 discusses this project; references 320, 322, 325, 326, and 327 discuss general wind data for the Marshall Islands.

PROJECT #88
SOUTH PACIFIC MOBILE TRAINING UNIT

(Photovoltaic demonstration system at the South Pacific Mobile Training Unit - Majuro Atoll - 1982.)

LOCATION:
Laura Island
Majuro Atoll, Marshall Islands

COST: Unknown

FUNDING SOURCE:
South Pacific Commission
P.O. Box D5
Noumea, New Caledonia

COMPLETION DATE: 1982

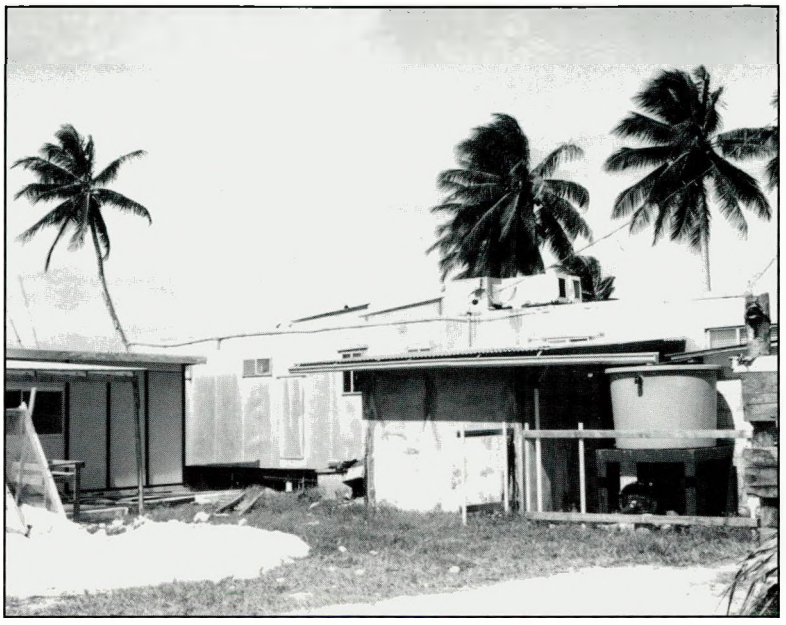
DESIGNER/SUPPLIER:
South Pacific Commission
Noumea, New Caledonia

CONTACT:
Energy Coordinator
Republic of the Marshall Islands
Majuro, Marshall Islands 96960

COMMENTS: In the early 1980's, the South Pacific Commission sponsored a school called the South Pacific Mobile Training Unit. (The School is not operating now.) This school traveled throughout the Pacific, and the staff instructed young adults from surrounding islands in various technologies appropriate for their localities. The school would stay in one place for a few months and then would move on to another island. In 1982, they ran a training session at the village, Laura Island, on Majuro Atoll. The students built and used a number of simple systems including a small photovoltaic system, a solar water heating system, and some wood cooking stoves. These systems worked successfully and were used for a few years after the school left. They have been dismantled now. See Project #37 for information on the school in Pohnpei.

LITERATURE: There are no references that specifically discuss this project. See references 86, 175, 176, 187, 189, 193, 196, and 205 for information on education and technology transfer.

PROJECT #89
PHOTOVOLTAIC SYSTEM ON A GOVERNMENT TRAILER



(The Solavolt panels are on the roof in the center of the photograph - 1986.)

LOCATION:
Government trailer
Majuro Atoll, Marshall Islands

COST: Unknown

FUNDING SOURCE:
U.S. Department of Energy
Energy Extension Service
Program

COMPLETION DATE: 1984

DESIGNER/SUPPLIER:
Solavolt International
P.O. Box 2934
Phoenix, Arizona 85062

CONTACT:
Energy Coordinator
Republic of the Marshall
Islands
Majuro, Marshall Islands 96960

COMMENTS: Originally, this photovoltaic system was to go to one of the outer islands to power an irrigation system for an agriculture project. Instead, it is providing electricity for a pump for a salt water toilet on a government trailer. The system includes 12 Solavolt panels mounted on the trailer roof and power controlling equipment.

LITERATURE: No references discuss this project specifically. References 280, 282, and 287 contain general discussions on photovoltaics; references 22, 82, 84, 85, 86, 284, 285, 286, 289, and 292 are some of the many that discuss energy policy and photovoltaics on the Marshall Islands.

PROJECT #90
SAIL-ASSIST FOR COMMERCIAL TRANSPORTATION

(The "Wetak II" out of the water for repairs to the hull - Majuro - 1986.)

LOCATION:
Enewetak Atoll
Marshall Islands

COST: $300,000

FUNDING SOURCE:
U.S. Department of Interior
Special Appropriation

COMPLETION DATE: 1983

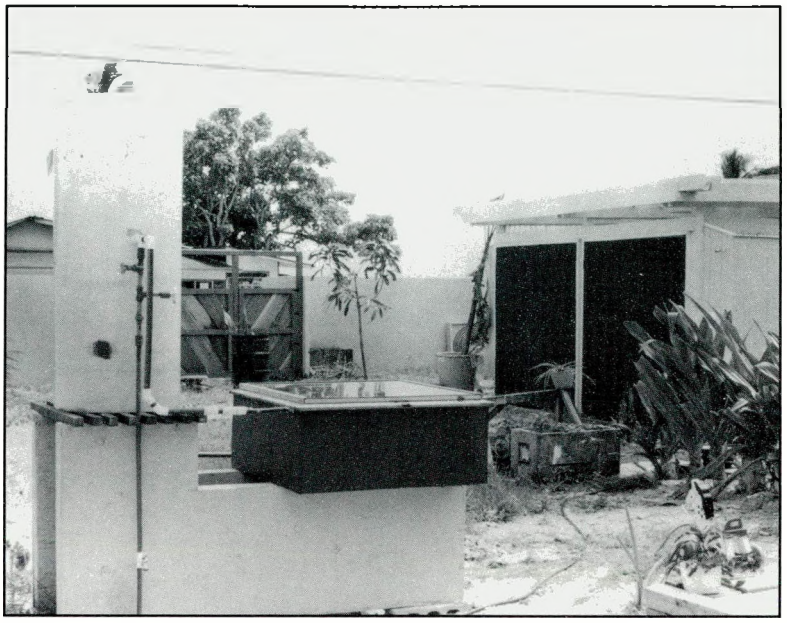
DESIGNER/SUPPLIER:
Glenn Fredholm, Skookum Marine, and BayCo Boat Works
Anacortes, Washington

CONTACT:
Energy Planner
Office of Capital Improvement Programs
P.O. Box 337 CHRB
Trust Territory of the Pacific Islands 96950

COMMENTS: Over the years, most of the people in the Western Pacific have switched from traditional sailing to modern boats and motors for fishing and transporting cargo and people. Lately, there has been considerable interest in using sails to assist motor-powered boats, particularly those scheduled, commercial boats traveling between the outer islands with cargo and people. The boat in this project, the "Wetak II" with Dan Quinn as captain, is the first boat built specifically to use sails as a significant part of its power. The ship is a motor sailer, relying mainly on a motor, and using the sails as auxiliary power. It holds nine people, including the crew of two, but it is used mostly to transport produce. The ship's home port is Enewetak, and it travels between nearby islands and Majuro. Generally, the project seems to be successful, and the sails do save fuel depending on wind speed and direction. Problems include wind direction and speed may not coincide with routes and schedules; there are cultural conflicts with navigating and limiting the number of people on the boat; and there is a minor problem now with the fiberglass hull.

LITERATURE: The captain sends monthly reports to the Trust Territory of the Pacific Islands; references 333, 336, 341, and 349 describe similar projects.

PROJECT #91
DOMESTIC SOLAR WATER HEATING DEMONSTRATION



(The inverted cone, solar water heating system including collector and storage tank - 1980)

LOCATION:
Private home
Majuro Atoll, Marshall Islands

COST: $7,000

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants program

COMPLETION DATE: 1980

DESIGNER/SUPPLIER:
W. Carlton Hawpe
45-249 Kenela St.
Kaneohe, Hawaii 96744

CONTACT:
Energy Coordinator
Republic of the Marshall
Islands
Majuro, Marshall Islands 96960

COMMENTS: The purpose of this project was to build and demonstrate a simple hot water heating system designed specifically for the tropics. The water was to circulate to a tank above the collector by natural convection and not depend on a pump with an outside power supply. The original collector was to have copper tubing in a flat coil to avoid soldering joints. However, the water did not circulate properly so Mr. Hawpe changed the design to have the tubing in an inverted cone configuration. The collector was built, attached to the hot water tank, and the entire system was connected to the water catchment tank. Mr. Hawpe rebuilt the system after a series of high tides destroyed it in 1979. Occupants of the house have changed a number of times over the last few years, but the system is still being used. Similar systems were not built on Majuro, probably because of the difficulty in forming the tube into the right shape. Mr. Hawpe sent the U.S. Department of Energy an excellent final report.

LITERATURE: Reference 305 is for the final report; references 2, 5, 6, 175, 191, and 192 discuss the project briefly.

PROJECT #92
SOLAR WATER HEATING FOR THE HOSPITAL

(Part of the solar water heating system on the roof of the new hospital - 1986.)

LOCATION:
New hospital
Majuro Atoll, Marshall Islands

COST: $9,800

FUNDING SOURCE:
U.S. Department of Energy
Technology Transfer and
Energy Extension Service
Programs

COMPLETION DATE: 1985

DESIGNER/SUPPLIER:
William Nagel
Capital Improvement Programs
Office
Majuro, Marshall Islands 96960

Paul McCleary
Ironwood Plumbing
P.O. Box 293
Kapoa, Hawaii 96746

CONTACT:
Energy Coordinator
Republic of the Marshall
Islands
Majuro, Marshall Islands 96960

COMMENTS: One important element of the construction work at the new hospital is to train and use local labor. The purpose of this project was use a skilled plumber and a licensed solar contractor to train five local technicians to size, install, and maintain commercial solar hot water systems. They have installed two systems at the hospital: the larger one includes six, 3 foot by 7 foot Grumman roof-mounted solar collectors connected to two, 120 gallon water tanks. A pump circulates the water. The system supplements the hot water for the hospital's exercise and rehabilitation facility. Another, smaller system supplements hot water for another of the medical facilities. The systems are installed, connected, and operating. The Republic of the Marshall Islands Office of Public Affairs has prepared a videotape on the installation to encourage information dissemination.

LITERATURE: The videotape describes the project in detail; reference 376 has a brief description; references 22, 82, 84, 85, and 86 discuss the Marshall Island's energy policy regarding solar water heating.

PROJECT #93
WIND WATER PUMPING FOR THE OUTER ISLANDS

(The pump house and Dempster windmill - Majuro - 1986.)

LOCATION:
Majuro Atoll
Marshall Islands

COST: $4,500

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants Program

COMPLETION DATE: 1983

DESIGNER/SUPPLIER:
Jim Abernathy
Department of Public Works
Republic of the Marshall
Islands
Majuro, Marshall Islands 96960

Dempster Systems, Inc.
Knoxville, Tennessee 37901

CONTACT:
Energy Coordinator
Republic of the Marshall
Islands
Majuro, Marshall Islands 96960

COMMENTS: Originally, this project was for the Department of Public Works to install one windmill on each of two outer islands for pumping water from shallow lense wells. Technicians from the Department were to develop a monitoring system to determine a pumping rate that would not deplete the lense of fresh water. By the time they received the grant money the equipment costs had increased so they could only purchase one machine. They installed the windmill on Majuro in order to test it, and the machine remains there today pumping water from a 10 foot deep lense to a city reservoir about 100 feet away. The system includes a pump house with an 18 foot tower on top, an 8 foot diameter Dempster windvane mounted on the tower, and a pump and shaft. They took extra precautions to prevent corrosion, and these precautions seem to have worked. Maintenance has been excellent, and the pumping rate has not been too great. In a 10 mph wind and with a 6 inch stroke the machine can pump about 8,000 gallons in 24 hours (about 5 gallons/minute).

LITERATURE: No reference discusses this project in detail. References 2, 175, 191, and 192 have brief discussions of the project.

PROJECT #94
WATER DESALINATION FOR EBEYE

LOCATION:
Ebeye Atoll
Marshall Islands

COST: $1,900,000

FUNDING SOURCE:
U.S. Department of Energy

COMPLETION DATE: 1987

DESIGNER/SUPPLIER:
SETS, Inc.
507 Varsity Building
1100 University Avenue
Honolulu, Hawaii 96826

Israel Desalination
Engineering, Inc.
Israel

CONTACT:
SETS, Inc.
507 Varsity Building
1100 University Avenue
Honolulu, Hawaii 96826

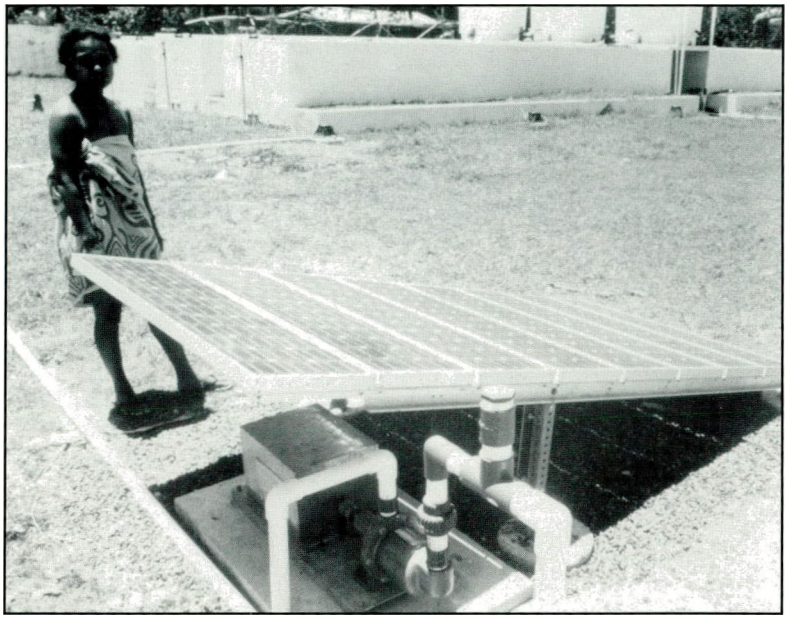
COMMENT: Maintaining adequate supplies of fresh water is a critical problem for many of the Pacific islands. For this project SETS, Inc., and Israel Desalination Engineering, Inc., are designing and installing a desalination system for Ebeye Atoll. The water supply problem is particularly severe for Ebeye, and this system should be the solution. The system will provide up to 300,000 gallons of fresh water per day by using waste heat from the new power plant to distill sea water in a series of stages. With the exception of power for the pumps, the system requires no additional energy. Such a system could be well-suited for other islands with new power plants and fresh water supply problems.

LITERATURE: No references discuss this project specifically yet. References 22, 82, 84, 85, and 86 discuss the Marshall Islands general policy toward water and energy development.

PART 9: REPUBLIC OF PALAU

Energy Program Manager
P.O. Box 100
Ministry of Natural Resources
Republic of Palau
Koror, Palau 96940

PROJECT #95
PHOTOVOLTAIC SYSTEM FOR AQUACULTURE



(ARCO photovoltaic panels and pump at the Micronesian Mariculture Demonstration Center - 1985.)

LOCATION:
Micronesian Mariculture
Demonstration Center
Koror, Palau

COST: $9,800

FUNDING SOURCE:
U.S. Department of Energy
Technology Transfer Program

COMPLETION DATE: 1985

DESIGNER/SUPPLIER:
Water & Energy Research Institute
University of Guam
UOG Station
Mangilao, Guam 96913

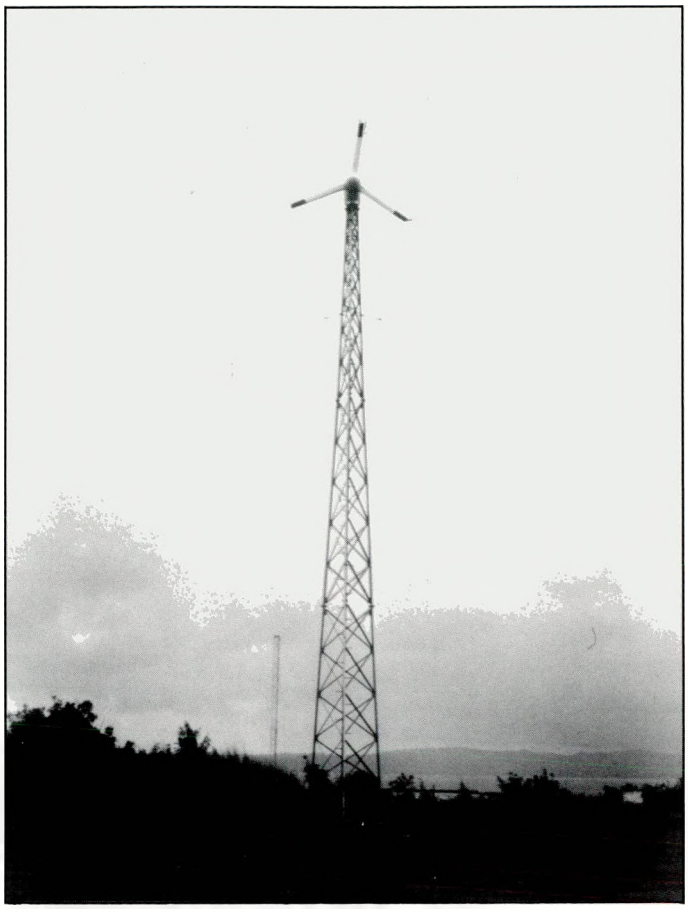
Tri Solar Corporation
Bedford, Maine 01730

CONTACT:
Pacific Fisheries Development
Foundation
Micronesian Mariculture
Demonstration Center
Koror, Palau 96940

COMMENTS: The Water & Energy Research Institute (WERI) installed this photovoltaic pumping system at the Micronesian Mariculture Demonstration Center in Palau. The system pumps sea water into a holding tank which distributes the water into hatchery tanks where species of giant clams are cultured. The major components of the sytem include eight ARCO photovoltaic modules Model M53, a Maximum Power Controller, a Robbins & Myers pump Model 35604, a Baldor Electric Company 3/4 horsepower DC motor, module support structures, and wiring and pipe. The system is functioning very well providing the hatchery tanks with the daily amount of seawater needed for the clams' photosynthesis process. An interesting match between energy source and end use is that the photovoltaic system provides the most power in the full sun and this is when the clams require the greatest water circulation.

LITERATURE: Reference 294 is an excellent final report; reference 376 offers a brief description; and references 295, 296, 297, and 298 describe other WERI projects.

PROJECT #96
WIND ELECTRIC MACHINE DEMONSTRATION



(EnerTech wind electric machine at Palau - 1985.)

LOCATION:
Koror, Palau

COST: $20,000

FUNDING SOURCE:
U.S. Department of Energy

COMPLETION DATE: 1982

DESIGNER/SUPPLIER:
Rockwell International
Rocky Flats Plant Energy
Systems Group
Golden, Colorado 80401

EnerTech Corporation
P.O. Box 420
Norwich, Vermont 05055

CONTACT:
Energy Program Manager
P.O. Box 100
Republic of Palau
Koror, Palau 96940

COMMENTS: This project is another in the series of wind projects from the U.S. Department of Energy and Rockwell International. See Projects #6, #22, #57, #67, and #87 for information on the others. There have been problems with all of these wind systems except for the one on Yap. These problems include lack of community support and technical expertise, lack of repair parts, corrosion damage, wind damage, insufficient wind speeds, and power fluctuations from the utility grid. This system includes a 1500 watt EnerTech down-wind turbine connected to the utility grid, a 60 foot Rohn tower, and an EnerTech control panel. Technicians from Rockwell International did a good job installing the machine, but power fluctuations from the utility grid caused the machine to operate erratically. The machine is no longer operating.

LITERATURE: Reference 321 discusses these wind projects in detail; references 22, 88, 89, 91, and 93 discuss Palau's energy policy and the wind electric potential.

PROJECT #97
GASIFIER DEMONSTRATION

LOCATION:
Babelthuap Island
Palau

COST: $25,000

FUNDING SOURCE:
U.S. Department of Energy
Energy Extension Service
Program

COMPLETION DATE: 1984

DESIGNER/SUPPLIER:
Hodam & Associates
North American Gasifier Co.
106 K Street, Suite #200
Sacramento, California 95814

CONTACT:
Energy Program Manager
P.O. Box 100
Republic of Palau
Koror, Palau 96940

COMMENTS: The Republic of Palau purchased a 15 kilowatt gasifier from North American Gasifier Co. to generate electricity from wood chips at the Nekken Forestry. The wood chips are partially combusted in the gasifier by controlling the air intake, yielding a combustible gas called producer gas. In turn, this gas is burned to power a generator for producing electricity. This is an established technology, but there have been problems with the gasifier to date. First, there are mechanical problems with the machine as a vacuum builds up in the gas line during operation causing a hose to collapse and the engine to shut down. Second, the gasifier must be loaded with wood chips every 30 minutes, and if the chips are damp or mixed with dirt the gasifier will not work properly. See Project #10 for a similar system from North American Gasifier that also has not worked as it should.

LITERATURE: There are no specific references for this project; see references 122, 123, and 125 for information on a similar system and references 22, 88, 89, 91, and 93 for discussions on Palau's energy policy.

PART 10: GENERAL - TRUST TERRITORY OF THE PACIFIC

Energy Planner
Office of Capital Improvement Programs
P.O. Box 337 CHRB
Trust Territory of the Pacific Islands
Saipan, Commonwealth of the Northern Mariana Islands
96950

PROJECT #98
PHOTOVOLTAIC SYSTEMS FOR ISLAND COMMUNICATION

(Part of the photovoltaic powered communication system - Palau - 1985.)

LOCATION:
Trust Territory of the
Pacific Islands

COST: $3,100 per system

FUNDING SOURCE:
Trust Territory of the Pacific Islands

COMPLETION DATE: Continuing

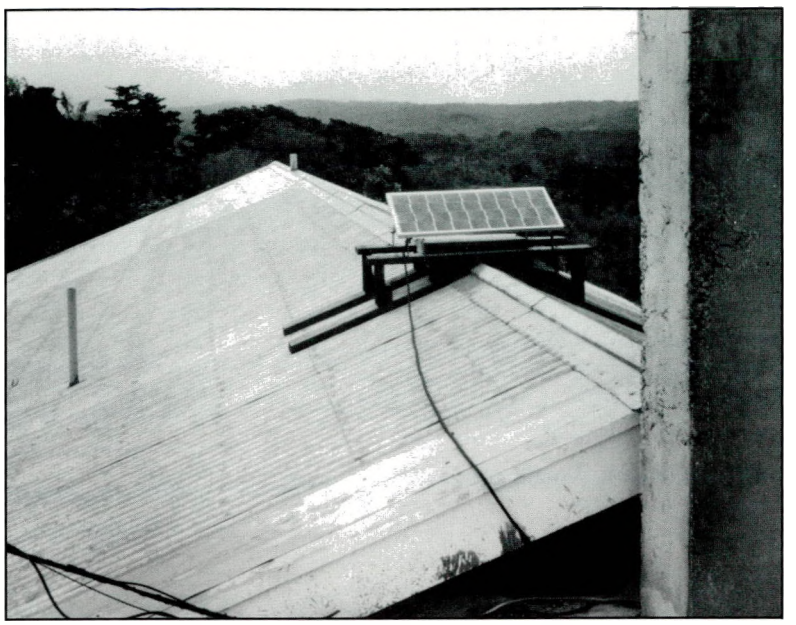
DESIGNER/SUPPLIER:
Solarex Corporation
1335 Piccard Drive
Rockville, Maryland 20850

CONTACT:
Energy Planner
Office of Capital Improvement
Programs
P.O. Box 337 CHRB
Trust Territory of the
Pacific Islands 96950

COMMENTS: Starting in 1980, the U.S. Department of the Interior through the Trust Territory of the Pacific Islands Communications Office has sponsored the installation of approximately 50 photovoltaic-powered communication systems for the outer islands throughout the Trust Territory. These systems are replacing small, conventional generators which usually have not been maintained properly. Each photovoltaic system consists of four Solarex 40 watt photovoltaic modules, two Willard DD-5-3 batteries, an ampmeter, and a module support structure. The Communications Office also distributed new Motorola SSB mobile/base radios. This is continuing project, and one that has been very successful with almost all of the units operating as expected.

LITERATURE: References 270, 271, 276, 280, 283, 287, and 291 are among the many that discuss similar projects.

PROJECT #99
PHOTOVOLTAIC LIGHTING AND REFRIGERATION



(Part of the photovoltaic refrigeration system at Aimeliik Elementary School, Palau - 1985.)

LOCATION:
Trust Territory of the
Pacific Islands

COST: $4,800 per system

FUNDING SOURCE:
U.S. Department of Energy
Energy Extension Service Program

U.S. Department of Housing
and Urban Development

COMPLETION DATE: 1982

DESIGNER/SUPPLIER:
Solavolt International
P.O. Box 2934
Phoenix, Arizona 85062

Polar Systems
Bel Air, California 90077

CONTACT:
Energy Planner
Office of Capital Improvement
Programs, P.O. Box 337 CHRB
Trust Territory of the
Pacific Islands 96950

COMMENTS: During the early 1980's, the U.S. Department of Energy and the U.S. Department of Housing and Urban Development sponsored the installation of 33 photovoltaic-powered refrigerator and lighting systems throughout the Trust Territory of the Pacific Islands. A typical system such as the one found at the Aimeliik Elementary School on Palau consists of seven, 40 watt Solavolt photovoltaic modules; six Delco 2000 sealed batteries; two Western Solar Refrigeration 12-1 refrigerators; a Specialty Concepts, Inc., voltage regulator; module supporting structure; and wiring harness. Of the two refrigerators installed here, one is presently in operation. The other refrigerator has failed for an unknown reason. Generally, the program has had only moderate success with many of the refrigators not working properly for a variety of reasons such as faulty equipment, improper design, and sizing errors. Solavolt has upgraded the systems in Palau by adding to each system two additional panels, new Trojan batteries, refrigerator fans, and freon. The systems are working better now, but there still is a high failure rate.

LITERATURE: See references 283, 287, 291, 292, and 299 for information on this and similar projects.

PROJECT #100
SMOKELESS STOVES

(A smokeless stove at an elementary school on Pohnpei - 1986.)

LOCATION:
Trust Territory of the
Pacific Islands

COST: $17,000

FUNDING SOURCE:
U.S. Department of Energy
Appropriate Energy
Technology Grants and
Technology Transfer Programs

COMPLETION DATE: 1985

DESIGNER/SUPPLIER:
Nancy Rody, formerly
Office of Food and Nutrition
Services
Trust Territory of the
Pacific Islands 96950

CONTACT:
Energy Planner
Office of Capital Improvement
Programs
P.O. Box 337 CHRB
Trust Territory of the
Pacific Islands 96950

COMMENTS: The smokeless stove project has been one of the most successful of the U.S. Department of Energy Pacific projects. The first part of the project occurred in 1979 when the Trust Territory Office of Food and Nutrition Services received a grant for $12,000 to build and demonstrate a smokeless stove. The stove is built of concrete and has a metal chimney. Smoke from the fire goes through the chimney out of the cooking area; holes in the top of the stove fit specific pots; and the design of the stove makes for efficient fuel consumption. The stove is healthier and more efficient than traditional ways of cooking and is particularly well-suited for schools where the principals appreciate their smokeless nature and energy efficiency. There have been a few cultural barriers discouraging the rapid switch from domestic, traditional cooking. Most of the original grant money along with a second grant for $5,000 has been used to train a few people to become experts, and they in turn have been teaching other people to build the stoves. See Appendix B for information on additional funding for this project.

LITERATURE: Reference 344 and 345 discuss the project in detail; references 2, 175, 191, 192, 346, 347, 348, and 376 discuss this and similar projects.

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SECTION III. APPENDICES AND INDEXES

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Appendix A: Additional Projects - U.S. Department of Energy Territorial Assistance Program - 1986

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PART 1: APPENDICES

APPENDIX A: ADDITIONAL PROJECTS -

U.S. DEPARTMENT OF ENERGY TERRITORIAL ASSISTANCE PROGRAM - 1986

The U.S. Department of Energy is sponsoring the following projects through their Territorial Assistance Program. Work is starting on these projects late in the calendar year, 1986, and should be complete in most cases by the end of 1987.

1) FOREST PLANTATIONS FOR FUELWOOD PRODUCTION
Location: American Samoa
Cost: $32,100
Comments: The purpose of this project is to determine the feasibility of using fuelwood plantations for fueling small gasifiers or steam boiler power plants. Three 4 to 5 acre experimental test plots — one each on a flat, coastal plain; a steep hillside; and an intermediate, level inland area — will determine growth rates for different species of trees using different fertilizing techniques. One feature of this project is the participation and cost-sharing by the U.S. Department of Agriculture Forestry Service and three agencies of the American Samoa Government: the Territorial Energy Office, the Department of Agriculture, and the Agriculture Experiment Station at the Community College.

2) BIOGAS DIGESTER AND PHOTOVOLTAIC AERATION FOR AN INTEGRATED FISHPOND
Location: Commonwealth of the Northern Mariana Islands
Cost: $44,500
Comments: This project continues the CNMI Energy Office's integrated digester plant and demonstration effort. Three new components will be added to a privately operated integrated farm and aquaculture system: 1) a photovoltaic-powered aeration system for providing sufficient oxygen for fish in an aquaculture pond; 2) an internal combustion engine fueled by scrubbed biogas from the digester; and 3) a system for recycling the digester effluent as irrigation water for agriculture.

3) PHOTOVOLTAIC-POWERED WATER PUMPING PROJECTS
Location: Federated States of Micronesia - Pohnpei and Truk States
Cost: $41,200
Comments: This project demonstrates the use of photovoltaic systems to power reliable pumps for potable water at eight remote locations in Pohnpei and Truk. Each of the systems will have a 3,000 gallon water storage tank provided from local cost-sharing. When the sun shines the systems will pump water into elevated storage tanks that in turn will distribute water for irrigation throughout the day and night by gravity feed. This is part of the continuing effort by local governments to provide low maintenance, reliable water supplies at remote locations.

4) PHOTOVOLTAIC LIGHTING FOR THE ADELUP GOVERNMENT COMPLEX
Location: Guam
Cost: $93,100
Comments: This project is for installing a photovoltaic lighting and battery storage system for the conference room, streets, and grounds at the Adelup Government Complex. The anticipated level of traffic to the Complex from people on Guam and from participants from throughout the Pacific attending functions at the Hafa Adai Conference Center will provide excellent exposure to this technology.

5) PHOTOVOLTAIC COMMUNICATION SYSTEMS FOR LOCAL MUNICIPALITIES
Location: Guam
Cost: $72,000
Comments: The purpose of this project is to provide emergency lighting and communication following typhoons and other disasters for 21 municipal centers on Guam. Each center will be equipped with a 25 watt Very High Frequency (VHF) commercial transceiver; four, 47 watt photovoltaic panels; and four deep-cycle (440 amp/hour) batteries. The Government of Guam will be providing additional funds for the project.

6) PHOTOVOLTAIC LIGHTING SYSTEMS FOR REMOTE VILLAGE COMMUNITY CENTERS
Location: Republic of the Marshall Islands
Cost: $81,700
Comments: This project is for installing small photovoltaic lighting systems at 31 remote locations on 21 separate islands. Each system will include a small photovoltaic array and battery system capable of powering two, 30 watt fluorescent lamps. An interesting feature includes hiring a local entrepreneur who will periodically visit each site in order to maintain and repair the systems. This person will be paid mostly by fees from users of the system.

7) RESIDENTIAL PHOTOVOLTAIC LIGHTING SYSTEMS FOR THE SOUTHWEST ISLANDS
Location: Republic of Palau
Cost: $50,700
Comments: This project is for providing stand-alone photovoltaic lighting systems for residences of the remote Southwest Islands. Each system includes three lights, one battery, and one photovoltaic panel. Approximately 50 systems will be installed on six islands.

APPENDIX B: ADDITIONAL PROJECTS -

U.S. DEPARTMENT OF ENERGY 1980 - 1983 CARRYOVER FUNDS FROM ENERGY EXTENSION

SERVICE AND STATE ENERGY CONSERVATION PLAN PROGRAMS

The following projects are being sponsored from carryover funds from the U.S. Department of Energy Energy Extension Service and State Energy Conservation Program Plan Funds for the Trust Territory of the Pacific Islands. Only the projects that include hardware development or demonstration are included here. Some of the projects have been completed and some are continuing.

1) OCCUPANT SENSORS FOR CONTROL OF GOVERNMENT AIR CONDITIONERS
Location: Federated States of Micronesia - Kosrae State
Cost: $6,000
Comments: This project is for installing automatic controls on 25 window air conditioners in the offices of the Kosrae State Government. These controls automatically sense when a room is unoccupied and turn off the air conditioners accordingly. Air conditioners are the most expensive appliance to operate on Kosrae, and these automatic controls should reduce their electrical consumption by one half.

2) OCCUPANT SENSORS FOR CONTROL OF GOVERNMENT LIGHTING
Location: Federated States of Micronesia - Kosrae State
Cost: $6,000
Comments: This project is a companion to the preceding one and is for installing automatic controls on lighting fixtures in 50 offices of the Kosrae State Government. As mentioned, these controls are able to sense when a room is unoccupied and will automatically turn off the lights. Savings of electricity for lighting will be less than for air conditioning but should still be considerable.

3) UPGRADING PHOTOVOLTAIC SYSTEMS FOR DISPENSARIES
Location: Federated States of Micronesia - Pohnpei State
Cost: $5,000
Comments: From experiences with photovoltaic systems for refrigeration, lighting, and fans on Pohnpei, it is apparent that the capacity of the systems needs to be increased in order for them to work properly. If the refrigerators were used for storing medicine only they would work as designed; however, they are cooling other things such as food, making them work harder and require more energy. This project will provide two additional Solavolt photovoltaic panels, a voltmeter, support structure, and eight batteries for improving the existing two systems on Pohnpei.

4) RETROFITTING POHNPEI HOSPITAL WITH SOLAR REFLECTIVE FILMS
Location: Federated States of Micronesia - Pohnpei State
Cost: $5,000
Comments: This project is for installing solar reflective film on 2100 square feet of windows at the Pohnpei State Hospital. The film will cover the east, west, and south facing windows that are exposed to the sun's radiation. This project should reduce air conditioning needs considerably. Work will be done by a private firm that wins the contract award.

5) MAND RIVER HYDROELECTRIC PROJECT
Location: Federated States of Micronesia - Pohnpei State - Mand River
Cost: $27,400
Comments: This money will be used to purchase material and build the penstock for the Mand River hydroelectric system that is currently being constructed. See Project #40.

6) ELECTRIC METERS FOR GOVERNMENT OFFICES
Location: Federated States of Micronesia - Pohnpei State
Cost: $5,000
Comments: Currently, most Pohnpei State Government offices do not have meters to measure electricity consumption. This makes it difficult to manage and conserve energy as individual offices cannot be held responsible for their own electricity consumption. This project is for the purchase and installation of such meters.

7) SMOKELESS STOVES
Location: Federated States of Micronesia - Truk State
Cost: $5,000
Comments: This is a continuation of the smokeless stove program described in Project #100. The Office of Food Services of Truk State will build approximately 20 smokeless stoves for schools located on islands around the Truk Lagoon. Work will be done by a team of technicians previously trained through the Office of Food Services by a grant from the U.S. Department of Energy Technology Transfer Program.

8) PHOTOVOLTAIC AGRICULTURAL WATER PUMPING SYSTEM
Location: Federated States of Micronesia - Truk State
Cost: $25,000
Comments: This project is for providing photovoltaic-powered water pumping equipment for irrigating farms on Fefan Island in the Truk Lagoon. The water, which will come from a central catchment system, will irrigate vegetables and other crops on approximately four farms on Fefan. This improvement of farm production is part of an effort by the Truk State Government to reduce their dependence on imported agricultural produce. See Projects #46 and #47 for similar systems photovoltaic pumping systems.

9) PHOTOVOLTAIC REFRIGERATION AND LIGHTING UPGRADE AND REPAIR
Location: Federated States of Micronesia - Yap State
Cost: $11,700
Comments: Photovoltaic refrigeration systems have been installed at outer island health dispensaries throughout Yap State. (See Projects #54, #55, and #99.) Most of them have not performed as expected, primarily because they are often used for storing things other than medicine, thereby requiring more energy. Also, some of the refrigerators have erratic thermostats; some do not have low voltage disconnects; and some have freon refrigerant leaks. For this project Solavolt will upgrade eight of the systems by installing additional photovoltaic modules, control hardware, and batteries.

10) METHANE DIGESTER
Location: Federated States of Micronesia - Yap State
Cost: $6,000
Comments: This project is for continuing the methane digester demonstration program by the Yap State Government started under Project #53.

11) REVOLVING FUND FOR VILLAGE HOUSEHOLD PHOTOVOLTAIC LIGHTING KITS
Location: Federated States of Micronesia - Yap State
Cost: $6,500
Comments: This project is to create a revolving fund for purchasing five photovoltaic lighting systems for households in remote villages of Yap. People can purchase these systems from the Yap Community Action Agency. The Agency in turn will use the money to purchase more systems for resale to the community.

12) INSTALLATION OF PHOTOVOLTAIC EQUIPMENT FOR OUTER ISLAND DISPENSARIES
Location: Republic of the Marshall Islands
Cost: $7,000
Comments: The purpose of this project is to expand and improve the existing outer island photovoltaic systems for health dispensaries by adding photovoltaic lighting systems to four of the dispensaries. Currently, these dispensaries do not have lighting. See Projects #80 and #81 for similar projects throughout the Marshall Islands.

13) SOLAR WATER HEATING FOR MACDONALD HOSPITAL
Location: Republic of Palau
Cost: $15,100
Comments: This project is for the procurement of funds to reimburse the Republic of Palau Ministry of National Resources for nine small solar water heating units they purchased for the MacDonald Hospital in 1984.

14) KAYANGEL PHOTOVOLTAIC PROJECT
Location: Republic of Palau
Cost: $57,000
Comments: This project is for installing a photovoltaic system to provide electricity on Kayangel atoll for 25 homes, a state office, a school, two meeting houses, and a dock. The residents of the atoll currently use kerosene for lighting. This project will also provide a pre-electrification survey, an assessment and evaluation of the system once installed, and maintenance and operation training for four Kayangel residents. The Republic of Palau will share some of the costs.

APPENDIX C: SOURCES FOR LITERATURE

No single collection contains all the literature shown in Section II. Literature. The individual Pacific energy offices have the reports for their geographic areas. Their addresses are shown at the start of each part in Section I. Projects. Other collections are found at:

East-West Center
1777 East-West Road
Honolulu, Hawaii 96848

Golden Gate Energy Center
Building 1055, Fort Cronkhite
Sausalito, California 94965

Micronesian Area Research Center
University of Guam
Mangilao, Guam 96923

Office of Capital Improvement Programs
P.O. Box 337 CHRB
Trust Territory of the Pacific Islands
Saipan, Commonwealth of the
Northern Mariana Islands 96950

United Nations Pacific Energy Development Programme
Private Bag
Suva, Fiji

U.S. Department of Energy - Pacific Site Office
P.O. Box 50168
Honolulu, Hawaii 96850

U.S. Department of Energy - San Francisco Operations Office
1333 Broadway
Oakland, California 94612

Water & Energy Research Institute
University of Guam
Mangilao, Guam 96913

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