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PROJECTS FROM FEDERAL REGION IX DEPARTMENT OF ENERGY APPROPRIATE ENERGY TECHNOLOGY PROGRAM PART II

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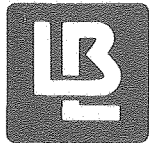
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Lawrence Berkeley Laboratory

UNIVERSITY OF CALIFORNIA

ENERGY & ENVIRONMENT DIVISION

PROJECTS FROM FEDERAL REGION IX
DEPARTMENT OF ENERGY APPROPRIATE ENERGY TECHNOLOGY PROGRAM
PART II

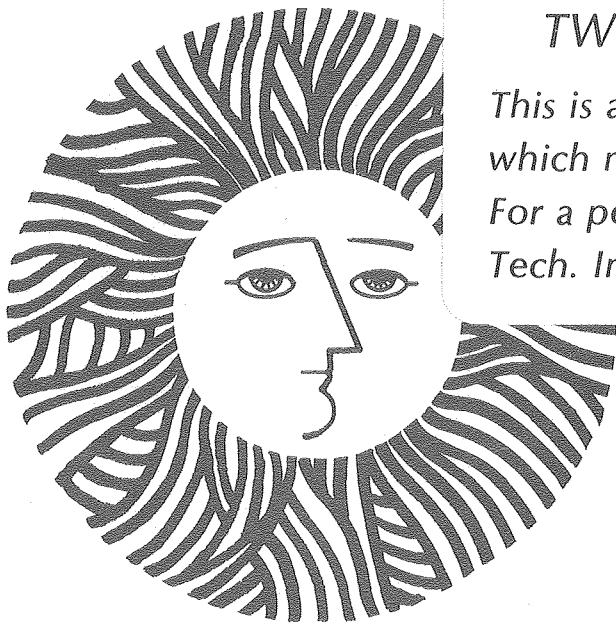
C. W. Case, H. R. Clark, J. Kay,
F. B. Lucarelli, and S. Rizer

January 1980

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PROJECTS FROM FEDERAL REGION IX
DEPARTMENT OF ENERGY APPROPRIATE ENERGY TECHNOLOGY PROGRAM
PART II

C. W. Case, H. R. Clark, J. Kay,
F. B. Lucarelli, and S. Rizer

January 1980

Prepared for the U.S. Department of Energy
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TABLE OF CONTENTS

Introduction	1
Projects:	
<u>Arizona</u>	
AZ-13. Solar Hot Water for the Prescott Adult Center	3
AZ-26. Solar Prototype House for a Residential Community	5
<u>California</u>	
CA-173. Solar AquaDome Demonstration Project	7
CA-208. Solar Powered Liquid Circulating Pump	9
CA-321. Appropriate Energy Technology Resource Center	11
CA-323. Digester for Wastewater Grown Aquatic Plants	13
CA-324. Performance Characteristics of an Anaerobic Wastewater Lagoon Primary Treatment System	15
CA-438. Appropriate Energy/Energy Conservation Demonstration Project	17
CA-496. Solar Energy For Composting Toilets	19
CA-682. Dry Creek Rancheria Solar Demonstration Project	21
CA-723. Demonstration For Energy Retrofit Analysis and Implementation	23
CA-790. Active Solar Space Heating System For the Integral Urban House	25
<u>Hawaii</u>	
HI-1. Java Plum Electric	27
HI-12. Low-Cost Pond Digesters For Hawaiian Pig Farm Energy Needs.	29
HI-22. Solar Beeswax Melter	31
HI-26. Methane Gas Plant For Operating Boilers and Generating Steam	33

Hawaii (Continued)

HI-57. Solar Water Heating in Sugarcane Seed Treatment Plants 35

Western Pacific

TT-9. Wind Powered Lighted Navigation Buoys 37

Appendices:

Appendix A - List of Projects Described in: Projects From Federal

Region IX DOE Appropriate Energy Technology Pilot

Program - Part I 41

Appendix B - Revised Description of: Biogas Energy for Hawaiian

Small Farms and Homesteads (Project Number: HI-11) 43

References 45

INTRODUCTION

This report is the second part of a six part series describing the 108 projects funded by the Department of Energy (DOE) Appropriate Energy Technology Pilot Program in Federal Region IX. The following is a brief introduction from Part I of the series, describing the history and philosophy of this Program.

In the spring of 1977 the Building and Community Systems Division of the Energy Research and Development Administration (now the Department of Energy), responding to the 1977 ERDA Authorization Act, instructed their San Francisco Operations Office (SAN) to establish a small grants pilot program for appropriate energy technology projects (AET) within Federal Region IX (Arizona, California, Hawaii, Nevada, and the western Pacific). Following program guidelines SAN made these grants available to small businesses, individuals, nonprofit organizations, public agencies, and Indian tribes to design, construct, and/or demonstrate small scale energy technologies which conserve depletable fossil fuel or which use renewable energy sources.

With \$500K to distribute in grants of up to \$50K SAN accepted applications from September to November, 1977. They received 1100 applications requesting \$21.3 million. After thorough technical/economic and peer reviews by a variety of state and university institutions and after receiving an additional \$750K from other DOE Divisions, SAN awarded 108 grants for \$1.25 million in April, 1978. The grants covered a complete spectrum of small scale energy technologies including solar active and passive systems, wind machines, biomass conversion systems, energy conservation devices, recycling methods, aquaculture and agriculture systems, hydroelectric devices, geothermal systems, and integrated methods.

In the spring of 1979, DOE created the Office of Small Scale Technologies, transferring the program administration to this new office. With a 1979 fiscal year budget of \$8.5 million the program has expanded into all ten federal regions. These regions have received over 10,000 applications requesting \$200 million and are just completing their review processes and awarding grants. Federal Region IX has offered a second program cycle during the winter of 1979, and after receiving another 1100 applications, they have distributed \$500K throughout the Region with 34 additional grants.

Some of the Region IX projects from the original cycle are either completed or nearing completion. A number of agencies including the Lawrence Berkeley Laboratory (LBL), the California Office of Appropriate Technology (OAT), the Hawaii Department of Planning and Economic Development, and the Trust Territory Office of Planning and Statistics are collecting economic and technical data from these projects. (Sources of data include quarterly reports from project managers, site visits, and direct communication with the project managers.) These data will be used for a variety of reports which will help DOE and other federal and state agencies determine the constituents of the program, analyze the direct and indirect energy savings of the projects, develop efficient and effective project reviewing and monitoring methods, and make changes in the program as the program progresses through various cycles throughout the country.

This report is the second of six reports which will synthesize the data which has been assembled so far from the 108 projects. The purpose of these reports is to assist DOE management in understanding the nature

of the projects, identifying constituents served by the program, quantifying energy impacts of the program, and clarifying objectives for later phases. Additionally, these documents will provide Congress and the public with easy-to-read reports which will acquaint them with a few of the general and technical accomplishments of the grants program.

To serve this purpose we have developed a descriptive format which will be used both for Region IX and nationally for all DOE/AET projects. For each project we are allowing a two page description including a diagram or picture. The description includes a simple entry for: project title and number; applicant name and address and applicant type; project type; amount of award; and project duration with date started and date completed. One or two paragraphs describe the project in general terms, and another paragraph gives brief technical details. A final section presents project results including details on direct and indirect energy savings. Also included are information on innovative features, regional or national demonstration possibilities, and aspects of the project which can be replicated elsewhere, either on a regional or national scale.

Project Title: SOLAR HOT WATER FOR THE PRESCOTT ADULT CENTER

Project Number: AZ-13

Applicant: Yavapai Council on Aging
Prescott, Arizona

Applicant Category:
Nonprofit Organization

Project Type: Installing and demonstrating a solar hot water heating system for an adult center.

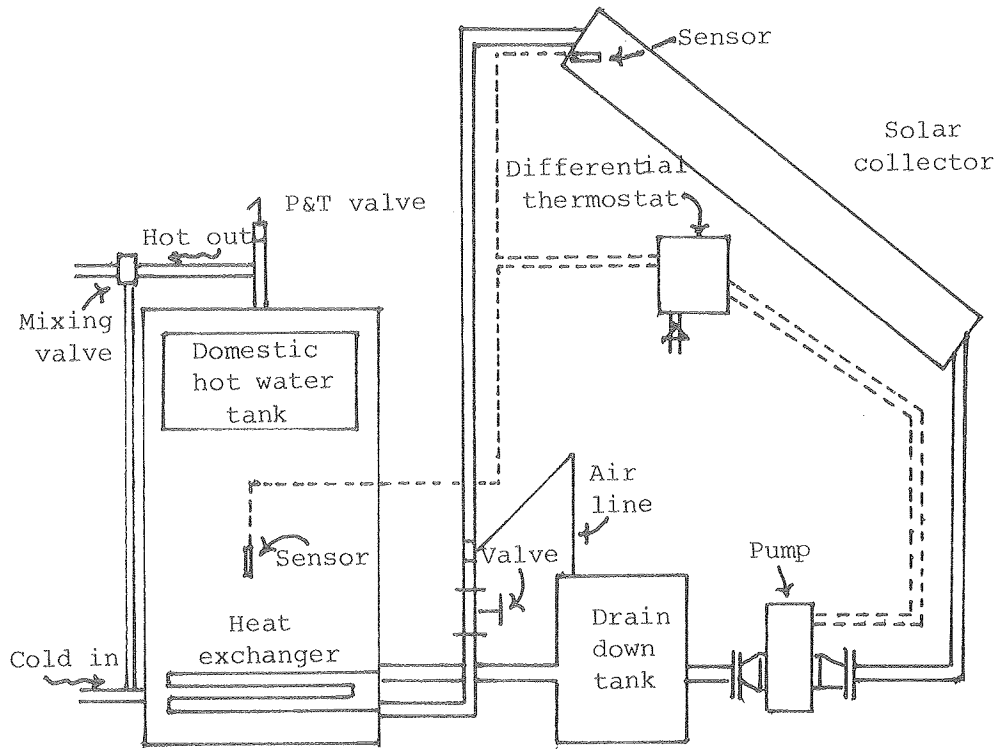
Award: \$1955

Project Term: 6 months (Project started May, 1978 - completed October, 1978)

Project Description:

• General: The Yavapai Council on Aging recently raised funds from community and city sources for constructing a home in Prescott for the Adult Center Club to provide various services for the elderly. These services include a variety of social activities and events as well as noon and occasionally evening meals. Construction of the building is finished, and now the Council is particularly concerned about operating costs, including the rising cost of energy. For this project DOE has awarded the Council a grant for installing and demonstrating a small solar hot water system. This project will substantially reduce the utility costs and will demonstrate the first nonresidential solar application in Prescott.

• Technical Details: The system is a closed loop heat exchanger system with standard plumbing fixtures and electrical wiring, an unusual gravity drain down phase, and two commercial flat plate collectors from Southwest Ener Tech, Series #376. Each collector includes 17 square feet of stainless steel absorber surface coated with selective black paint, 2" of fiberglass insulation and ½" of dead air space, parallel stainless steel tubes resistance roll welded to the absorber plate, and tempered glass with single glazing. The storage tank is an 80 gallon Ford domestic hot water tank. Electricity provides backup hot water heating.



XBL 802-8049

Schematic Diagram of the Solar Hot Water System

Project Results:

● **Energy Savings:** Based on F-Chart calculations (Lucarelli and others, 1979, p.32) the collector system will provide 8.9 million Btu of energy annually, or about 35% of the annual energy required for hot water at the Center. (The Center uses 100 gallons of hot water per day at 140^oF.) Annual electricity savings will be approximately 3.25 Mwh (11.1 million Btu). The collector should have a lifetime of 20 years, giving a lifetime energy savings of 65 Mwh (222 million Btu) of electricity.

● **Demonstration Potential:** Significant indirect energy savings can result by demonstrating this system to the Prescott community, which gave this Center broad support, and also to the 600 senior citizen members. DOE and the community should encourage the Center to implement a strong demonstration plan in order to receive the maximum energy savings impact from this project.

Project Title: SOLAR PROTOTYPE HOUSE FOR A RESIDENTIAL COMMUNITY

Project Number: AZ-26

Applicant: Mr. Mark Scanlon
Solar System Enterprises
Route #4
P.O. Box 90
Flagstaff, Arizona 86007

Applicant Category:
Small Business

Project Type: Building and demonstrating an integrated technology/energy efficient prototype house.

Award: \$40,770

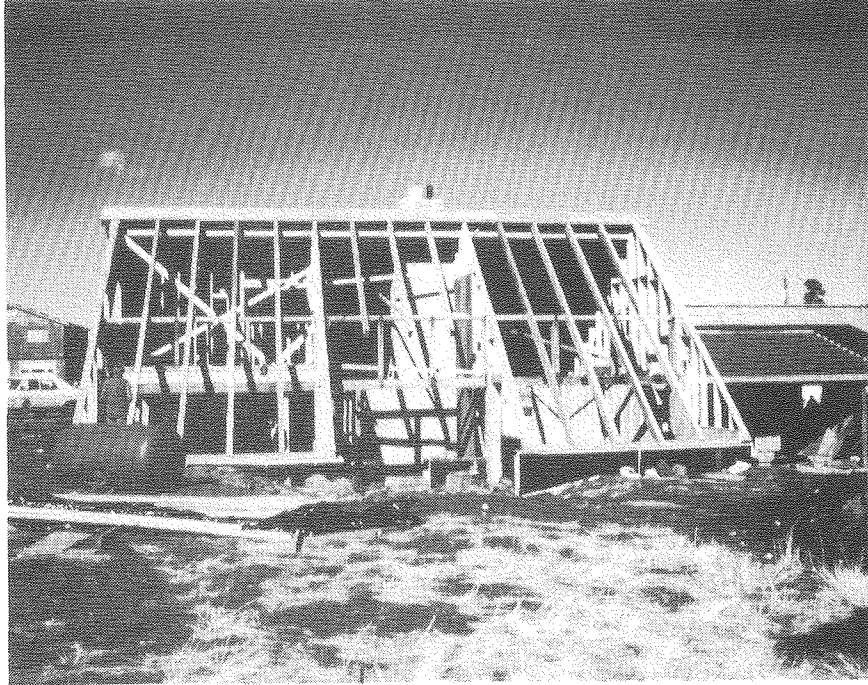
Project Term: 15 months (Project started June, 1978 - completed August, 1979)

Project Description:

● General: DOE awarded a grant to Mr. Scanlon of Solar System Enterprises for designing, constructing, and demonstrating an integrated technology/energy efficient prototype house for a planned 40 acre residential community. His small business designed the house, which has just been built, to have 90% of the space and hot water requirements met by active and passive solar systems and the remaining 10% supplied by wood heat. A complete list of alternative technologies incorporated within the house includes: passive solar heating and cooling with two greenhouses, underground construction, and earth berming; household water recycling; a water circulating fireplace and provision for a water circulating woodstove; active solar domestic hot water and space heating; and a composting toilet. All of these systems are operating now, and the house is open to the public for inspection. Solar System Enterprises is collecting data on the energy efficiency of the house.

● Technical Details: The passive construction includes a thermal mass of 600 square feet of black, cast-in-place, concrete floor tiles, a 200 square foot dark stone direct gain wall, underground construction with earth berming, two solar greenhouses with 560 square feet of glass, and a 340 square foot solarium. Grey water can be recycled to the greenhouses. A Hydroplace water circulating fireplace supplements the sub-slab active radiant heating system, and the builders have installed plumbing for a Hydrostove, water circulating wood stove. Both of these connect to the 300 gallon hot water storage heating tank. Two separate solar collector systems, each consisting of 72 square feet of Olin brass all copper tubes and absorbers, provide hot water for space heating and domestic use. The radiant system consists of 3/4" copper tubes spaced on 18" centers buried beneath the concrete slab and connected to the

storage tank. The toilet is a Mullbank composting toilet.



CBB 801-127

Prototype House During Construction

Project Results:

● Energy Savings: Lucarelli and others (1979, p.33) estimate the annual space and water heating load of the house to be about 77.2 million Btu/year (34% hot water load, 66% space heating load). Annual energy savings at the point of end use will then be about 24.5 Mwh (83.6 million Btu) assuming that the house would otherwise use electricity for space and water heating. Lifetime energy savings will be 635 Mwh (2.17 billion Btu) of electricity based upon a 20 year expected life of the active solar hot water system and a 30 year life for the passive solar components.

Project Title: SOLAR AQUADOME DEMONSTRATION PROJECT

Project Number: CA-173

Applicant: Applied Aquatic Resources Institute Applicant Category:
P.O. Box 29145 Small Business
Presidio of San Francisco
San Francisco, California 94129

Project Type: Designing, constructing, and testing two solar aquaculture systems.

Award: \$15440

Project Term: 18 months (Project started June, 1978)

Project Description:

● General: For this project the Applied Aquatic Resources Institute has completed construction of a small prototype Solar AquaDome aquaculture system and is now building two full-sized AquaDomes with slightly different features for testing purposes. A Solar AquaDome is a closed-cycle, self-contained, aquaculture unit using solar energy for heating water and producing natural foods. The system uses a filter of plastic fixed film substrates for attaching bacterial and detritivore communities. These communities serve as part of the water reconditioning system, consuming, metabolizing, and ultimately incorporating the waste materials from the cultured fish. This process cleanses the water of these pollutants and converts the pollutants into a form that can be fed back to the cultured fish or passed along the food web. The Institute has constructed and is testing a small 12' diameter AquaDome unit, has just finished constructing one full sized 27' diameter unit inside an existing unit, and will monitor both of these systems with a variety of biological and chemical measurements and tests. The Institute calculates that an acre of multiple commercial units can produce up to 180,000 pounds of inexpensive polycultured fish and shrimp per year. The backyard farmer can build smaller systems.

● Technical Details: These are the specifications of the 12' and 27' diameter systems.

	<u>12' Unit</u>	<u>27' Unit</u>
Diameter	12'	27'
Depth	26"	42"
Total Volume	2000 gal. (245 ft ³)	15,000 gal. (2004 ft ³)
Center Volume	400 gal.	5000 gal.
Initial Bio-weight	42.5 lbs.	152.5 lbs.
Final Bio-weight	127.5 lbs.	1000-2000 lbs.
Initial Density	0.17 lbs/ft ³	0.08 lbs/ft ³
Final Density	0.52 lbs/ft ³	0.5-1.0 lbs/ft ³

● Construction details of AquaDome #1 include:

Site preparation: Ground filling and laying a foundation of concrete pavers;

Main Pool: Installing a pre-fabricated 27' aluminum walled pool covered with a PVC framed, polyethelene dome;

Center Filter: Installing a 15' diameter center filter, ring of lifts, bio-web interior substrates, and circulation system;

Sprayers: Installing a fine-mist, automatic spraying system.

Project Title: SOLAR POWERED LIQUID CIRCULATING PUMP

Project Number: CA-208

Applicant: Dr. Alfred L. Johnson
504 Strand
Manhattan Beach, California 90266

Applicant Category:
Small Business

Project Type: Designing, constructing, and testing a solar powered liquid circulating pump for solar hot water systems.

Award: \$8971

Project Term: 18 months (Project started June, 1978)

Project Description:

● General: With this DOE grant Dr. Johnson is designing, constructing, and testing a prototype solar powered liquid circulating pump for solar hydronic heating systems. Liquid piston engines are usually simple, rugged, low-cost, low-thermal efficiency devices, but Dr. Johnson is designing a pump which uses dissipated thermal energy to heat the circulating fluid, thereby improving the efficiency of the engine. In addition, controls may be eliminated as the pump will operate only when solar energy is available and will circulate the fluid at a higher flow rate during increasing incident solar energy. Dr. Johnson's design is an adaption of the Savery steam powered pump, a precursor to the early Newton and Watt steam engines. The thermodynamic efficiency is about 5%, but this value is acceptable because the heat powering the pump is rejected to the liquid leaving the pump.

● Technical Details: The pump will circulate approximately 10.5 gallons per minute with a pressure rise of 9.8 feet at maximum heat absorption. This performance is equivalent to the typical circulator used in solar hydronic heating systems. Assuming 5% thermodynamic efficiency for the pump, 35% efficiency for the solar absorber, and 84 watts per square foot normal incident solar energy, an absorber will need an area of 14.5 square feet to supply heat to power the pump. The absorber can be either an insulated flat plate with dual glazing and spectrally selective coating on the heat pipe coupled surface or a concentrating type with passive optical or thermally powered tracking. Dr. Johnson is evaluating these systems for optimum design, and within the next few months he will build and test a prototype pump.

The system operates in this manner. An insulated heat conducting rod (heat pipe) conducts heat from an absorber into the steam chamber and cylindrical boiling tube. Heat transfers to the small volume of water within the cylindrical boiling tube; steam evolves; and the pressure within the entire tank increases. As the pressure increases, water flows through

the outlet check, and the steam/water interface within the insulated inner tank moves toward the bottom. When the steam/water interface reaches the bottom of the siphon, the column of water in the vertical riser of the siphon vents, allowing the steam to escape. This action causes the steam/water interface to move toward the top of the inner insulating tank as the water displaces the steam. The steam bubbling upward through the large mass of cool water cools; the pressure reduces further until the pressure within the tank is lower than that of the reservoir; and then water flows in through the inlet check valve. Due to the condensation of the steam, the bubbles that were exhausted collapse and the entire tank fills with water. Heat conducting from the solar absorber causes steam to evolve again within the inner insulated tank; the steam/water interface occurs again; the inlet check closes; the outlet check opens; and the water forces out as steam until the cycle repeats.

Project Title: APPROPRIATE ENERGY TECHNOLOGY RESOURCE CENTER

Applicant: Northcoast Center for Policy Studies Applicant Category:
c/o Dr. Robert G. White Nonprofit Organization
Political Science Department
Humboldt State University
Arcata, California 95521

Project Type: Establishing a local appropriate energy technology resource center and library.

Award: \$2500

Project Term: 12 months (Project started June, 1978 - completed June, 1979)

Project Description:

● General: This DOE grant is for establishing the nucleus of the Northcoast Center for Policy Studies appropriate energy technology resource center and library. The purpose of this project is to demonstrate that a local center, if thoughtfully set up and organized, can be an important tool for encouraging, fostering, and demonstrating locally small scale alternative energy technologies. In central Arcata this center occupies a comfortable, well-lit room in a building shared with Net Energy, a local well established nonprofit solar energy organization. The center will concentrate on wind, wood, biomass, and low-head hydroelectric technologies. Therefore, occupying space with a solar oriented organization with similar objectives will be complementary, not only in developing technologies, but also in sharing staff and facilities. The center is using the grant for purchasing 140 books and periodicals which are the nucleus of the library, for paying administrative costs (this amount was tripled in matching funds by Humboldt State University), for cataloging books, and for staffing the library during the summer and fall. The books are non-circulating, and the room is set up to make use of the materials in a helpful and convenient fashion. There is always a staff person present to answer questions and offer information and assistance. The center has printed a brochure as part of the grant, and this brochure is being circulated throughout the community advertising the library. They are also sending out a user questionnaire for evaluating the present library collection and resource center and for determining future needs. The center now hopes to obtain continuing community support for expanding and for establishing firm ties with other organizations such as Net Energy.

Project Results:

● Demonstration Potential: We are finding that these types of projects,

involving information dissemination and often including workshops, are some of the most successful grants. Usually there is considerable community interest and support, and matching funds often appear. One problem is to publicize the library or project, and the Center appears to have solved this problem by using a central location, publishing brochures and questionnaires, and establishing ties with a well organized complementary organization. For this project a small amount of money has been spent for the nucleus of a well publicized and organized AET community center, and this project should result in considerable long range indirect energy savings.

Project Title: METHANE GENERATOR FOR WASTEWATER GROWN AQUATIC PLANTS

Applicant: Solar AquaSystems, Inc.
P.O. Box 88
Encinitas, California 92024

Applicant Category:
Small Business

Project Type: Developing and demonstrating a continuous process for generating methane from wastewater grown aquatic plants.

Award: \$7534

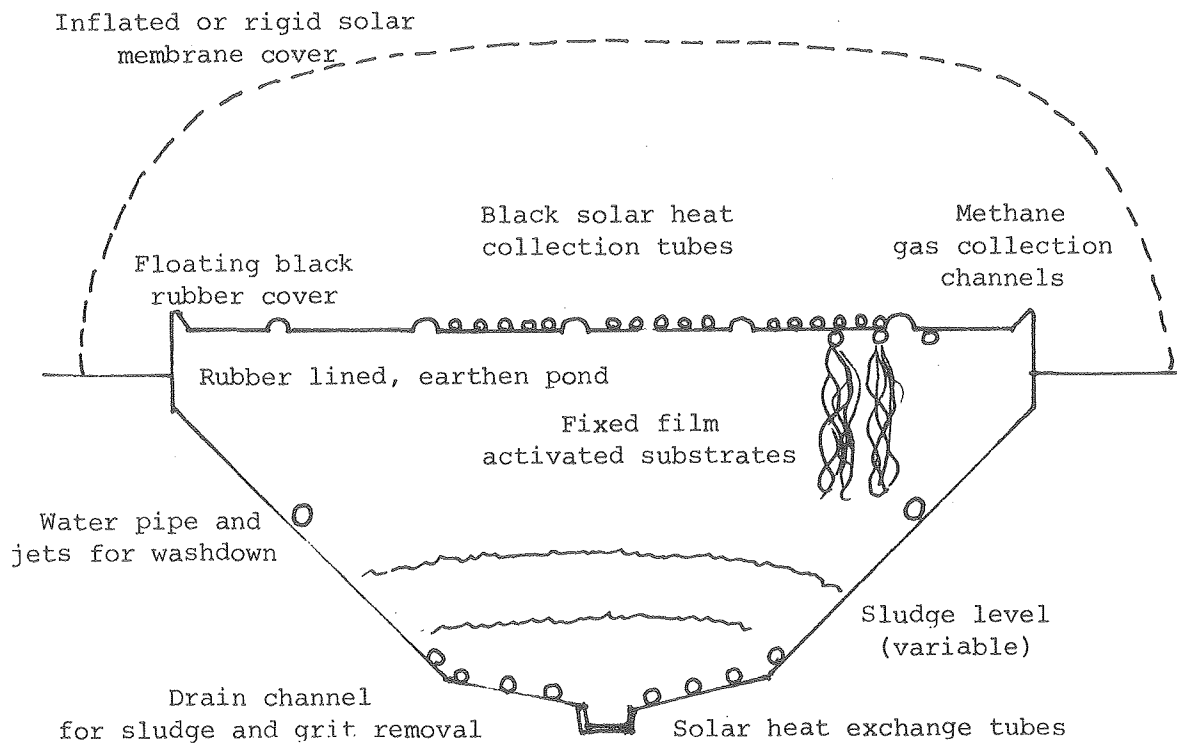
Project Term: 18 months (Project started June, 1978)

Project Description:

● General: DOE awarded Solar AquaSystems two grants for complementary projects: Project CA-324 is for helping develop a solar heated anaerobic wastewater treatment system, and this project, CA-323, is for developing a process for generating methane gas from the biomass conversion of water hyacinths and other aquatic plants. This methane could partially offset some of the energy requirements of the wastewater treatment system.

Water hyacinths and other aquatic species are drawing increasing attention for treating wastewater, and one proposed solution to the biomass accumulation of these plants is digesting them anaerobically for methane gas, followed by drying for compost fertilizer. Several investigators have used water hyacinths as an anaerobic feed stock for gas production in a batch digester system, but no one has developed a continuous flow digesting system. For this project Solar AquaSystems has built and is testing such a continuous flow system.

● Technical Details: A continuous feed, hypalon-enclosed digester is fed with water hyacinths produced by the 2000 gal/day demonstration wastewater facility (20 to 40 lbs/day net weight) at Cardiff, California. The digester consists of a trench trapezoidal in cross sectional area, approximately 8 feet long, 3 feet wide at the top, and 3 feet deep. The trench is lined with hypalon and covered with a hypalon top, producing a bag seal at the edges. For enhancing methane production biological substrate (Activated Bio-Web Substrates) for retaining methagenic bacteria are incorporated into the hypalon cover along with heating pipes from a solar heating device. For optimizing heat retention a greenhouse encloses the entire digester. For determining optimal operating methods Solar AquaSystems will perform a variety of tests, subjecting the system to different environmental conditions, loading rates, and detention times. They will evaluate percentage methane and quality of gas.



XBL 802-8050

Schematic Diagram of the Methane Generator

Project Results:

● **Energy Savings:** Solar AquaSystems estimates the methane production level of the digester at 5.35 cubic ft/lb of water hyacinth (dry). The energy required for harvesting and chopping the plants is about 15% of the total amount produced. Based on an assumed plant use factor of 0.8, Lucarelli and others (1979) estimate a net annual energy production of 2.3 million Btu of gas.

Project Title: PERFORMANCE CHARACTERISTICS OF AN ANAEROBIC WASTEWATER LAGOON PRIMARY TREATMENT SYSTEM

Project Number: CA-324

Applicant: Solar AquaSystems, Inc.
P.O. Box 88
Encinitas, California 92024

Applicant Category:
Small Business

Project Type: Constructing, evaluating, and demonstrating anaerobic primary treatment for an aquaculture wastewater treatment system.

Award: \$7935

Project Term: 12 months (Project started June, 1978 - completed June, 1979)

Project Description:

● General: DOE awarded Solar AquaSystems two grants for complementary projects: This project is for helping develop a solar heated anaerobic wastewater treatment system, and project CA-323 is for developing a continuous process for generating methane gas from aquatic plants used for treating wastewater. (The methane gas partially offsets some of the energy required for the treatment system.) In conjunction with these two grants, Solar AquaSystems has developed an alternative wastewater treatment system combining the best features of algae lagoon systems (low operation and maintenance costs, low energy needs, high dilution factors, and toxin removal capabilities) with the best of conventional high technology systems (reduced land requirements, greater process control, and advanced treatment capability). This system produces a high flow-rate, controlled environment aquaculture process called the Solar AquaCell System.

The total process integrates these major elements: 1) the basic multi-cell lagoon process; 2) floating aquatic macrophytes, particularly water hyacinths and duckweeds; 3) greenhouse covered ponds for providing insulation and for warming the water; 4) high surface area fixed-film substrates (Activated Bio-Web Substrates) for providing a habitat for the bio-flow and associated invertebrate detritivore community; and 5) a dual aeration and solar heat exchange system for maintaining proper dissolved oxygen concentration, transferring solar heat to the water in order to increase metabolic rates, and providing gentle stirring and partial mixing of the wastewater past the aquatic plant surface area and the Bio-Web Substrates.

This grants deals with the anaerobic primary portion of a demonstration facility in Cardiff, California, consisting of two anaerobic lagoon type cells in series. These cells act as sedimentation basins for settling and digesting raw sewage and for producing methane gas.

- Technical Details: Rubber lines the two anaerobic cells, and each cell has a floating rubber cover for collecting methane gas and controlling odor. The first cell (1190 gallons) acts as a sedimentation basin but with upflow percolation through a sludge layer. The second pond (2380 gallons) contains vertically hanging Bio-Web Substrates to which micro-organisms adhere. This bioweb serves the same purpose as packing material in conventional trickling filters for secondary water treatment.

Project Results:

- Energy Savings: According to Solar AquaSystems experimental data from the anaerobic primary lagoon system shows a savings of 13,000 kwh per year over conventional primary treatment and 53,000 kwh per year over conventional secondary treatment (Lucarelli and others, 1979, p.38). (These savings are for a one million gallon per day facility.) In addition to the energy savings of the system, the anaerobic lagoon also produces 6.84 million cubic feet/year of methane. Assuming a plant capacity factor of .85, the system produces about 5.82 billion Btu of gas annually. According to Lucarelli and others (1979, p.39) total direct energy savings from this project are 76 Mwh (259.4 million Btu) of electricity and 5.82 billion Btu of natural gas annually. The system should have a 20 year life, which will result in a lifetime energy savings of 1520 Mwh (5.8 billion Btu) of electricity and 116.3 billion Btu of natural gas.

- Indirect Energy Savings: This anaerobic lagoon system can have applicability throughout California and nationally. For the city of Hercules Solar AquaSystems is constructing a similar treatment system with a 2 million gallon/day capacity (MGD). This plant will be completed by late fall. The firm is also negotiating a second contract with the city of San Diego. Lucarelli and others (1979, p.65) have estimated total indirect energy savings based on a conservative estimate of a one million gallon/day system being funded and installed somewhere in California each year for a five year period. These five plants would offer annual indirect energy savings of 30.4 billion Btu.

Project Title: APPROPRIATE ENERGY/ENERGY CONSERVATION DEMONSTRATION PROJECT

Project Number: CA-438

Applicant: Shasta County Community Action Agency Applicant Category:
1535 Oregon Street, Suite B Nonprofit Organization
Redding, California 96001

Project Type: Demonstrating energy conservation and appropriate energy technologies through a community action agency.

Award: \$3100

Project Term: 16 months (Project started June, 1978 - completed Sept., 1979)

Project Description:

● General: Self-Help Home Improvement Project, Inc., a delegate of the Shasta County Community Action Agency, provides home repair and weatherization services mostly for low income families residing in Shasta, Siskiyou, Trinity, and Tehama Counties in California. Self-Help is using this DOE grant to provide education and assistance in energy conservation and appropriate energy technologies to these families.

They converted some of their own office into a demonstration project, including retrofitting with insulation and low energy lighting, adding a greenhouse for both heat and food, and installing a solar water pre-heater. Additionally, they have published pamphlets and diagrams explaining construction methods in conjunction with their ¼ scale cutaway appropriate energy technology module.

● Technical Details: Self-Help tore down their 23' x 22' building to the open frame, removed the electric heating, and installed duct work, R-19 blanket insulation, and energy saving fluorescent lighting. They reframed their windows and installed removable vinyl storm windows and 5/8" sheetrock. Over the concrete slab floor, they placed a fiber pad and indoor/outdoor carpeting, significantly improving the floor insulation.

An inexpensive 8' x 20' cocoon greenhouse with a 75° sloping south-wall produces food and circulates heat into the office through removable corrugated fiberglass panels and vents. (This is the only source of space heating.) Seams are caulked and the interior covered with 8 mil clear vinyl. (This greenhouse is described in The Heat and Food Producing Greenhouse by R. Fisher and B. Yanda, 1976, John Muir Publications, Inc., Santa Fe, New Mexico. Self-Help made certain changes in

the construction because of material problems.)

The solar water heater is a small on-site constructed system with 56 square feet of solar panel raising the average water temperature to 125° F. The existing electric water heater system provides storage and backup heating. The ¼ scale home training module has been supplied with pamphlets and outfitted with explanatory mockups and examples of the retrofit project and other solar devices.

Project Results:

● Demonstration: Self-Help has publicized this project widely through local newspapers, radio, and TV coverage. They are also providing open houses, lectures, and tours for schools, service clubs, churches, and other public groups. In addition, they recommend that their client families (last year about 225) attend these sessions.

Project Title: SOLAR ENERGY FOR COMPOSTING TOILETS

Project Number: CA-496

Applicant: The Farallones Institute/Rural Center
c/o Mr. Max L. Kroschel
15290 Coleman Valley Road
Occidental, California 95465

Applicant Category:
Nonprofit Organization

Project Type: Constructing and demonstrating various solar assisted composting toilets and pasteurizers.

Award: \$10,000

Project Term: 18 months (Project started June, 1978)

Project Description:

● General: This project is for constructing, operating, and testing a variety of composting toilets including a solar assisted Clivus Multrum, a Toa Throne, two solar assisted owner-built (OBM) composting toilets, and two solar pasteurizing units. The Farallones Institute is seeking an ecologically sound, safe, efficient, waterless disposal system for use anywhere, especially on land unsuitable for cesspools.

● Technical Details: The Clivus Multrum is in a direct gain south side enclosure with black painted surfaces, double glazed door, insulation, and an insulated curtain for preventing heat loss at night. The Toa Throne is in a free standing insulated enclosure with a flat plate hot air collector and rock storage for space heating. The OBMs have stud walls insulated with 4" glass wool and lined on the interior with ½" masonite with fiberglass resin coating. False bottoms of 2x4 redwood slats with ½" gaps at a 30° slope provide ventilation from below. A flat black, Hexcell, aluminum flat-plate hot air collector system heats the incoming air. There is sump drainage and recirculation of the liquid. All toilets have insulated exhaust vents and wind turbine tops. One OBM is included in a solar bathroom with a grey water treatment filter and an irrigation distribution system. Two solar pasteurizers are designed to heat 55 gallon drums of human excrement up to 140°F. Different mixes for comparison purposes will use sawdust, wood ashes, chopped straw, grass clippings, and bentonite. To test the process, a drum will be inoculated with hookworm and roundworm ova. The temperatures at important points in all systems will be monitored using thermocouples with hourly temperatures recorded by a multi-log data recorder.



CBB 801-125

The Toa Throne Building with Collector System in Foreground

Project Results:

● Test Conclusions: The Institute is testing the OBM composting toilet #1, and these are the results. The solar air heater greatly enhances the performance of the toilet. Compost temperatures under the seat (the freshest material and directly in line with the collector) average above 100° F even on cloudy mornings. Ambient temperature of the aging compost chamber averages 75° F as does the temperature of the aging compost. This is 15° - 20° F above average for the Toa Throne. Liquid buildup is still a problem. However, the unit is overloaded to double its design capacity (avg. 150 uses/week versus 70 uses/week design loading). Reduction of loading will be possible by adding low-water toilets for visitors and an additional drum privy for short-term workshop residents. The solar bathhouse privy should also divert a portion of present loading (Quarterly Report, 1979, Farallones Institute).

Project Title: DRY CREEK RANCHERIA SOLAR DEMONSTRATION PROJECT

Project Number: CA-682

Applicant: Dry Creek Rancheria
c/o Ms. Cynthia Smith
Highway 128
Geyserville, California 95441

Applicant Category:
Indian Tribe

Project Type: Retrofitting a community tribal building and installing a solar heating system for demonstration.

Award: \$10,980

Project Term: 6 months (Project started June, 1978 - completed Nov., 1978)

Project Description:

● General: The goals of this project were to install an active space heating system in the tribal community building at the Dry Creek Rancheria, train tribal members to install solar systems, establish a tribal information center for alternative technologies, and conduct a workshop for constructing breadbox solar hot water heaters. Originally the tribe retrofitted the double trailer community building for installing a passive solar heating system, but because of soil instability they could not build this system. Instead they have installed a water-to-forced-air active solar heating system, added insulation and other weatherization features, remodeled the floor, added new heating duct work, and equipped the system with monitoring devices. Tribal members, with help from Sonoma State College students, did all the work. The project includes conducting a local workshop for constructing breadbox solar hot water units. Also, the tribal information center is issuing a pamphlet for Native American communities describing this project and others which use alternative energy methods.

● Technical Details: Eight aluminum 4' x 10' collectors, constructed on-site and mounted alongside the building, have a total collector surface of 325 square feet, fiberglass glazing, copper tube absorbers, and 1" Thermex insulation (R-8). The collector frames are extruded aluminum and have aluminum sheet backplates. Storage is an 800 gallon water tank, storing to 180° F with a shut off valve preventing higher heat because of manufacturing limitations. The system is drain-down and the backup energy source is propane, which (as a primary source) costs \$100 - \$150 per month in the winter. The 14 foot head pump has an auxiliary pump to help the water reach the collectors at first and which shuts off once the system is working. The heat exchanger converts hot water to forced air.



CBB 801-119

Building the Collector System

Project Results:

- **Energy Savings and Demonstration Potential:** The direct and indirect energy savings from projects such as this can be considerable. This small project has provided temporary jobs for tribal members, trained them to install solar units-which they hope to do throughout this Native American community, demonstrated solar space heating at a central community site, encouraged the beginning of an energy information center, disseminated solar information to a large group of people, and provided a solar bread-box workshop.

Project Title: DEMONSTRATION FOR ENERGY RETROFIT ANALYSIS AND IMPLEMENTATION

Project Number: CA-723

Applicant: Davis Alternative Technology Associates
P.O. Box 503
Davis, California 95616

Applicant Category:
Nonprofit Organization

Project Type: Demonstrating solar energy and energy conservation retrofitting for low-income homes.

Award: \$19,897

Project Term: 16 months (Project started June, 1978)

Project Description:

● General: The Davis Alternative Technology Associates (DATA) and the Sacramento Housing and Redevelopment Agency (SHRA) have undertaken a retrofit demonstration project for low-income housing. The project will retrofit six houses belonging to SHRA to conserve energy and/or utilize solar energy. The goal is to provide the greatest thermal performance at the lowest cost because low-income housing is typically financed by limited government budget allocations. The project is designed so that subsequent retrofit projects can be accomplished independently by SHRA. The project will provide a model for similar projects in other cities.

● Technical Details: The retrofit potential of each of six houses was determined by an on-site inspection, an interview with the residents, and a computer analysis. The computer algorithm analyzes energy conservation, design features, their economic trade-offs, and determines the relative benefits of several low-cost, low-technology options for each residence. Of the six houses in the project, two use greenhouse additions and all six use combinations of exterior shade screens, home insulation, water heater insulation blankets, low-flow shower heads, and faucet aerators. SHRA will monitor the utility bills for a year to evaluate the effectiveness of the retrofit. The retrofit analysis and computer algorithm will serve as the basis for a non-technical retrofit workbook.

Project Results:

● Energy Savings: According to Lucarelli and others (1979, p.41) DATA estimates that two of the houses with water heater blankets and floor insulation can save 26.4 million Btu of natural gas per year per house. The two houses with the water heater blankets and greenhouses can save an estimated 20.2 million Btu per year per house. The water heater blankets alone can each save 14.4 million Btu per year. Lucarelli estimates the total annual energy savings for the six houses to be 122 million Btu per year of natural gas (the backup fuel). Assuming a 20 year lifetime for the conservation devices and materials, the lifetime energy savings will be 2.4 billion Btu of natural gas.

● Demonstration Potential: DATA is developing an energy conservation retrofit workbook for the SHRA field representatives. This book is nearly completed and will be used in conjunction with special training sessions for the SHRA workers, enabling them to continue with the retrofit work.

Project Title: ACTIVE SOLAR SPACE HEATING SYSTEM FOR THE INTEGRAL URBAN HOUSE

Project Number: CA-790

Applicant: Mr. Jeffrey C. Poetsch
Integral Urban House
1516 5th Street
Berkeley, California 94710

Applicant Category:
Nonprofit Organization

Project Type: Designing, constructing, filming, and demonstrating an active solar space heating system.

Award: \$8000

Project Term: 18 months (Project started June, 1978)

Project Description:

● General: The Farallones Institute operates the Integral Urban House for demonstrating to the public home-site appropriate technology in an urban setting. The nonprofit Institute conducts research and education in food raising, water and energy conservation, and use of renewable resources and recycling systems appropriate to urban living. The Institute is one of the most successful of this type in the U.S., receiving national recognition for its work and serving as a model for similar institutions.

With the present grant monies and student volunteers, the members have designed, constructed, and installed an active solar space heating system and made a color and black & white videotape documenting the project's step-by-step progress. They have built and installed the solar collectors and rock storage, and a commercial firm is building the duct system which the Institute will install in the fall of 1979. They will then install solar controls also.

● Technical Details: There are 3 aluminum solar collectors, constructed onsite, totaling 200 square feet integrated into the south roof of the house. Insulation is 3½". The glazing for each collector is a 4' wide Filon covering Hexcell absorbers, which provide a total of 4,000 square feet of absorption surface for heating air. The absorbers are coated with an enabsor type paint having urethane resin. A 7 cubic yard rock storage bin in the basement, insulated with glass foam, holds 8 tons of ½" washed river gravel in 5 gallon containers. For heat monitoring, 12 thermal couples have been variously placed in the bin. Woodstoves provide additional space heating. The film documentary with 8 mm film is 24 minutes long. Project steps are in black & white, and the introduction and closing summary are in color.



CBB 801-121

The Integral Urban House

(Space heating solar collectors are on the upper roof - water heating collectors are on the lower roof.)

Project Results:

● **Demonstration Potential:** The space heating system compliments the other technologies demonstrated in this remodeled urban house. (Other technologies include solar domestic water heating, composting toilet, energy efficient conservation devices, passive solar architecture, urban gardening and animal raising, aquaculture, and woodheating.) The Farallones Institute uses a wide variety of methods for publicizing and demonstrating the house including publications, modules, pamphlets, classes, tours, and open houses. (The Sierra Club has just published a book describing the House and its energy adaptations.)

Project Title: JAVA PLUM ELECTRIC

Project Number: HI-1

Applicant: Mr. Verne Trostle
P.O. Box 1302
Kaunakakai, Hawaii 96748

Applicant Category:
Individual

Project Location: Wiauluia Valley
Molokai, Hawaii

Project Type: Building a Pelton impulse wheel hydroelectric system for a small farm.

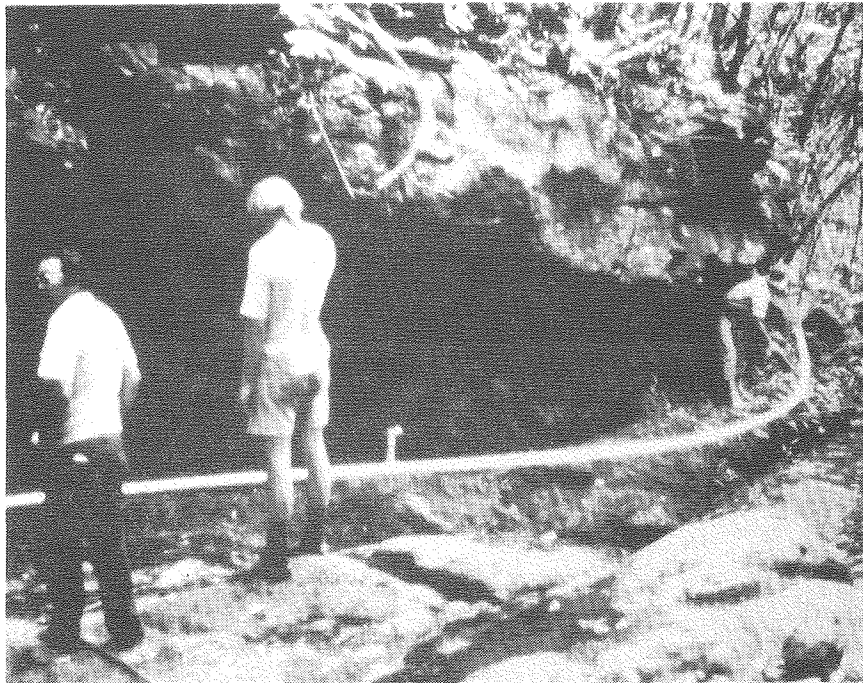
Award: \$1235

Project Term: 12 months (Project started June, 1978 - completed June, 1979)

Project Description:

● General: For this project Mr. Trostle has designed and built a small hydroelectric system using a Pelton impulse wheel, generator, and battery storage for providing electricity for a small organic market farm located in the remote Wiauluia Valley on Molokai Island. Prior to this project the farm had no electricity. There is a great deal of interest throughout the Pacific in small hydroelectric systems, and, if properly publicized, this will demonstrate how these systems can provide electricity in similar situations.

● Technical Details: In the mountains behind the garden there is a pool at the base of a low waterfall. A siphon takes water from the pool through a monel strainer. The water descends through 2000 feet of 1½" PVC pipe, giving a head of 208 feet. The heart of the installation, a Pelton impulse wheel manufactured by Bill Kitching (Organic Gardening and Farming, June, 1978) requires an extremely well fitted casing to keep spray from the electrical components. The wheel drives a 60-ampere automotive type alternator. Four six-volt heavy duty batteries float across the circuit. The normal load consists of 12-volt electric lights and a radio in each house. There is also an inverter rated at 1.6 kw for operating power tools. People on the farm perform all the maintenance.



CBB 801-129

PVC Piping Descending to the Pelton Impulse Wheel

Project Results:

- **Energy Savings:** Volunteers donated the labor but materials cost around \$2000. The capacity of the system is untested but should be around 500 w, giving an equipment cost of about \$4000/kw. This is quite expensive compared to equipment costs of low-speed diesels such as those providing Molokai Electric generation at \$400/kw (despite the diesels' dependence on imported fuel oil). In terms of value the system is worth \$2000 as there is no utility service to the site, and a pole line would cost more than the hydroelectric system. The logistics for operating a portable generator would be difficult.

- **Demonstration Potential:** These small hydroelectric systems have a great potential on many of the Pacific islands. Such systems are extremely important considering most of the Pacific islands' dependence on imported fuel oil and the remoteness and lack of power on many of the islands. Therefore, it is important to publicize and encourage projects such as this.

Project Title: LOW-COST POND DIGESTERS FOR HAWAIIAN PIG FARM ENERGY NEEDS

Project Number: HI-12

Applicant: Mr. Michael H. Weitzenhoff
Agricultural Engineering
University of Hawaii
Honolulu, Hawaii 96822

Applicant Category:
Individual

Project Type: Methane generating for small farms.

Award: \$9500

Project Term: 18 months (Project started September, 1978)

Project Description:

● General: The anaerobic digesting of manure in lagoons is the principal method for disposing or treating of wastes on Hawaiian hog farms, but this practice is posing increasing threats to local agricultural environments. First, washdown water carrying wastes into the lagoons escapes by evaporation and seepage into groundwater aquifers, resulting in water loss and pollution. Second, lagoon systems are land intensive (typically 120' x 40') relative to land availability in Hawaii, and the lagoons fill in after 5 - 10 years of operation. Third, the anaerobic and aerobic digestion processes result in obnoxious odors, an increasing annoyance as land surrounding such farms becomes developed. Finally, the methane gas created at the pond bottom via anaerobic digestion percolates to the surface and is lost to the atmosphere.

The applicant's pond covers deal with the third and fourth problems. The first problem can be handled only by using a totally enclosed digester system - see project HI-11. But because of expense, retrofitting of such systems may not be feasible for marginal farmers. In such cases, collecting domes of the type described below may be more acceptable and less costly.

● Technical Details: The applicant developed two systems which failed before he conceived of the one currently in use. The first system consisted of an 8 mil black polyethylene film stretched over a lagoon surface and anchored along its perimeter with weights. A floating gas outlet line allowed gas harvesting. The film developed large tears during the tropical storms. Also, the 8" PVC pipe for carrying raw wastes from the pens to the digester constantly clogged. A second system differed from the first in that: 1) the dome material was positioned on the lagoon surface and kept in place by the PVC pipe frame; 2) a tight gas seal was

maintained; and 3) raw waste flowed unrestricted under the cover eliminating inlet piping needs. This system failed for various reasons. Differential expansion of dome material caused the cover frame to contort, allowing accumulated gas to escape. Also, the dome material decomposed as a result of exposure to the sunlight's ultra-violet rays.

In the third and final design, the cheap polyethylene cover material was abandoned for more expensive but durable nylon reinforced butyl. Second, to maintain a gas seal, the system of weights placed discretely around the perimeter was replaced by a continuous waterbag system. The current system is a 14' x 14' x 4.5' dome constructed of 0.032" butyl sheeting. The lower 1.5' of walls are the waterbags. The bags maintain the gas under positive pressure. Gas is removed by a line at the dome's top.

Project Results:

● Energy Savings: These domes may be expensive for average farms, probably costing a good deal more than the \$200 - \$300 originally projected. Also, the low pressure biogas requires additional compression in order to be supplied to heaters and pumps. Experience shows that 5000 - 5500 cubic feet of biogas (60% methane) daily may be collected from digesters covering an entire pond farm, with a heating value of almost 3.12 million Btu daily. This assumes an average hog farm size of 500 hogs.

Project Title: SOLAR BEESWAX MELTER

Project Number: HI-22

Applicant: Mr. Sebastian Denzler
Box B
Kaelakekua, Hawaii 96750

Applicant Category:
Individual

Project Type: Constructing and demonstrating a small solar beeswax melter.

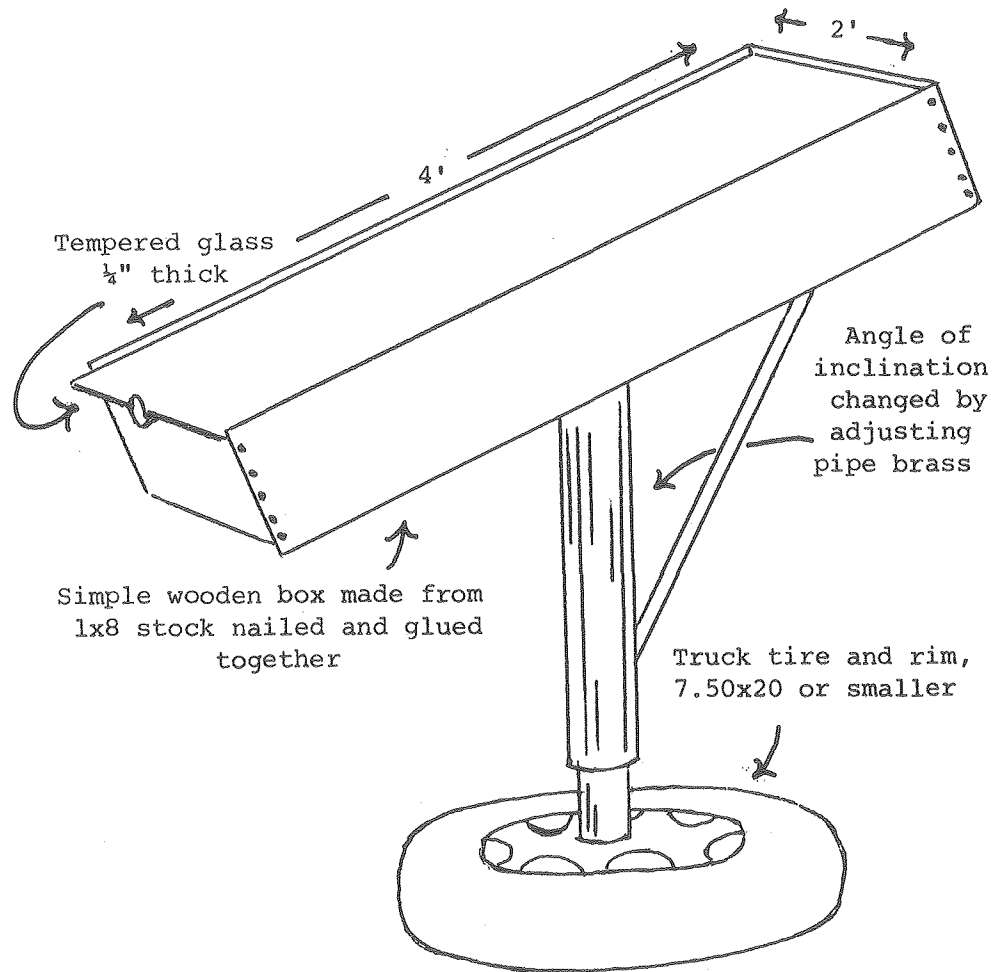
Award: \$328

Project Term: 1 month (Project started June, 1978 - completed July, 1978)

Project Description:

● General: During World War I, because of the fuel shortage, Mr. Denzler experimented with melting wax by sunlight instead of by steam to help his father in his beekeeping business. Mr. Denzler has now developed a simple melting box that produces a wax that is cleaner and thus more acceptable to bees than more commonly used methods (high intensity lamps or propane heat) produce. Furthermore, small scraps of wax can be melted effortlessly and as easily as large scraps so that the box is feasible for beekeepers having few colonies.

● Technical Description: The melter consists of a simple tilted wooden box 4' x 2' (or 3') x 8" deep covered by 1/4" tempered sheet glass lapped over at the bottom to allow moisture to escape but not heat. A pivoting 3" pipe standing in a 7.50 x 20 truck tire and rim supports the box. A 3/4" brace allows for height adjustment and is hinged to the box so the tilt angle can be changed, allowing the sun to enter the box at about 90°. Wax deposits are placed inside the collector on a heavy black enameled metal tray that tips, draining into an aluminum collector pan. The tray rests on an asbestos pad and several inches of rock wool. A do-it-yourselfer can construct the box in about 3 days. The size can be expanded.



XBL 802-8051

Beeswax Melter

Project Results:

● **Demonstration Potential:** This project shows that very small grants can result in successful projects. (This is the smallest grant DOE has awarded in the Region IX AET Pilot Program. DOE has also given Mr. Denzler another AET grant for constructing a solar coffee drying platform.) For a number of years Mr. Denzler has been active in promoting and applying appropriate technology devices for farming, and he will publicize the beeswax melter throughout the Hawaiian Islands.

Project Title: METHANE GAS PLANT FOR OPERATING BOILERS AND GENERATING STEAM

Project Number: HI-26

Applicant: Thomas E. Smith & Associates Applicant Category:
P.O. Box 3168 Small Business
Lihue
Kauai, Hawaii 96766

Project Location: G.N. Wilcox Memorial Hospital and Health Center
Lihue
Kauai, Hawaii

Project Type: Installing and demonstrating a digester using wastes from the hospital to generate methane gas.

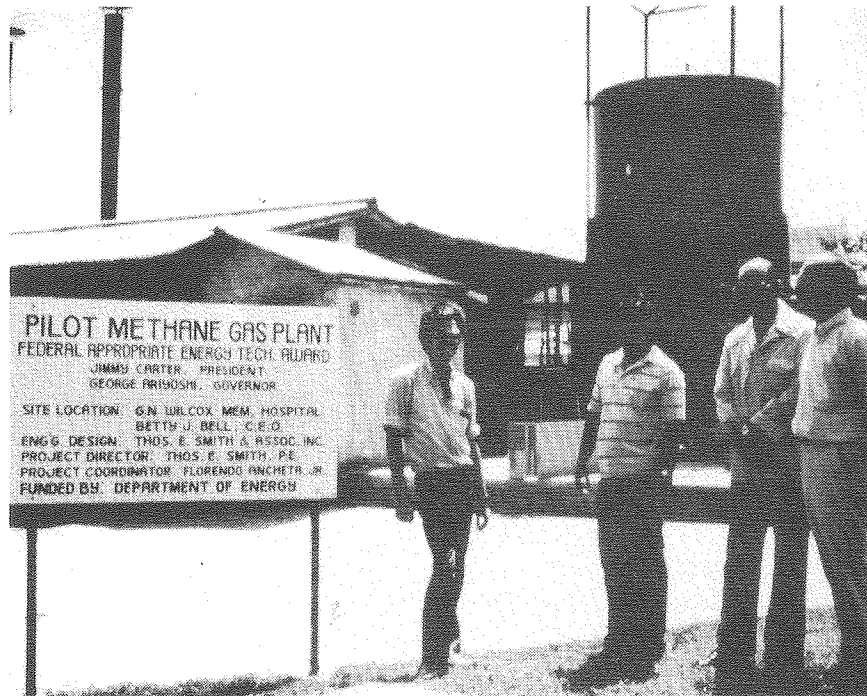
Award: \$40,000

Project Term: 18 months (Project started June, 1978)

Project Description:

● General: DOE awarded a grant to Thomas E. Smith & Associates for constructing and demonstrating a methane generator for the G.N. Wilcox Memorial Hospital. The methane replaces imported fuel oil for generating steam for hot water, sterilizers, and cooking. The generator, which is operating now, digests wastes pumped from the hospital cesspools. Methane gas, generated by the digester, passes to a gas storage tank and from there to the boilers which have been fitted with gas manifolds, a manometer, and regulators. LP gas or oil is the backup fuel, and the switch is made automatically whenever the methane supply is low.

● Technical Details: The steel digester tank, located above ground on a reinforced concrete pad, is 174" long and 92" in diameter. A small heat exchanger uses solar energy for heating the tank. A self-priming centrifugal pump agitates the slurry in the tank, and a heavy duty submersible sewage pump pumps the sewage 125 feet from the cesspools to the digester. The gas storage tank consists of a 104" diameter outer tank holding water and a slightly smaller inverted tank which retains the gas. The inverted tank rides up and down on guides, depending on whether gas is entering or exiting the tank. Between the digester and the gas meter there is an H₂S scrubber containing ferric oxide filters. From storage, gas is piped 110 feet to the boilers.



CBB 801-123

The Wilcox Memorial Hospital with Generator System in Background

Project Results:

● **Energy Savings:** The hospital employs 355 people or 120 persons per shift. Of the 155 beds available in the hospital, an average of 97 are occupied at any one time. Assuming a waste output of 0.27 dry pounds per capita-day of total solids, the hospital population should generate 61.3 pounds of total solids or 50.7 pounds of volatile solids per day as sewage. The hospital will combine the sewage with 25 pounds of volatile solids of organic refuse and around 1 pound of ground newspaper to achieve an optimal carbon nitrogen ratio of 30 to 1. Assuming a reasonable gas output of 9 cubic feet of biogas per pound of volatile solids, Lucarelli and others (1979, p.46) estimate the daily gas output at about 693 cubic feet, with a methane content of about 65%. On an annual basis the plant, at 80% use capacity, will generate 131 million Btu of energy and 1.97 billion Btu over a 15 year lifetime.

Project Title: SOLAR WATER HEATING IN SUGARCANE SEED TREATMENT PLANTS

Project Number: HI-57

Applicant: Hawaiian Sugar Planters Association Applicant Category:
c/o Mr. Ken I. Mashima Nonprofit Organization
99-193 Aiea Heights Drive
P.O. Box 1057
Aiea, Hawaii 96701

Project Type: Constructing and demonstrating an industrial/agricultural solar hot water system.

Award: \$10,000

Project Term: 12 months (Project started Sept., 1978 - completed Sept., 1979)

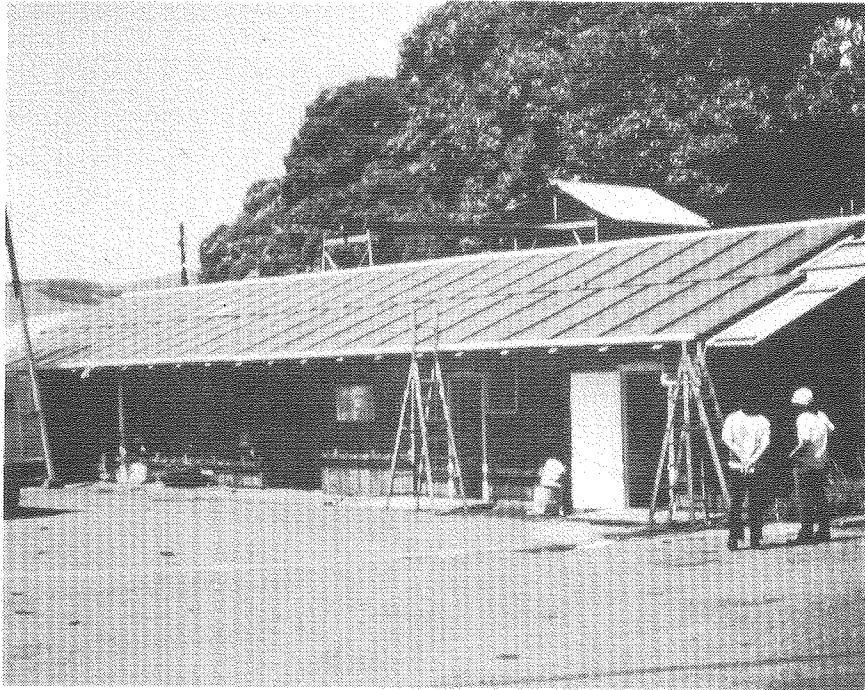
Project Description:

● General: DOE awarded Mr. Ken Mashima and the Hawaiian Sugar Planters Association a grant for \$10,000 for installing a solar water heating system at the experimental station on Oahu to assist in propagating sugar cane seedlings. Sugarcane is propagated by planting pieces of the cane stalk. Before planting, the pieces of seed material are immersed first in hot water and then in cold chemically treated water to enhance the germination and to control diseases affecting the sugarcane. This cold water bath is a modification of an earlier process and prevents overcooking of the pieces. A typical seed treatment facility uses large amounts of energy to maintain water at 125° F on a 24 hour basis in the treatment tanks. (Some large treatment facilities use up to 10 billion Btu of energy annually to heat water.) With this grant Mr. Mashima and the Association have installed a solar water heating system for the hot water tank.

● Technical Details: The solar system heats 1,600 gallons/day of water from 68° F to 125° F. The solar system is composed of 1,000 square feet of flat plate collectors and a 2,000 gallon water storage tank. The 44 collectors, mounted in pairs in a parallel configuration and constructed on-site by local labor, use Roll-Bond absorber plates and polyester Lumar glazing. The water, heated by the collectors, circulates either through the hot water seed treatment tank or the storage tank for later use. All piping and tanks are insulated.

The only serious difficulty encountered was the thermal expansion in the connecting joints. The joints were originally connected with regular plumber's solder, and every one had to be redone with high-temperature tin-antimony solder. Initial performance was marginal as the uncovered

tank lost a great deal of heat during the night. Mr. Mashima is installing an insulated cover to correct this problem.



CBB 801-115

Collector System for the Sugarcane Treating Facility

Project Results:

● **Energy Savings:** The solar system will maintain the water temperature in the 1,000 gallon seed treatment tank at 125° F. The collector system will supply 236.4 million Btu of energy annually, saving 295.5 million Btu of fuel annually (Lucarelli and others, 1979, p.47). Assuming a 20 year life for the project, the system will provide lifetime savings of 5.9 billion Btu of fuel oil.

Project Title: WIND POWERED LIGHTED NAVIGATION BUOYS

Project Number: TT-9

Applicant: Mr. Charles R. Ludwig
NASA Tracking Station
Agana, Guam 96916

Applicant Category:
Individual

Project Type: Designing and constructing wind powered lighted navigation buoys to improve safety conditions for fishing.

Award: \$3000

Project Term: 12 months (Project started September, 1978)

Project Description:

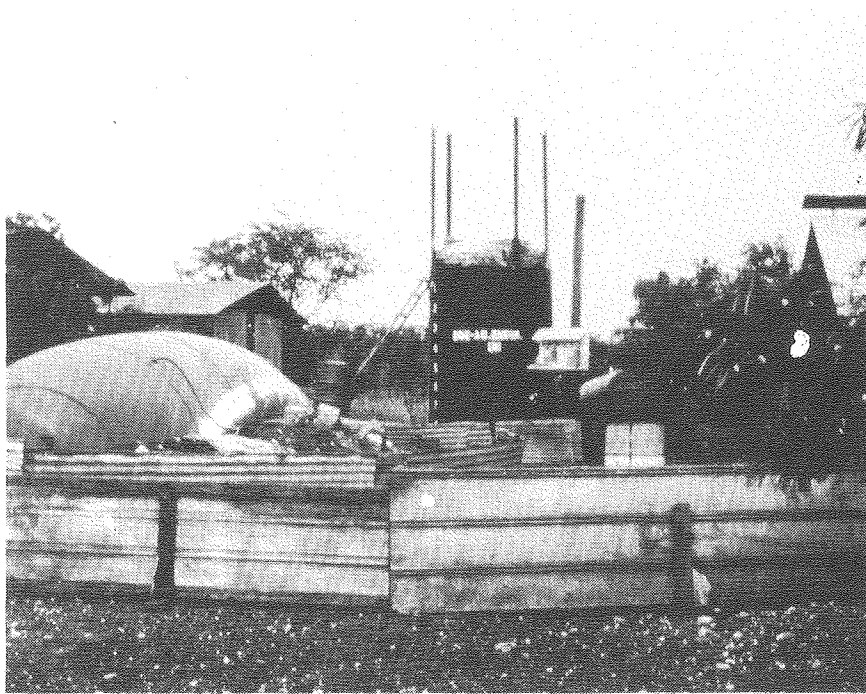
● General: Mr. Ludwig had just started construction of the prototype wind powered buoy when he suffered a severe accident and will be unable to continue with the project.

For this project Mr. Ludwig was to build a prototype navigation buoy with a light powered by a small, commercially available, marine wind machine. A system of these buoys in some of the remote and hazardous Guam harbors would allow the fishermen to extend their days into the early mornings and late evenings. The buoys were to be corrosion and typhoon proof, and Mr. Ludwig was to work closely with the Coastguard while developing and installing them.

APPENDICIES

Appendix A: A List of Projects Described In: Projects From Federal Region IX DOE Appropriate Energy Technology Pilot Program - Part I.

Appendix B: Revised Description of: Biogas Energy for Hawaiian Small Farms and Homesteads (Project Number: HI-11).



CBB 801-131

Project HI-11: Generating System

Appendix A: A List Of Projects Described In: Projects From Federal Region IX DOE Appropriate Energy Technology Pilot Program - Part I.

<u>Project Title</u>	<u>Project Number</u>
<u>Arizona</u>	
Concept Testing of an Energy Management System	AZ-15
Solar Air Active Heater/Passive Cooler Collector	AZ-41
Hardware Package and Workshop Curriculum for Residential Solar Hot Water Systems	AZ-52
Project SAW: Solar - Adobe - Wind	AZ-81
Solar Adobe Project	AZ-85
<u>California</u>	
Two Stage Evaporative Cooler	CA-18
Lompico Logs	CA-184
Solar Process Heating for a Bottle Sterilizing Plant	CA-649
Solar/Woodstove Domestic Water Heating Systems	CA-668
Solar Heated Greenhouse	CA-706
Remote Location Wind Electric System	CA-716
<u>Hawaii</u>	
Anaerobic Digester for Small Farms	HI-11
<u>Nevada</u>	
Solar Heating for a Rural Firehouse	NV-12
Pyramid Lake Solar Assisted Fish Hatchery	NV-21
Agua Caliente	NV-64

<u>Project Title</u>	<u>Project Number</u>
<u>Western Pacific</u>	
Satawan Health Dispensary Solar Hot Water System	TT-1
Western Pacific Solar Hot Water Heater Construction and Demonstration	TT-6
Fishmeal From Solar Heated Driers	TT-11

Appendix B: Revised Description of: Biogas Energy for Hawaiian Small Farms and Homesteads

Project Title: BIOGAS ENERGY FOR HAWAIIAN SMALL FARMS AND HOMESTEADS

Project Number: HI-11

Applicant: Mr. Michael H. Weitzenhoff
Agricultural Engineering
University of Hawaii
Honolulu, Hawaii 96822

Applicant Category:
Individual

Project Type: Methane generating for small farms.

Award: \$13,000

Project Term: 14 months (Project started September, 1978)

Project Description:

● General: Mr. Weitzenhoff originally designed this project to include two components: 1) the demonstration of the economic and technical feasibility of biogas recovery systems for small hog farms and 2) the demonstration of a corresponding system for homesteads. The hog farm system was to involve the anaerobic digestion of hog wastes for producing methane, which in turn would contribute to the energy self-sufficiency of the farm. The homestead system would use household wastes to generate methane. A photosynthetic loop would increase gas production. Digested household wastes would not only produce methane but would also serve as feed for algae and fast growing water plants such as hyacinths in an aquaculture pond. These plants would be returned to the digester to increase total gas production.

A variety of reasons, including the unavailability of the test homestead site, the limited gas generated from waste plants, and public health problems, forced the abandonment of the homestead portion of the project. Instead, a pond aquaculture system was incorporated into the hog farm portion. Mr. Weitzenhoff also intended to develop a computer simulation model to relate farm and homestead energy needs with a variety of inputs such as total farm waste generation and digestion mechanism. However a subsequent literature search revealed that similar models already exist.

● Technical Details: Currently, hog manure plus wasted feed and wash-down water from a building housing about 100 hogs is pumped via sumps underneath the hog pen and into the digester. The digester is a 24" long, 6' diameter sausage shaped bag made of flexible PVC reinforced material manufactured in Taiwan. The digester's total capacity is 20 cubic meters (5280 gallons). Liquid capacity is about 75% of this. The digester allows

a total waste flow (manure + urine + washdown water + wasted feed) of about 2.64 gallons per hog per day, or 264 gallons per farm per day. Mean residence time of waste in the digester is about 15 days.

An 8" PVC input line extends from the 2" and 3" sump pump lines into the digester and under the liquid level to maintain a gas seal. Two 8" PVC output lines extend from the digester (also from below the liquid level) to allow for outflow of sludge and effluent.

Mr. Weitzenhoff used mostly second-hand locally available equipment. The sump pump, a 5 hp WWII surplus Barnes centrifugal pump, moves the wastes from the sump tanks to a holding/settling tank. The settling tank allows heavy materials to settle out and permits more precise control of input flows to the digester. Gas evolves from the digester and is stored in a 3500 gallon steel tank. Originally the steel tank served as the system digester and was operated first by itself and then in parallel with the present digester. Due to inferior performance it was removed from operation.

The second major part of the project includes recycling about 1/5 of the digester effluent through a pond in which algae are cultured. The algae laden water is then used as washdown liquid as an alternative and supplement to fresh water. The washdown water then reenters the digestion cycle. The advantage of algae cultivation is the increase in gas production. The gas is used to power the pond water pump (a 2 hp Sears centrifugal), to power infrared heaters inside the hog house, and to light night lamps.

Project Results:

- Energy Savings: The digester should cost about \$1800 (including piping and installation). Based on data from the grantee, about 1248 cubic feet of 71% methane, or 866 cubic feet of methane, should be forthcoming daily from this operation, producing 258 million Btu annually. Over a lifetime of 10 years, the system will produce about 2.58 billion Btu.

REFERENCES

Case, C.W., Lucarelli, F.B., Morris, J., and Clark, H.R., 1979, Projects From Federal Region IX DOE Appropriate Energy Technology Pilot Program - Part I; Lawrence Berkeley Laboratory Report LBL-9642, Lawrence Berkeley Laboratory, Berkeley, California, 37p.

Lucarelli, F.B., Morris, J., Kay, J.M., Rizer, S., Case, C.W., and Clark, H.R., 1979, The Energy Savings Potential of the Region IX Appropriate Energy Technology Grants Program: An Assesment of Twenty Projects; Lawrence Berkeley Laboratory Report LBL-9715, Lawrence Berkeley Laboratory, Berkeley, California, 161p.

