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AID
RENEWABLE ENERGY DATA BASE

Prepared by

Volunteers in Technical Assistance
(VITA)

for

Office of Energy
Bureau for Science and Technology
Agency for International Development
Washington, D.C.

DESCRIPTION OF THE DATA BASE

The Agency for International Development (AID) Renewable Energy Data Base is a compilation of detailed technical and financial data on renewable energy activities in selected AID-funded projects. At present, the data base describes 80 projects/ subprojects implemented since 1975. A list of the projects follows this Introduction.

In this notebook, the projects are arranged in AID project number order within geographic region:

Asia/Near East
Latin America/Caribbean
Africa
Centrally Funded

For each project, the data base contains the project number and title, country, years of operation, status, length of project funding, appropriation category, project purpose, renewable energy outputs, project inputs, a summary of renewable energy activities, key words, descriptions of technical applications, annotations of project technical reports, evaluation findings, key persons, detailed funding data, project revisions, and follow-on activities.

An Index provides detailed subject and country access to the projects.

PREPARATION AND UPDATE OF THE DATA BASE

The Renewable Energy Data Base was prepared by Volunteers in Technical Assistance (VITA) under AID contract number LAC-5701-C-00-5057-00. Data were gathered from project documents available in the AID central document depository and from numerous reports provided by contractors, evaluators, and missions. The preparers of the data base make no claim that the data base is complete; it reflects solely the documents reviewed. If the reader has documents of a technical nature that augment or update the project descriptions in the data base, please forward those documents to:

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Washington, D.C. 20523
(703) 235-8902

HOW TO VIEW DOCUMENTS CITED IN THE DATA BASE

All project documents cited in the Renewable Energy Data Base are available for review on microfiche at the AID Library. The reports may be viewed Monday through Friday from 10:00 A.M. to 5:00 P.M. at:

AID Library
Room 105 (Lobby)
1601 North Kent Street (SA-18)
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To order reports, contact:

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ONLINE VERSION OF THE DATA BASE

This notebook corresponds to an online file linked to the AID Development Information System (DIS) Projects Data Base. For access to that file, contact:

Training Office
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Agency for International Development
7222 47th Street
Chevy Chase, Maryland 20815
(301) 951-7191

EGYPT

2630016.01	Applied Science and Technology Research
2630103	Basic Village Services
2630123.01	Energy Policy and Planning
2630123.02	Renewable Energy Field Testing

NEAR EAST REGIONAL

2980192	Agricultural Technology Exchange

INDIA

3860465	Application of Sci/Tech to Rural Development
3860474	Alternate Energy Resources Development
3860475	Madhya Pradesh Social Forestry
3860478	Maharashtra Social Forestry
3860488	Forestry Research, Extension, and Training
3860495	National Social Forestry Project

BANGLADESH

3880045.07	PVO Co-Financing II

PAKISTAN

3910366	Institutional Grants
3910478	Energy Planning and Development
3910481	Forestry Planning and Development

PHILIPPINES

4920262	Tiwi Geothermal
4920264	Feasibility Studies
4920294	Nonconventional Energy Development
4920343	Project Design
4920375	Rural Energy Development

THAILAND

4930304	Renewable/Nonconventional Energy
4930324	Micro/Mini Hydroelectric Plants

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INDONESIA

4970266.03	S&T/Research/Training
4970268	Low-Cost Technology
4970300	Energy Manpower and Training
4970318	Energy Planning for Development
4970333	PUSPIPTEK Energy Research Laboratory
4970340	Development Studies

ASIA REGIONAL

4980265	ASEAN Regional Development

COSTA RICA

5150138	Science and Technology
5150145	Natural Resources Conservation
5150175	Energy Policy Development

DOMINICAN REPUBLIC

5170126	Natural Resources Management
5170143	Energy Policy Development
5170144	Energy Conservation and Resource Development
5170173	Forestry Management

ECUADOR

5180029	Alternative Energy Sources Project

GUATEMALA

5200245	Rural Enterprises Development
5200274	Highlands Agricultural Development

HONDURAS

5220071	Feasibility Studies
5220157	Rural Technologies
5220166	Rural Water and Sanitation
5220168	Natural Resources Management

PERU

5270226	Small Hydro Development

JAMAICA

5320065	Energy Sector Assistance

CARIBBEAN REGIONAL

5380049	Energy Sector Structural Adjustment

DJIBOUTI

6030013	Infrastructure and Energy Initiatives

MOROCCO

6080158.01	Cidera School
6080159	Renewable Energy Development
6080180	Energy Planning Assistance

KENYA

6150205	Renewable Energy Development

SAHEL REGIONAL

6250937.03	Renewable Energy Project - Cape Verde
6250937.07	Renewable Energy - Senegal

LESOTHO

6320206	Renewable Energy Technology

BOTSWANA

6330209	Botswana Renewable Energy Technology

SOMALIA

6490122	CDA Forestry

SUDAN

6500041	Rural Renewable Energy
6500059	Energy Planning and Management
6500064	Eastern Reforestation

ZAIRE

6600114	Shaba Refugee Health

TUNISIA

6640325	Tunisia Renewable Energy

NIGER

6830205	Niamey Dept Rural Development
6830230	Forestry and Land-Use Planning
6830235	Solar Energy
6830240	Niamey Dept Development II

SENEGAL

6850201	Cereals Production
6850208	Bakel Crop Production
6850219	Fuelwood Production
6850243	Reforestation
6850247	Village Woodlots

MALI

6880217	Renewable Energy Project

AFRICA REGIONAL

6980424	Energy Initiatives in Africa
6980424.01	Communal Reforestation - Rwanda
6980424.03	National Energy Planning Advisor - Liberia
6980424.12	Energy for Small and Medium Enterprises - Malawi
6980424.23	Regional Improved Stoves Program
6980424.32	Improved Rural Productivity
6980424.87	Hydropower for Agro-Processing - Madagascar

CENTRALLY FUNDED

9365701	Low Cost Energy Technologies
9365703	Energy Policy and Planning

1. Project Number: 2630016.01 2. Geo: EGYPT

3. Title: APPLIED SCIENCE AND TECHNOLOGY RESEARCH

4. Project Life/PACD: 1977-79 (extended to 86)/ October 1, 1986

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 24,400

   B. R.E. Components: 517 (Phase I)*
   405 (Phase II)**
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   922 (TOTAL)***

   *Subobligated Phase I funding, as estimated by ASRT.

   (Source: Applied Science and Technology Program: Executive Summary on Program Activities Phase I-Phase II, 2/80, p. 35, PDHAD334)

   **Represents 374.9 Phase II expenditures through January 1, 1984, and 30.1 budgeted for 1984, the final year of the Biogas Technology project.

   (Source: BOSTID Quarterly Report No. 10: Phase II, 3/84, p. 14, PDAAP237)

   ***Since the figures are derived from two different sources and different procedures were used to calculate them, there may be an overlapping of funds reported for Phase I and Phase II.

7. Loan or Grant/Appropriation Category (US$000):

   G / SA / 8,100
   G / ES / 16,300

   (Source: DIS)

8. Project Purpose:

   To improve the institutional capability of the Egyptian scientific/technological community to develop and manage research programs to solve priority development problems.

9. Renewable Energy (R.E.) Outputs:

Biogas site visits; Bench-scale feasibility study of methane production; Construction of prototype digester designs adapted to Egyptian conditions; Better understanding of biogas technology, including the environmental benefits from waste recycling, pollution control, and fertilization, as well as the economics and social aspects affecting its acceptance; Establishment of a well-equipped laboratory for analytical support of bio-energy development.

10. R.E. Inputs:

Technical advisory services; Commodities; Travel.

11. Summary of R.E. Components:

The Academy of Scientific Research and Technology (ASRT) was the Egyptian agency responsible for the project. The National Research Centre (NRC), one of eleven ASRT "institutes," carried out much of the project's specific technical research. A panel on biogas from the Board on Science and Technology for International Development (BOSTID)/National Research Council of the U.S. National Academy of Sciences (NAS) met regularly with the NRC/Cairo biogas technology group to offer assistance.

The project included a variety of R&D and demonstration activities. The biogas technology project, undertaken by the NRC, had five multidisciplinary components: laboratory and bench-scale research, fertilizer evaluation, engineering, fundamental microbiology, and sociological aspects. Laboratory and pilot work studied such variables as digestibility of wastes, gas formation rates, toxicity, pathogens, and effective use of digester effluent. Engineering and development work involved the design, construction, testing, and operation of prototype digesters and development of gas devices for household and other uses. Six family-size digesters and one industrial-size unit were designed and constructed; the former are operating in both traditional and newly planned Egyptian villages; the latter is operating in a large poultry-rearing operation. The biogas project included site visits to the People's Republic of China, India, Thailand, the Philippines, Brazil, and the United States, and an international conference on the State of the Art on Biogas Technology, Transfer, and Diffusion, held in Cairo in November 1984, attended by more than 135 scientists from 38 countries.

(Sources: Joint Consultative Committee Program Evaluation Report, 3/80, pp. 20-21, PDHAD340; BOSTID Quarterly Report No. 10, 3/84, pp. 12-15, PDAAP237; and NAS/BOSTID proposal, 3/81, p. 12, PDHAD812; Applied Science and Technology: An

Egyptian-American Cooperative Program, circa 1986, p. 29, document number pending)

12. R.E. Project Descriptors:

Biogas; Methane; Biomass digestion; Manures.

13. R.E. Technology Applications:

A. Prototype Digesters

Prior to village demonstration, constructed three prototype digesters at the NRC demonstration center: (1) a fixed roof 10 cubic meter rectangular Chinese design water-pressure digester; (2) a 6 cubic meter domed-roof cylindrical Chinese digester; and (3) a newly developed design combining features of both the plug-flow and the Indian movable cap type, with provisions for solar heating of the feed water, composting of the digester effluent on the top of the plug flow part, and attachment of a latrine and animal shed. Consult source for design drawings.

(Source: Biogas Technology, Transfer and Diffusion, 1986, p. 580, PNAAW773)

B. Family Size Digesters in Al-Manawat

Successfully operated (for 18 months) two family-size biogas digesters (one a modified Indian design, the other a modified Chinese design) in Al-Manawat, a traditional Egyptian village. As of November 1984, both units were still functioning properly, and technical, social, and economic features were being monitored on a continuous basis. Each digester has a 10 cubic meter capacity. The modified Indian type is attached directly to an animal shed and farm house latrine. The second, an improved version of the cylindrical Chinese design (wide and shallow), is installed within the premises of the village collective services unit. Consult final source for design drawings.

(Sources: BOSTID Program Plan for Phase II 1983-1984, 3/83, p. 21, PDHAD708; BOSTID Quarterly Report No. 9: Phase II, 12/83, p. 14, PDAAP077; Biogas Technology, Transfer and Diffusion, 1986, p. 580, PNAAW773)

C. Family Size Digesters in Omar Makram

Installed and tested (for approximately 6 months) three family-size biogas units in Omar Makram, a newly planned village on the western perimeter of the Nile Delta. The Sharkawy family unit is adapted from a Chinese design; it

provides all gas requirements for cooking, baking, and water heating. The Diab family unit is adapted from a small Indian design; it is suitable for family needs (only three animals are necessary to provide feedstock instead of five animals as required in the original design). The third unit, an Indian design, is being shared by two families. All three units were reported operating satisfactorily and performance was being monitored on a regular basis, but the communal digester had experienced problems of a social nature. Consult final source for design drawings.

(Sources: BOSTID Program Plan for Phase II 1983-1984, 3/83, p. 21, PDHAD708; BOSTID Quarterly Report No. 9: Phase II, 12/83, p. 14, PDAAP077; Biogas Technology, Transfer and Diffusion, 1986, p. 580, PNAAW773)

D. Biogas Testing and Assessment Laboratory

Installed a biogas testing and assessment laboratory within the National Research Centre.

(Source: BOSTID Program Plan for Phase II (1983-1984), 3/83, p. 21, PDHAD708)

E. Digester for Poultry Hatchery

Designed and built a 50 cu. m. per day biogas digester for a commercial poultry hatchery at Shubra Kass, Garbeya Governorate (Nile Delta). Poultry manure is used as a feedstock for the biogas process.

The digester is a tunnel-type design with arched roof constructed with a separate floating gas collection system. It was outfitted originally with mechanical mixing rods which proved ineffective with the high percentage of wheat straw feedstock; subsequently, gas and slurry recirculation systems were added for more efficient mixing and scum-breaking. Heating was provided by circulating hot water in a tube bundle immersed in the digester. Initially the water was heated by a biogas-fed water heater consuming 10-15 cubic meters of biogas daily. This was replaced by a 4 KVA Honda gasoline engine-generator modified to operate on biogas. The electricity produced was used for poultry house lighting and other electrical equipment. A specially designed heat exchanger around the engine's exhaust provided heated water for slurry mixing and digester heating. Heat loss from the digester was reduced by enclosing the unit in a plastic greenhouse. Productivity increased to

between 1 to 1.2 cubic meters biogas per cubic meter per day due to the above modifications. Consult final source for digester design drawings.

(Source: BOSTID Quarterly Report No. 8: Phase II, 10/83, p. 17, PDAAN719; Summary Status Report, 10/85, document number pending)

F. Digester Enclosures

As a standard practice the National Research Centre enclosed digesters within a tent of UV-resistant polyethylene, to increase air temperature by means of the "greenhouse effect." Greenhouse temperature exceeded considerably the ambient temperature, and gas productivity increased by 50% on the average.

(Source: Biogas Technology, Transfer and Diffusion, 1986, pp. 231 & 240, PNAAW773)

G. Manure-Handling Systems

Modified manure-handling systems by converting the soil floor of an animal shed to concrete with a slight slope to facilitate urine drainage into a special small canal from which it flows to a chamber where it is mixed with dung. The researchers believed strongly that the proper adaptation and optimization of the manure-handling system could make the difference between success and failure of the entire rural biogas system.

(Source: Biogas Technology, Transfer and Diffusion, 1986, p. 235, PNAAW773)

H. Pressure Regulators

Modified locally available low-cost pressure regulators used for butane gas to obtain constant end-use pressure of 30 cm water from a continuously variable pressure Chinese digester; constant pressure of 25 cm was obtained by adapting imported natural gas pressure regulators.

(Source: Biogas Technology, Transfer and Diffusion, 1986, p. 237, PNAAW773)

I. Optimum Operating Conditions for Anaerobic Digestion

Conducted bench-scale studies on the optimum operating conditions for anaerobic digestion for certain organic wastes. Determined that within the levels of variables studied, an initial total solids concentration of 8%, a hydraulic retention time of 5 days, and a temperature of about 40 degrees C appeared to be the optimum operating

conditions for digesters using cattle manure. For poultry droppings as feedstock, optimum conditions appeared to be about 7% initial total solids concentration and a hydraulic retention time of 10 days at 50 degrees C. For feedstocks of mixtures of poultry droppings/maize stalks, the Total Solids figure was kept constant (8%) and the C/N ratio varied experimentally; in this study the optimum C/N ratio was found to be between 20 and 30.

(Source: Biogas Technology, Transfer and Diffusion, "Study of the Optimum Operating Conditions for the Anaerobic Digestion of Some Organic Wastes", pp. 392-399, 1986, PNAAW773)

J. Biogas Production from Crop Wastes

Studied biogas production from geranium flour (air dried sample from the residue remaining from geranium plants, Pelargonium graveolens, after extraction of the essential oil), Akalona (the epidermis of the wheat grains resulting from the scouring of the wheat grains during the milling process), watermelon (Citrullus vulgaris) residues, and mixtures of each with cow dung in batch-fed laboratory digesters. Tables and graphs are provided.

(Source: Biogas Technology, Transfer and Diffusion, "Biogas Production from Some Organic Wastes", pp. 463-473, 1986, PNAAW773)

K. Fertilizer Value of Digested Effluents

Assessed the fertilizer value of digested effluents produced from a variety of organic substrates, with cow dung as the main constituent. Assessment techniques consisted of laboratory, greenhouse, and field tests using both sandy and clay soils. Proper physical, chemical, and bacteriological examinations were conducted. Treatments included blank runs, farmyard manures, and chemical fertilizers in order to provide comparative analysis with the digested effluent. Tables and graphs are provided. Large experiments, designed to satisfy statistical needs, were undertaken to determine the effect of fertilizers on growth and yields of maize, wheat, rice, cotton, broad bean, spinach, and carrots. Cost-benefit analyses of the effluent applications were conducted.

(Source: Biogas Technology, Transfer and Diffusion, "Assessment of Anaerobically Digested Slurry as a Fertilizer and Soil Conditioner", "Repeated Application of Anaerobically Digested Slurry and Its Effect on the

Yield and NPK Uptake of Wheat, Turnips and Onion Plants", and "Biogas Manure as a Complete Fertilizer, Feasibility for Egyptian Farmers", pp. 463-550, 1986, PNAAW773)

L. End-Use Gas Devices

Conducted extensive R & D work on the development and testing of appropriate end-use gas devices, including household burners and stoves (both simple and modern), gas lamps, space heaters, refrigeration cooling, and gasoline engine modification to run on biogas.

(Source: Biogas Technology, Transfer and Diffusion, 1986, p. 579, PNAAW773)

M. Digester for Aluminum Company

Designed a 320 cubic meter (approximate) plug-flow type digester with separate floating gasholder for the Aluminium Company of Egypt. The gas, estimated capable of supplying 200 households, will be used by the nearby company-owned housing complex. Feedstock will be mainly dung from the 500 or so cows and calves of the company-owned animal sheds. Effluent will be used for desert land reclamation. The unit will be highly mechanized, using slurry pumps for feeding and heating by both passive solar means and biogas combustion for controlling the digestion temperature.

(Source: Biogas Technology, Transfer and Diffusion, 1986, p. 586, PNAAW773)

N. Two-Stage Digester for Army Camp

A two-stage digester of 190 cubic meter total capacity (150 cubic meter digesting volume) with a 20 cubic meter fixed film compartment was designed, built, and operated for 422 days to assess digestion of kitchen refuse and other garbage of an army camp. A circulation pump pumped water from two boilers fueled by diesel fuel or biogas through a heat exchanger inside the digester. A circulation pump pumped slurry to the plant. An air compressor pumped biogas to the bottom of each of the four digester chambers and to the gasholder for mixing the digesting slurry. Investment costs amounted to 20,000 Egyptian pounds (LE) and carried a pay-back period of less than six months (based on international fuel prices). Over 200 tons of fresh garbage, containing 248.5 kg/day total solids, were fed to the digester at an average rate of 480.9 kg/day. Garbage consisted of 85.5% dry bread pieces, 9.8% kitchen refuse, and 4.7% spoiled cooked food. The digester produced 84,668 cubic meters biogas with the average of 200.6 cubic meters per day, or

1.337 cubic meters biogas per cubic meter digesting slurry per day. The gas was used for the cooking of army meals. The amount produced was equivalent to 51.64 liters of kerosene (worth 12,784 LE at world market prices), but it totally replaced fuel worth $44,600/year (49,900 LE), due to the low efficiency of kerosene and diesel fuel cookers in common use. The favorable payback period encouraged the army authorities to finance a stronger program for biogas popularization in Egyptian army camps.

(Source: Biogas Technology, Transfer and Diffusion, "Biogas Production from Kitchen Refuses of Army Camps of Egypt Using a Two Stage Biogas Digester", pp. 589-599, 1986, PNAAW773)

O. Egyptian-Chinese Design Digester

Built an Egyptian-Chinese digester with 8 cubic meter active volume, which began operation in November 1984 for the Mahmoud Zafan household in Al Manawat. The design contained a number of novel features distinguishing it from a Chinese design:

- It required less underground depth, making it more appropriate for high groundwater areas.
- It is easier, faster, and less expensive to build.
- The unit is more compact due to the inlet and outlet being adjacent both to each other and to the animal shed walls. This physical arrangement also makes it easier for partial recycling of the effluent and allows optimum slurry heating using both the greenhouse effect and the absorption/radiation of heat to and from the animal shed retaining wall.
- The redesign of the outlet chamber provides for increased gas storage capacity and reduces gas losses.
- The effluent flows out automatically by gas pressure.
- An internal baffle reduces bypassing, thus enhancing the pathogen-killing rate and more uniform digestion.

Preliminary performance was good, with relatively high gas production rates. Consult source for drawing.

(Source: Twelfth Progress Report (PR/12), 2/85, document number pending)

P. Modified BORDA-Type Digester

Constructed a 10 cubic meter modified BORDA-type digester, which began operation in November 1984 for the Maroof Awad family in Al Manawat. The digester has two components: a spherical bottom and a cylindrical top with movable metallic gas holder. The digester can be considered a modified Indian-type, with the lower section resembling the Chinese shallow and wide model. Costs were lower than a comparable Indian model. The design is more suitable to the Egyptian conditions of lower ambient temperature and higher water table than the Indian design. Consult source for drawing.

(Source: Twelfth Progress Report (PR/12), 2/85, document number pending)

Q. Horizontal Plug Flow Digester

Constructed a 13 cubic meter horizontal plug flow digester in Al Manawat for the Abdel Rahman Awad family. This is a miniaturized version of the model designed for the Misr Aluminium Company, mentioned in 13. M, above, built to test many novel features, including new systems for scum containment, mixing, and breaking. It has two compartments: a rectangular one with a pyramid-shaped fixed roof, and a second circular chamber with movable metallic gas holder. Consult source for drawing.

(Source: Twelfth Progress Report (PR/12), 2/85, document number pending)

14. R.E. Technical Reports and Publications:

A. The Expected Role of Biogas Technology in Rural Areas of Egypt: Energy Considerations. M.A. Hamad and M.M. El-Halwagi, Pilot Plant Laboratory/National Research Centre, Cairo, August 1982, 14 pp., PDHAD336.

This study discusses the role that biogas technology can play in rural areas of Egypt, looking at a number of limiting factors and estimating waste availability, gas production, and suitable land availability under present housing conditions. Assumptions are based on adapted Indian and Chinese family- and community-size digesters. A preliminary economic appraisal is made for both a 6 cu. m. Indian-type and 6 cu. m. Chinese-type digester.

B. Applied Science and Technology Research in Egypt: Quarterly Report No. 13 - Phase II - for the Period October-December 1984. BOSTID/NAS, Washington, D.C., January 1985, 56 pp., PDAAQ693 or PDHAD641.

Includes a report on the International Conference on Biogas Technology, Transfer and Diffusion held in Cairo November 17-24, 1984, marking the last major activity of the biogas demonstration project. Reported findings include:

- All outputs of a biogas system (fertilizer, animal feeds, waste disposal, etc., as well as methane) should be considered when determining economic viability.

- Large community digesters (approximately 50 cu. m.) appear to be more financially viable than small household digesters (approximately 10 cu. m.) due to economies of scale and larger cash flows.

- More substantive data based on a wider range of experience with various digester designs and feeds in different social and environmental situations are needed to evaluate economic viability realistically.

- More study is needed on the important role of social and institutional factors in the diffusion of biogas technology.

- There is a need for a central clearinghouse to collect, synthesize, and distribute biogas information from various disciplines.

- For technology transfer, mechanisms are needed to facilitate cooperation and communication between all developing countries where biogas technology applications, expertise, and experience are found.

C. Biogas Technology, Transfer and Diffusion. M.M. El-Halwagi (ed.), Elsevier Applied Science Publishers, New York, 1986, 735 pp., PNAAW773.

This book contains the proceedings of the International Conference held at the National Research Centre, Cairo, on November 17-24, 1984. It covers a range of technical, environmental, social, economic, informational, and institutional aspects relating to biogas systems design, operation and diffusion, with particular relevance to developing countries.

A wealth of information is provided on digester design, raw materials utilization, biogas and slurry

applications, biogas economics, and actual field experiences in many locations worldwide. Included is a summary of the state of the art of biogas technology and areas that require further work.

D. Applied Science and Technology: An Egyptian-American Cooperative Program. A.S. Nockrashy, Osman Galal, and Jay Davenport, BOSTID, Washington, D.C., circa 1986, 88 pp., document number pending.

An overview of the Applied Science and Technology project, including a one-page review of the biogas component and several biogas-related photos.

E. Development and Application of Biogas Technology in Rural Areas of Egypt, Summary Status Report. M.M. El-Halwagi, National Research Centre, Cairo, October 1985, 20 pp., document number pending.

General overview of project, including drawings of the various project digester designs and lists of key project personnel and major project publications.

F. Biogas Generation from Animal and Agricultural Wastes in Africa. M.M. El-Halwagi and Adel M. A. Daiem, National Research Centre, Cairo, September 1980, 49 pp., document number pending.

Biogas technology and its applicability in Africa are reviewed. Two case studies are presented: the Tanzanian and the Egyptian experiences. Concrete suggestions are outlined for development and utilization of biogas at the national, subregional, and regional levels.

G. Evaluation of the Performance of Two Rural Biogas Units of Indian and Chinese Design. M.M. El-Halwagi, et al. In Energy in Agriculture, Volume 1, Number 3, February 1983, pp. 235-250, Elsevier Scientific Publishing Company, Amsterdam, document number pending.

Presents the results of operating and monitoring of a 5 cubic meter Chinese digester and a modified horizontal vertical Indian model over a sufficient period of time to reflect the effect of seasonal variations on ambient temperature. Water-buffalo dung was the feedstock.

H. Rural Biogas Technology: Effect of Digester Pressure on Gas Rate and Composition. M.A. Hamad, et al. In Journal of Engineering and Applied Sciences, Volume 2, 1983, pp. 49-57, document number pending.

Presents in graph and table form the results of a study on the effect of digester pressure on gas rate and

composition using an experimental Chinese digester with 5 cubic meter volume. Water buffalo dung, fermented at a 40 day retention time, was the feedstock.

I. Design and Construction of a New Type of Digester Attached to an Egyptian Poultry Farm. M.M. El-Halwagi, et al. Paper presented at 3rd International Conference on Anaerobic Digestion, Boston, Aug 14-19, 1983, 23 pp., document number pending.

Design and construction details are presented for the 50 cubic meter tunnel arched-roof digester installed at the poultry-rearing operation in Shubra Kass. Chicken manure mixed with wheat straw is the feedstock. A preliminary economic appraisal is included.

J. Asian Biogas Development: A Progressive Report in Two Parts. P. Goodrich et al. (Part I) and M.M. El-Halwagi (Part II), 1983, 94 pp., document number pending.

Part I reports on a three-and-one-half-week biogas fact-finding tour to China, Thailand, and India by project personnel in November 1979. It includes photos, drawings, and tables. Part II is a diary report, containing observations on biogas technology in India, the Philippines, and China, based on July 1981 visits.

K. A number of progress reports were generated by M.M. El-Halwagi, Cairo, with the following ones available for review (document numbers pending):

Third Progress Report (PR/3), 1/80, 14 pp.

Fifth Progress Report (PR/5), 2/81, 13 pp.

Sixth Progress Report (PR/6), 9/81, 54 pp.

Seventh Progress Report (PR/7), 10/82, 56 pp.

Seventh Technical Progress Report (PR/7T), 10/82, 117 pp.

Eighth Progress Report (PR/8), 4/83, 15 pp.

Ninth Progress Report (PR/9), 10/83, 24 pp.

Tenth Progress Report (PR/10), 3/84, 10 pp.

Twelfth Progress Report (PR/12), 2/85, 16 pp.

L. Additional project reports include the following (document numbers pending):

Summary Report on Project Status by the End of Phase I (PS/I). M.M. El-Halwagi, Cairo, Sept. 1980, 18 pp.

Report of the Biogas Panel. Drs. Prakasam, Capener, and Goodrich, February 1981, 4 pp.

Demonstration Projects: The Development and Application of Biogas Technology in Rural Areas of Egypt. January 1982, 4 pp.

Biogas Technology For Rural Areas of Egypt - A Project Outline. March 1982, 11 pp.

Parasites of Health Significance. M. Adel Tawfik Abbas, March 1982, 4 pp.

Biogas Project Annex 3: Work Carried Out by Fertilizer Evaluation Group, 13 pp.

Report of the Biogas Panel. P.R. Goodrich, H.R. Capener, and T.B.S. Prakasam, April 7, 1982, 6 pp.

Report on the Visit to Far East During the Period April 30-June 1, 1983. M.A. Hamad, National Research Centre, Cairo, 85 pp.

M. Other papers and published articles produced by the project include these (document numbers pending):

The 'Bio' Connection: Biomass, Biogas, Bioproductivity. Fatma El-Gohary. In Mazingira, Volume 5, Number 1, 1981, pp. 80-84.

Pilot Demonstration of Biogas Technology in Rural Areas of Egypt. M.M. El-Halwagi. In Proceedings of the National Seminar on Biogas Technology, Ludhiana, India, July 9-11, 1981, pp. 108-113.

Village Demonstration of Biogas Technology: An Egyptian Case Study. M.M. El-Halwagi, et al. In Natural Resources Forum, Volume 6, 1982, pp. 329-343.

Development of Appropriate Biomass Energy Technologies for Rural Areas of Egypt: The National Research Centre Programme. M.M. El-Halwagi, et al. Paper presented at mid-April 1984 meeting on Alternative Energy at National Research Centre, 15 pp.

A Pilot Experiment for Cooperative Community Biogas Facilities in Rural Egypt Indicated Social Failure. M.M. El-Halwagi, M.A Hamad, and A.N. Abdel Dayem, National Research Centre, Egypt. Paper presented at the International Biogas Workshop on Community Plants, May 1984, Bremen, Federal Republic of Germany, 13 pp.

15. Evaluations/Major Findings:

A. Joint Consultative Committee Program Evaluation Report. BOSTID/NAS, Washington, DC, October 1983, 31 pp., PDHAD340.

This evaluation was conducted near the end of Phase I and was to be used as a background document for considering Phase II. Little is said on the biogas activity. It was stated, however, that Dr. Kamal, Director of the NRC, characterized progress during Phase I on biogas demonstration as "excellent." The Joint Consultative Committee (JCC), a continuing group of Egyptian and American scientists responsible for overseeing the overall ASTR project, commended NRC/Cairo and ASRT for incorporating social acceptance of biogas technology into the project at its earliest design stage, and stated that social aspects of biogas technology introduction into rural areas should be the major thrust during Phase II.

B. Overview and Inputs for Evaluation: Project 263-0016. ASRT, Cairo, December 1979, 45 pp., PDHAD340.

This report evaluates the progress of Phase I activities (from project inception in 1977 until December 1979) and provides guidelines, objectives, and possible recommendations for Phase II planning.

A summary of progress on biogas activities is provided. A two-month delay resulted from problems in obtaining local currency, and another delay is foreseen in acquiring equipment and instruments from the U.S.

C. Overview and Inputs for Evaluation: Project 263-0016. BOSTID/NAS, Washington, DC, February 1980, 38 pp., PDHAD340.

Describes the current project status. In spite of constraints of equipment, procurement delays, lack of local currency budget allocations, costly use of local contractors for pilot digester construction, and lack of funds for incentive pay for project personnel, the biogas project proceeded remarkably well in Phase I laboratory, technology assessment, and village survey work. This is attributed to (1) detailed planning for project direction and periodic assessment and (2) an appropriately

structured management approach.

D. Evaluation Report: Applied Science and Technology Research. Clinton A. Stone, et al., May 6, 1980, 48 pp., PDHAD340.

Provides a brief summary of the biogas project. The evaluators noted the successful transfer of Chinese technology for the construction of domed, underground biogas digesters. They felt that the project had made substantial progress to date and had a sound technical plan; however, they cautioned that to be successful, the project must analyze and plan for all aspects of biogas demonstration at an early date.

16. Key Persons:

A. AID/Washington:

Carolyn I. Coleman
AID, ANE/TR/ENR, Room 4440-19 NS, 201 C Street, NW, Washington, DC 20523, 647-9734

B. AID/Mission:

James Riley, Director
Industry, Science, and Technology Division, USAID/Cairo

C. Contractors:

Dr. Philip R. Goodrich
Department of Agricultural Engineering, Room 305, University of Minnesota, 1390 Eckles Ave., St. Paul, MN 55108
(612) 625-7733

Dr. Harold R. Capener
Department of Rural Sociology, Cornell University, Ithaca, NY 14853
(607) 255-3092

Dr. T.B.S. Prakasam
Metropolitan Sanitary District of Greater Chicago, 100 E. Erie, Chicago, IL 60611
(312) 751-5600

D. Host Country:

Dr. A. S. El-Nockrashy, Director
International Secretariat, Academy of Scientific Research and Technology (ASRT), Cairo

Dr. Mohamed Kamel, President

ASRT, Cairo

Dr. Mohamed El-Halwagi (principal investigator-Biogas Technology Project)
Dr. A.M. Abdel Dayem, Professor of Chemical Engineering
M. A. Hamad
National Research Centre, Tahrir Street, Dokki, Cairo

17. Obligations by Fiscal Year (US$000):

A. Projected Budget Summary by Year for Entire Phase I (Fiscal year not stated)

YR 1	3,900
YR 2	4,200
TOTAL	8,100

(Source: Project Paper, 12/76, PDHAD808)

B. Projected AID Disbursements by Fiscal Year for Phase II

FY	FX	LC	TOTAL
81	7,065.1	1,235.0	8,300.1
82	2,542.2	1,557.6	4,099.8
83	2,145.8	1,754.4	3,900.2
TOTAL	11,753.1	4,547.0	16,300.1

(Source: Project Paper: Phase II, 7/80, PDHAD801)

18. Host Country Funding of R.E. Components (US$000): 9,135*

*For entire project; R.E. costs not specified separately.

(Source: Second Amendment to Grant Agreement, 8/31/80, PDHAD803)

19. Summary of R.E. Costs (US$000):

A. Projected Cost Summary for Phase I*

Technical assistance	1,571.8
Training	1,105.3
Equipment	4,835.0
Other costs	380.0
Contingencies	207.9
TOTAL	8,100.0

*For entire Phase I; R.E. costs not specified separately.

(Source: Project Paper, 12/76, PDHAD808)

B. Projected Cost Summary for Phase II*

	FX	LC	TOTAL
Policy, management training and support	1,750	867	2,617
Demonstration projects	1,807	931	2,738
R&D projects	2,070	778	2,848
Support systems	6,010	1,971	7,981
Contingency	116	0	116
TOTAL	11,753	4,547	16,300

*For entire Phase II; R.E. costs not specified separately.

(Source: Project Paper: Phase II, 7/80, PDHAD801)

20. R.E. Component Revisions:

A. Phase I was funded at $8.1 million and had a PACD of October 1, 1980. LOP funding was increased to $24.4

million and the PACD extended to October 1, 1983, to provide for Phase II. The GOE contribution likewise was increased to $9.135 million.

(Source: Second Amendment to Grant Agreement, 8/31/80, PDHAD803)

B. The PACD was extended to October 1, 1986.

(Source: Near East Region Implementation Report No. 38, 7/31/85)

21. Follow-On Activities:

A. International Conference on State-of-the-Art of Biogas Technology Transfer and Diffusion held in Cairo on November 17-24, 1984, with funding from a grant to NAS/National Research Centre by the AID/Washington Office of Energy (Bioenergy Systems and Technology Project 936-5709) and by GATE/GTZ. More than 135 participants from 38 countries attended, representing developing country research institutes, universities, government ministries, and private industry. The conference included a field trip to biogas installations at National Research Centre/Cairo and at two nearby villages.

(Sources: BOSTID Quarterly Report No. 13 - Phase II, 1/85, PDHAD641 or PDAAQ693; BOSTID Quarterly Report No. 15 - Phase II, 8/85, PDHAE749; Outgoing telegram, 10/84, PDHAD713; and numerous incoming cables, PDHAD712)

B. NRC/Cairo concluded an agreement with Volunteers In Technical Assistance (VITA) in which VITA would provide funding "at cost" for the construction of a demonstration digester at a commercial poultry farm in the village of Shubra Kass, Garbeya Governorate.

(Source: BOSTID Quarterly Report No. 4: Phase II, 9/82, PDHAD336)

C. NRC/Cairo was requested to provide construction cost estimates of biogas generators by the Ministries of Defense and of Energy, indicating their interest in pursuing activity in this technology.

(Source: BOSTID Quarterly Report No. 4: Phase II, 9/82, PDHAD336)

D. Favorable payback estimates based on operation for 422 days of a large biogas plant at an army camp encouraged army authorities to finance a stronger program for biogas popularization in Egyptian army camps. See 13. N, above, for more details.

(Source: Biogas Technology, Transfer and Diffusion, "Biogas Production from Kitchen Refuses of Army Camps of Egypt Using a Two Stage Biogas Digester", pp. 589-599, 1986, PNAAW773)

E. The Organization for the Development of the Egyptian Village (ORDEV) suggested that National Research Centre/ Cairo, under contract to ORDEV, build 1,000 biogas digesters.

(Source: BOSTID Quarterly Report No. 4: Phase II, 9/82, PDHAD336)

F. As a result of the successful biogas demonstration at Al-Manawat, a number of villagers requested digesters for themselves, bearing 25% of the investment cost. At the 1984 biogas conference, it was reported that three additional units had been recently built in the village.

(Source: Biogas Technology, Transfer and Diffusion, 1986, p. 580, PNAAW773)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: August 1986 (jrl)
Revised February 1987 (jrl)
Revised March 1987 (jrl)

1. Project Number: 2630103 2. Geo: EGYPT

3. Title: BASIC VILLAGE SERVICES

4. Project Life/PACD: 1980-85/PACD not specified

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 70,000

   B. R.E. Components: Not specified

   (Source: Project Paper, 6/80, PDAAF811)

7. Loan or Grant/Appropriation Category (US$000):

   G / ES / 70,000

   (Source: DIS)

8. Project Purpose:

   To improve and expand a continuing capacity in local units to plan, organize, finance, implement, and maintain locally chosen infrastructure projects.

9. Renewable Energy (R.E.) Outputs:

   Completed rural infrastructure projects serving needs of village people, especially the poor.

10. R.E. Inputs:

    Funds; Training; Technical assistance.

11. Summary of R.E. Components:

    The Basic Village Services (BVS) Program was designed to promote governmental decentralization and local capacity building as a means of supporting rural development. The Organization for Reconstruction and Development of the Egyptian Village (ORDEV) is the central government entity in charge of the program's administration, while the Inter-Agency Committee (IAC) for Basic Village Services is responsible for formulating BVS planning and implementation procedures. Popularly elected village councils identify projects based on local needs for funding under the BVS

program. Although nearly all selected projects centered around potable water, feeder roads, small canals and drainage systems, a few were to involve renewable energy, notably biogas.

In 1981, AID held up biogas projects in Fayoum due to a determination that the projects were not, at the time, technically viable. It was felt that they could resume in a few months once AID could provide technical assistance. A biogas and a solar desalination project were proposed for Beheira. As per phone conversation of October 13, 1986, with main contractor, Chemonics, no R.E. projects were ever implemented.

(Sources: Annual Report, 3/81, PDAAL832; Annual Evaluation 3/82, PDAAQ409)

12. R.E. Project Descriptors:

    Biogas.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings:

    Project evaluations do not cover R.E. technologies in detail.

16. Key Persons:

    A. AID/Washington: Not specified

    B. AID/Mission: Not specified

    C. Contractors:

       Chemonics, 2000 M Street, NW, Washington, D.C., (202) 466-5340

    D. Host Country:

       Organization for Reconstruction and Development of the Egyptian Village (ORDEV)

17. Obligations by Fiscal Year (US$000):

PROJECTION OF EXPENDITURES FOR ENTIRE PROJECT

FY	AID
80	---
81	33,220
82	18,445
83	18,335
TOTAL	70,000

(Source: Project Paper 6/80, PDAAF811)

18. Host Country Funding of R.E. Components (US$000): 21,000*

*For entire project; R.E. costs not specified separately.

(Source: Project Paper, 6/80, PDAAF811)

19. Summary of R.E. Costs (US$000):

PROJECTED COST SUMMARY FOR ENTIRE PROJECT*

	FX	LC	TOTAL
Subproject construction	---	60,000	60,000
Technical assistance	3,000	3,100	6,100
Training in the USA	1,425	---	1,425
Inflation	1,100	775	1,875
Contingency	352	248	600
TOTAL	5,877	64,123	70,000

*R.E. costs not specified separately.

(Source: Project Paper, 6/80, PDAAF811)

20. R.E. Component Revisions: Not specified

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: August 1986 (jrl)

1. Project Number: 2630123.01 2. Geo: EGYPT

3. Title: ENERGY POLICY PLANNING, RENEWABLE FIELD TESTING, AND UTILITY MANAGEMENT. SUBPROJECT NO. 1: ENERGY POLICY PLANNING

4. Project Life/PACD: 1982-86(extended to 87)/December 31, 1987

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 32,600

   B. Entire Subproject: 8,500

   C. R.E. Components: Not specified

   (Source: Project Authorization, 5/13/82, PDHAD389)

7. Loan or Grant/Appropriation Category (US$000):

   G / ES / 8,500

   (Source: Project Authorization, 5/13/82, PDHAD389)

8. Project Purpose:

   To assist the Government of Egypt to strengthen its institutional capacity to establish and maintain an energy information base; To conduct national and sectoral analyses of energy resources, production technologies, and consumption needs to support national and sectoral energy planning; To provide training and technical assistance on key energy issues affecting near-term decisions and long-term energy/economic planning.

9. Renewable Energy (R.E.) Outputs:

   A competent Renewable Resource Technology Services group within the Engineering Support group of the Organization for Energy Planning (OEP); A Network Energy Tracking System describing the energy flows for a number of R.E. sources in Egypt, and a data base on supply and consumption, including statistics for biomass production and use, solar system sales, etc.; Increased sensitivity and capability on the part of Egyptian policymakers to plan and/or implement R.E. policies.

10. R.E. Inputs:

Technical assistance; On-the-job training; Long-term training; Commodities.

11. Summary of R.E. Components:

The specific aim is to help establish the newly formed Organization for Energy Planning (OEP) as an effective energy planning organization with complete analytical capabilities. OEP is organized along functional lines, with a Policy, Planning & Analysis group, an Engineering Support group which will include a Renewable Resource Technology Services group, and an Information Services group. Four major activities, designed to become on-going OEP activities, have been defined by OEP: industrial energy conservation, national energy analysis, electrical energy conservation, and transportation energy conservation. There are no distinct R.E. components, but these are intermingled throughout the project. For example, the National Energy Analysis will develop a Network Energy Tracking System, an automated system for monitoring and displaying energy flows in Egypt, including biomass, hydro, solar, etc. It will also compile an initial data base on energy supply and consumption, including such topics as solar system sales, biomass production and use, etc. The Electrical Energy Conservation activity will collect electricity supply data, including hydroelectric supply sources.

Argonne National Laboratory was hired through a Participating Agency Service Agreement (PASA) to begin the organizational process in a timely manner, to help develop scopes for early special studies and execute private sector contracts, and to assist in preparing the request for proposals for the U.S. prime contractor.

12. R.E. Project Descriptors:

Biomass; Solar energy; Hydroelectric power; Energy conservation; Energy planning.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

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647-9734

B. AID/Mission:

Eric Peterson, Program Manager
USAID, c/o U.S. Embassy, Cairo, Egypt

C. Contractors:

Dr. Thomas D. Wolsko, Project Manager
Energy & Environment Systems Division
Argonne National Laboratory, 9700 South Cass Avenue,
Argonne, IL 60439-4815
(312) 972-3727

D. Host Country:

Dr. Hussein Abdallah, Director
Organization for Energy Planning (OEP)
1 Aisha El Taymouria Street, Garden City, Cairo, Egypt

17. Obligations by Fiscal Year (US$000):

Projected obligations for entire subproject:*

FY82	2,229
FY83	2,131
FY84	2,189
FY85	1,981
TOTAL	8,530

*Total LOP funding of $8.53 million differs somewhat from the $8.5 million authorized.

(Source: Project Authorization, 5/13/82, PDHAD389)

18. Host Country Funding of R.E. Components (US$000):

4,212*

*For entire subproject.

(Source: Activity Grant Agreement, Annex 1, 8/29/82, PDHAD390)

19. Summary of R.E. Costs (US$000):

Subproject Activity Illustrative Financial Plan

	AID			GOE
	FX	LC	TOTAL	
Technical Assistance	2,205	711	2,916	803
Training	640	246	886	0
Commodities	979	0	979	0
Other	682	390	1,072	1,966
Evaluation	45	13	58	28
Contingency	420	135	555	279
Inflation	1,537	497	2,034	1,136
TOTAL	6,508	1,992	8,500	4,212

(Source: Activity Grant Agreement, 8/29/82, PDHAD390)

20. R.E. Component Revisions:

A. PACD extended one year to December 31, 1987.

(Source: First Amendment to Activity Grant Agreement, 5/14/84, PDHAD390)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: July 1986 (jrl)

1. Project Number: 2630123.02 2. Geo: EGYPT

3. Title: ENERGY POLICY AND RENEWABLE ENERGY FIELD TESTING PROJECT. SUBPROJECT 2: RENEWABLE ENERGY FIELD TESTING ACTIVITY

4. Project Life/PACD: 1982-87(extended to 88)/August 28, 1988

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 32,600

   B. Entire Subproject: 24,100

   C. R.E. Components: 24,100

   (Source: First Amendment to Project Authorization, 7/29/82, PDHAD820, and Second Amendment to the Activity Grant Agreement, 6/30/85, PDHAE768)

7. Loan or Grant/Appropriation Category (US$000):

   G / ES* / 32,600**

   (Source: *DIS; **First Amendment to Project Authorization, 7/29/82, PDHAD820)

8. Project Purpose:

   Collect data and conduct field tests on selected renewable energy technologies to permit a judgment as to the technical, economic, and social feasibility of their widespread replication in a 5-10 year time frame.

9. Renewable Energy (R.E.) Outputs:

   Data collected and analyzed on selected field tests of R.E. applications; Egyptians trained and information system in place allowing for dissemination of information on feasibility of system replication; Technical, economic, and social analyses on current applications and new initiatives as means to evaluate information for future energy planning in renewables.

10. R.E. Inputs:

Technical assistance; Training; Project management; Commodities.

11. Summary of R.E. Components:

Subproject 2, Renewable Energy Resources Field Testing, has four major components:

- Collect data and conduct field tests on selected R.E. technologies to permit a judgment as to the technical, economic, and social feasibility of these systems in a variety of Egyptian industrial, agricultural, and remote settings;

- Establish an information system to collect and disseminate data on renewables systems in Egypt on a continuing basis to support policy and investment decisions and system replication of those applications that are most promising within a 5-10 year timeframe;

- Provide training, education, and operational experience to potential users of renewable energy systems and decisionmakers, especially training on system maintenance and repair, to enhance and accelerate the building of the required technical infrastructure; and

- Provide the means to evaluate and support new initiatives through studies and field tests that may evolve as solar energy technologies are proven and accepted in the Egyptian environment.

The scope of this subproject will include all R.E. technologies and their related applications with the exception of biomass and mini-hydro, which are topics for activities under other projects.

As of July 1986, the technologies to be field tested consisted of the following: solar thermal industrial process heat (IPH) for fruit dehydration, poultry processing, and textile dyeing; photovoltaics for ice making (replacing earlier plans for a solar thermal Rankine engine concept), lighting, irrigation, and desalinization; and wind for village electric power, grid-connected wind farm, and reverse osmosis (RO) desalinization. Planned IPH activities in milk processing and metal processing were postponed, and alternatives were under consideration.

Battelle Memorial Institute is performing the Wind Energy Assessment. Louis Berger International is the prime contractor for the management of the field tests and supporting analyses, with support from subcontractor Meridian

Corporation. Initial local implementation was carried out by the Qattara Hydro Renewable Energy Authority (QHREA), but was transferred by the Government of Egypt to the Egyptian Electricity Authority (EEA).

(Source: Latest update from Egyptian Renewable Energy Field Testing Project Briefing, 7/24/86, PDCAR520)

12. R.E. Project Descriptors:

Desalinization; Drying; Electric power generation; Ice; Irrigation; Solar energy; Solar heating; Photovoltaic energy; Waste heat recovery; Wind energy; Solar collectors; Crop driers.

13. R.E. Technology Applications:

A. Installed six wind measuring stations that use Second Wind measuring equipment including a data logger with a one-month storage capacity EPROM chip. A chip reader extracts the data from the chip and stores it, by means of Second Wind's software program "ARCHIVE", on an IBM/PC diskette which, when used with another Second Wind program, "INTOLOT", converts the data into an ASCII format that is readily incorporated into Lotus 1-2-3 spreadsheets for report generation. Anemometers were placed at 10 meter heights at all sites, with additional ones at 20 meter heights at two sites.

(Sources: Letter of 10/15/84 from David Renne to Fred March, PDHAD772; Letter of 4/17/85 from David Renne to Peter Borgo, PDHAD782; and Technical Status Report, Egypt Wind Resource Assessment Program, 3/1/85-3/31/85, PDHAD773)

B. Recorded and retrieved data on mean wind speeds (meters/second) for May 1985 at five of the six measuring stations (at 10 m height unless otherwise noted): 5.5 m/s at Hurghada; 8.2 at Ras Ghareb (8.6 at 20 m height); 5.2 at El Obayed; 4.7 at El Kasr; and 5.1 (5.8 at 20 m height) at Ras el Hekma. Calculated annual average wind speed of 7.3 m/s at Ras Ghareb harbor station.

(Source: Technical Status Report, Egypt Wind Resource Assessment Program, 6/1/85-7/31/85, PDHAD773; see also letter of 4/26/85 from David Renne to Eric Peterson, PDHAD774, with accompanying analyses of data, including tables on hourly wind speed for each month of 1983 for Ras Ghareb.)

C. Measured average wind speed of 9.2 meters/second at 10 meters above ground and 9.6 meters/second at height of 20 meters above ground at Ras Ghareb for period April-September 1985.

(Source: Application Review, 5/86, p. 5, PNAAV127)

D. Modeled wind turbine performance for operation in the 1983 wind regime measured at the Harbor Station at Ras Ghareb, using Meridian Corporation's Wind Energy System Performance Model, for the following eight (seven horizontal and one vertical axis) U.S. wind turbines: 7-meter rotor, 10 kW BWC Excel-10; 8.8-meter rotor, 20kW Jacobs 29/20; 9.8-meter rotor, 25 kW Carter Systems Model 25; 13.4-meter rotor, 50 kW Enertech 44/50; 12-meter rotor, 60 kW Storm Master Model 12/Series 6; 16.5-meter rotor, 80 kW ESI-54S; 17-meter rotor, 100 kW North Wind; and 18.1-meter rotor, vertical axis 200 kW Vawtpower 185-II. Computer simulations indicated that a wind farm of approximately 250 kW peak power could produce approximately 625,000 kilowatt-hours per year (assuming 90% up-time). Four of the eight turbines modeled could meet that requirement; the other four required a total capacity of between 250 and 400 kW.

In July 1986 it was reported that an RFP was to be released shortly and the pre-RFP market/economic analysis report had been completed. The wind farm at Ras Ghareb was to serve about 60,000 residents, provide approximately 250 kW grid-connected power, and be a fuel saver for a gas-fired plant.

(Source: Application Review, 5/86, pp. 32-40, PNAAV127; Egyptian Renewable Energy Field Testing Project Briefing, 7/24/86, PDCAR520)

E. Prepared color-coded annual wind resource assessment maps for Egypt.

(Sources: Various Technical Status Reports, PDHAD773; and letter of 4/26/85 from David Renne to Eric Peterson, PHDAD774)

F. Performed preliminary conceptual design of a modular 6 ton per day ice-making plant powered by 35 kWp PV array/233 kWh battery/22 kW diesel hybrid system and recommended its construction and field testing at Wadi El Raiyan near El Faiyum. Horizontal daily global insolation for proposed site, located at 29 degrees north latitude, ranges from 3.4 kWh per square meter/day in December to 8.1 kWh per square meter/day in June, based

on recorded data from a meteorological station in El Faiyum. The PV array and battery were sized to supply 40% (168 kWh per day) of the average daily energy demand of the load (420 kWh per day), with the diesel generator supplying the rest. The load consisted of refrigeration for ice-making and heat gain compensation, pumping for water supply, and operational/security lighting. Because of energy efficiency requirements, plate and flake ice-making technologies were reviewed, with flake technology selected in this preliminary design because of its relatively continuous load.

In July 1986 it was reported that an RFP was to be released shortly and the pre-RFP market/economic analysis report had been completed.

(Source: Photovoltaic/Diesel Powered Ice Making Plant, 5/86, PNAAV125; Egyptian Renewable Energy Field Testing Project Briefing, 7/24/86, PDCAR520)

G. Village wind electric systems at Dakhalla, consisting of several 10-25 kW turbines, were to serve about 150 residents to power lights, TV, and refrigerator. In mid-86 it was in an early stage of development. Technology review was scheduled for June 1986, and Statement of Work for December 1986.

(Source: Egyptian Renewable Energy Field Testing Project Briefing, 7/24/86, PDCAR520)

H. The wind-powered desalinization system planned for Hurghada was to serve a research facility for 200-450 people. Design called for provision of 50 cu. meters of water per day by a reverse osmosis unit coupled to a 80 kW turbine or cluster with diesel. The technology and application reviews had been drafted by July 1986, and the Statement of Work was scheduled for November 1986.

(Source: Egyptian Renewable Energy Field Testing Project Briefing, 7/24/86, PDCAR520)

I. The PV village power system, planned for installation in Bahariya Oasis, was to be a stand alone or hybrid system to provide electricity for lighting and water pumping. The Statement of Work was scheduled for December 1986.

(Source: Egyptian Renewable Energy Field Testing Project Briefing, 7/24/86, PDCAR520)

J. The PV desalinization system was designed to produce 10-20 cu. meters of water per day by means of a 25 kWp PV array coupled to a reverse osmosis or an electrodialysis unit.

Its application review and conceptual design were under review in July 1986, and the Statement of Work was scheduled for November 1986.

(Source: Egyptian Renewable Energy Field Testing Project Briefing, 7/24/86, PDCAR520)

K. The solar thermal IPH fruit drying system, consisting of a 102 square meter hot air collector, was planned for the Agricultural Production Authority, Giza. The final Statement of Work was scheduled for November 1986.

(Source: Egyptian Renewable Energy Field Testing Project Briefing, 7/24/86, PDCAR520)

L. The IPH facility at GPC, Heliopolis, was designed to process 100,000 chickens per day by means of a 370 square meter flat plate collector array for scalding. The final Statement of Work was scheduled for September 1986; the pre-RFP market/economic analysis report had been completed by July 1986.

(Source: Egyptian Renewable Energy Field Testing Project Briefing, 7/24/86, PDCAR520)

M. The IPH textile processing plant was designed to supply hot water by a 370 square meter flat plate collector array to Helwan Spinning and Weaving for textile washing. The final Statement of Work was scheduled for November 1986.

(Source: Egyptian Renewable Energy Field Testing Project Briefing, 7/24/86, PDCAR520)

14. R.E. Technical Reports and Publications:

A. Technical Status Reports, Battelle Memorial Institute, Richland, Washington, USA PDHAD773, for the periods:

6/1/85-7/31/85:	6 pp.
4/1/85-5/31/85:	9 pp.
3/1/85-3/31/85:	8 pp.
2/1/85-2/28/85:	5 pp.
1/1/85-1/31/85:	4 pp.
12/1/84-12/31/84:	4 pp.
10/1/84-10/31/84:	6 pp.
9/1/84-9/30/84:	6 pp.
8/1/84-8/31/84:	5 pp.
10/11/83-11/18/83	4 pp.

Report on status of work undertaken by Battelle Memorial Institute in developing an updated wind energy resource assessment for Egypt, selecting and evaluating candidate

sites for various applications of wind energy utilization, and providing short courses and training for Egyptian personnel in wind energy resource assessment, siting, and site evaluation procedures.

B. Application Review For Field Test #6: Photovoltaic /Diesel Powered Ice-Making Plant at Wadi El Raiyan. Meridian Corporation, Falls Church, VA, May 1986, 114 pp., PNAAV125.

This report provides preliminary conceptual design work on a 6 ton per day ice making plant powered by a hybrid photovoltaic (PV)/battery/diesel system, to be used for fish preservation. It assesses user requirements, solar resource, and technology options. The report recommends that a plant powered by a 35 kWp PV array, a 22 kW diesel generator, and 233 kWh battery storage be constructed and field tested at Wadi El Raiyan. (See Technology Applications above for more detail.)

C. Technology Review For Field Test #6: PV/Diesel Powered Ice-Making Plant at Wadi El Raiyan. Meridian Corporation, Falls Church, VA, May 1986, 98 pp., PDAAV128.

This report focuses on products and companies, and includes profiles of manufacturers and historical perspectives of component technologies.

D. Application Review For Field Test #11: Wind Farm at Ras Ghareb. Meridian Corporation, Falls Church, VA, May 1986, 51 pp., PNAAV127.

This report recommends that the project proceed with the design of a 250 kilowatt wind farm, composed of between 5 and 15 wind turbines each producing between 20 and 65 kilowatts peak power, and that it be constructed and tested in a grid-connected windfarm at Ras Ghareb. Data on the wind resource, local electricity generation and load, and results of a study to ascertain the wind system performance of eight U.S. wind turbines (seven horizontal axis and one vertical axis) in the Ras Ghareb wind resource are presented.

E. Technology Review For Field Test #11: Wind Farm at Ras Ghareb. Meridian Corporation, Falls Church, VA, May 1986, 79 pp., PNAAV126.

This report provides an historical perspective on wind farms in the U.S., a review and analysis of wind generator hardware, and a profile of U.S wind turbine manufacturers.

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

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USAID ANE/TR/ENR, Room 4440-19 NS, 2291 C Street, N.W.,
Washington, DC 20523
647-9734

B. AID/Mission:

Lawrence Ervin, Director
Office of Science and Technology

Eric A. Peterson, Project Officer
USAID/Cairo

C. Contractors:

Frederic March, Director, Energy Planning/Management
Thomas G. West, Liaison Project Manager
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5113 Leesburg Pike, Suite 700, Falls Church, VA 22041
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D. Host Country:

Dr. Emand El Sharkowi
Egyptian Electricity Authority (EEA)
Ministry of Electricity and Energy, Abassiya, Cairo

17. Obligations by Fiscal Year (US$000):

	FX	LC	TOTAL
FY82	1,778	465	2,243
FY83	9,286	513	9,799
FY84	4,217	1,764	5,981
FY85	2,510	1,544	4,054
FY86	1,531	510	2,041
TOTAL	19,322	4,796	24,118

(Source: Project Paper 3/18/82, PDAAN861 or PDHAD840)

18. Host Country Funding of R.E. Components (US$000):

4,361

(Source: Second Amendment to the Activity Grant Agreement, 6/30/85, PDHAE768)

19. Summary of R.E. Costs (US$000):

ACTIVITY ILLUSTRATIVE FINANCIAL PLAN

ACTIVITY ELEMENTS	LOP Total	Grantee LC	Total
Technical assistance	6,000	1,045	7,045
Field test	11,052	1,418	12,470
Training and travel	1,000	75	1,075
New initiatives	2,000	550	2,550
Evaluation	150	0	150
Contingency	3,916	1,273	5,189
TOTAL	24,118	4,361	28,479

(Source: Second Amendment to the Activity Grant Agreement, 6/30/85, PDHAE768)

20. R.E. Component Revisions:

A. In March 1984 the GOE transferred responsibility for renewable energy projects from the Hydro and Renewable Energy Authority (QHREA) to the Egyptian Electricity Authority (EEA).

(Source: Project Implementation Letter No. 8, 7/25/84, PDHAD417)

B. PACD extended from August 28, 1987, to August 28, 1988.

(Source: First Amendment to Activity Grant Agreement, 8/29/84, PDHAD935)

C. The First Amendment to Project Authorization increased total LOP funding from $8,500,000 to $32,600,000 to provide financing for Subproject 2. It also renamed the project "Energy Policy and Renewable Energy Field Testing" from "Energy Policy and Planning Project." (The project was also referred to as the "Energy Policy Planning, Renewable Energy Field Testing, and Utility Management Project", since Utility Management is intended to be a third component.)

(Sources: Grant Agreement and First Amendment to Grant Agreement, 7/29/82, PDHAD820)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: July 1986 (jrl);
Revised January 1987 (jrl)

1. Project Number: 2980192 2. Geo: NEAR EAST REGIONAL

3. Title: PATTERNS OF AGRICULTURAL TECHNOLOGY EXCHANGE AND COOPERATION IN A SIMILAR ECOSYSTEM: THE CASE OF EGYPT AND ISRAEL

4. Project Life/PACD: 1984-87/September 1987

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 2,536*

   B. R.E. Components: 365.35**

   (Sources: *Project Data Sheet, 5/10/84, PDHAA647; **Project Implementation Order/Technical Services No. 298-0192-2-6248003, Attachment No. II, 6/1/84, PDHAA654)

7. Loan or Grant/Appropriation Category (US$000):

   G / ES / 2,536

   (Source: Project Data Sheet, 5/10/84, PDHAA647)

8. Project Purpose:

   To promote agricultural cooperation between Egypt, Israel, and the United States and to accelerate agricultural development in Egypt and Israel.

   (Source: Project Data Sheet, 5/10/84, PDHAA647)

9. Renewable Energy (R.E.) Outputs:

   Laboratory and field experiments on soil solarization conducted; Research reports generated; Agrometeorological studies conducted.

10. R.E. Inputs:

    Technical assistance; Commodities; Travel; Other direct costs; Indirect costs.

11. Summary of R.E. Components:

    This project addresses four primary areas of joint agricultural concern to Egypt and Israel, one of which is

"Solar Heating of Soils for Disease, Pest, and Weed Control." Research work will be undertaken by Israeli and Egyptian Ministries of Agriculture, and the Hebrew University of Jerusalem. The USDA's Office of International Cooperation and Development (OICD) will be in charge of project management, coordinating and administering the cooperative research.

The research aims to explore the feasibility of using solar heating, achieved by covering the soil with transparent polyethylene sheets during the hot summer months, to control soilborne pests. Field experiments will be conducted in four locations: Giza, Ismailiya, Qalyubya, and Fayum. The significance of soil reinfestation due to irrigation or propagation material will be investigated. The short and long term effects of solarization on soilborne pests, plant growth and yield, and soil salinity in Egypt will be assessed. Laboratory experiments will study the effectiveness of this treatment for a variety of pathogens and pests. Agrometeorological studies will examine the efficiency of solar treatments in different areas, under different irrigation systems, and in various soil types. Later research will be oriented toward semi-commercial and commercial supervised applications.

12. R.E. Project Descriptors:

Solar heating; Solar energy; Pest control; Soil sterilization.

13. R.E. Technology Applications:

A. Conducted solarization experiments in field and demonstration plots during 1981-1985 in various furrow-irrigated sites in Egypt with a variety of crops. This included solarization on selected farmers' plots to assess effectiveness of this treatment under semi-commercial conditions. Soil types were clay loam at Giza and loamy sandy or sandy in other sites. Two polyethylene sheets (450 cm wide and 0.04 mm thick, containing ultra-violet absorbent) provided the solarization. Typical maximal temperatures of nonsolarized soil, recorded in August 1983 at Giza and Fayed at a depth of 20 cm (measured by a distance thermograph), were 33-34 degrees Celsius, while solarized soil temperatures were usually 7-8 degrees Celsius higher. Control of broomrape and the corky root disease, as well as yield increase, lasted for 2 or 3 successive seasons. Soil salinity decreased.

(Source: Effectiveness of Soil Solarization in Furrow-Irrigated Egyptian Soils, 8/86, XDAAU776-B)

B. Conducted first solarization experiment in Egypt at the Giza Experiment Station in 1981-1982. Observed pronounced reduction in weed populations after removal of polyethylene sheets; the reduction remained significant throughout the growing season. Amaranthus, Chaenopodium, Plantago, Portulaca, and Solanum nigrum were controlled, while Mellilotus and Cyperus rotundus were not. Broadbean plants were stunted during first stages of growth in solarized soil and were found to have significantly less Rhizobium nodules, but they recovered later in the season. Solarization eradicated broomrape (Orobanche crenata), first detected 3 months after planting, and yield increased by 25%.

(Source: Effectiveness of Soil Solarization in Furrow-Irrigated Egyptian Soils, 8/86, XDAAU776-B)

C. In a second experiment at Giza, the effects of solarization with and without Rhizobium inoculation of seeds were examined. Results are indicated below:

EFFECT OF SOIL SOLARIZATION AND RHIZOBIUM (R) INOCULATION ON BROOMRAPE POPULATION,* AND ON BROADBEAN GROWTH AND YIELD**
(GIZA 1983-84)

Treatment	R	Broomrape (No./sq m)	Broadbean Yield (kg/ha)	Broadbean Yield (%)
Nonsolarized	+	30.2	1,480	314
Nonsolarized	-	30.0	472	100
Solarized	+	0	2,456	520
Solarized	-	0	2,512	532

*Broomrape population for nonsolarized controls, with and without inoculation, are not significantly different (P=0.05).

**Yield (kg/ha) for solarized treatments, with and withouation, are not significantly different (P=0.05)

(Source: Synthesized from Table 2, Effectiveness of Soil Solarization in Furrow-Irrigated Egyptian Soils, 8/86, XDAAU776-B)

D. Conducted experiment in Ismailiya/El-Manayef, Egypt, studying effect of soil solarization on root diseases, growth, and yield of tomatoes. Found that solarization significantly controls root knot and corky root diseases in tomatoes, and almost doubles the yield per plant and more than triples the weight-yield per hectare (since

twice as many plants survived to bear fruit, in addition to average 50% heavier fruits). Results are summarized below:

EFFECT OF SOIL SOLARIZATION ON ROOT DISEASES, GROWTH, AND YIELD OF TOMATOES, EL-MANAYEF
1985-1986

Soil Treatment	Stand plants/ inch	Plant fresh wt.(g)	Root knot nem.%	Corky root %	Av. fruit wt.(g)	Yield g/plant	Yield kg/ha
Non-solar.	1.5	266	48	6	26.6	843.8	15,832
Solarized	3.0	484	6	0	38.2	1442.8	54,142

(Source: Extracted from Table 1, Semi-Annual Report No. 3, 10/85 - 3/86, XDAAU776A)

E. Performed experiment in Tamyia/El-Fayoum to study optimum time and duration for solarization to control white and pink rot, soil borne diseases of onion. Solarization treatments were applied in test plots for 4- and 6-week periods beginning in June and July, 1985, and for a 6-week period beginning in August 1985, and monitored against a control plot. Preliminary results are as follows:

Treatment	No. of leaves	Plant height (cm)	Bulb diameter (cm)	Neck diameter (cm)	Plant weight (g)
June 4 wks	9.79	42.10	3.96	1.34	75.4
June 6 wks	9.22	39.44	3.95	1.31	82.7
July 4 wks	10.02	40.11	5.19	1.75	87.5
July 6 wks	9.17	43.46	5.53	1.68	91.2
Aug. 6 wks	9.28	42.28	5.68	1.79	82.7
Control	9.16	35.33	3.88	1.16	66.9

No white or pink rot was observed.

(Source: Semi Annual Report No. 3, 10/85 - 3/86, XDAAU776A)

F. Conducted two other experiments in sandy loam and sandy soils in the Ismailiya region. Observed improved growth of onion plants in the solarized plots shortly after planting and throughout the growth period, with increased height, neck diameter, number of leaves, and bulb diameter. Few plants with pink root disease were detected, and these were only in the non-solarized plots.

(Source: Effectiveness of Soil Solarization in Furrow-Irrigated Egyptian Soils, 8/86, XDAAU776B)

G. Conducted experiments on the effect of solarization on nematode population. In the first Giza experiment, Rotylenchulus reniformis populations were reduced initially by 93-95%, but after a period of time the difference with the control population was less pronounced. Population of this nematode was also reduced significantly in the second Giza experiment. Populations of five other nematode genera were reduced significantly (69-100%) in experiments conducted in different sites.

(Source: Effectiveness of Soil Solarization in Furrow-Irrigated Egyptian Soils, 8/86, XDAAU776B)

H. Conducted experiments in the loamy sandy soil at Fayed and the sandy soil at the Youth Farms-Sinai. Results showed lower salinity in solarized plots than in control plots in nearly all cases.

(Source: Effectiveness of Soil Solarization in Furrow-Irrigated Egyptian Soils, 8/86, XDAAU776B)

14. R.E. Technical Reports and Publications:

A. Effectiveness of Soil Solarization in Furrow-Irrigated Egyptian Soils. M.F. Abdel-Rahim, M.M. Satour, K.Y. McKail, S.A. El-Eraki, A. Grinstein, Y. Chen, and J. Katan, The Hebrew University of Jerusalem, Rehovot, Israel, August 1986, 22 pp., XDAAU776B.

This report reviews the progress made in Egypt using soil solarization treatment to control soilborne pests for a variety of crops under various conditions. Details are furnished in 13, above.

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

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B. AID/Mission: Not specified

C. Contractors:

Dr. Joan Wallace
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D. Host Country:

EGYPT:

Dr. Mohamed F. Abdel Rahim, Director
Dr. Kamel Y. Mickail, Deputy Director
Dr. Mokhtar Satour
Plant Pathology Institute, Giza

Dr. M. Goueli, Chairman, Department of Agricultural Economics, Zagazig University

Dr. Y.A. Mohieldin, Undersecretary
Egyptian Ministry of Agriculture

ISRAEL:

Dr. J. Katan, Department of Plant Pathology and Microbiology
Dan Yaron, Professor of Agricultural Economics
The Hebrew University of Jerusalem, The Levi Eshkol School of Agriculture, Rehovot 76-100, P.O. Box 12, Israel

Dr. A. Grinstein, Department of Pesticide Application, ARO, The Volcani Center, Bet Dagan, Israel

Professor S. Pohoryles
Israeli Ministry of Agriculture

17. Obligations by Fiscal Year (US$000):

ESTIMATED PROJECT BUDGET BY PROJECT YEAR

YR1	761.461
YR2	860.307
YR3	913.728
TOTAL	2535.496

(Source: Project Implementation Order/Technical Services No. 298-0192-2-6248003, Attachment No. II, 6/1/84, PDHAA654)

18. Host Country Funding of R.E. Components (US$000):

EGYPT:	953*
ISRAEL:	1,114*

*For entire project, R.E. costs not specified separately.

(Source: Project Data Sheet, 5/10/84, PDHAA647)

19. Summary of R.E. Costs (US$000):

PROJECTED COSTS FOR THE SOLAR HEATING OF SOIL FOR DISEASE, PEST AND WEED CONTROL COMPONENT

EGYPT:

Salaries & benefits	35.100
Supplies & equipment	47.000
Travel	30.100
Other direct costs	54.500
Indirect costs	13.300
Subtotal	180.000

ISRAEL:

Salaries & benefits	100.400
Supplies & equipment	44.450
Travel	19.100
Other direct costs	3.400
Indirect costs	18.000
Subtotal	185.350
TOTAL	365.350

(Source: Project Implementation Order/Technical Services No. 298-0192-2-6248003, Attachment No. II, 6/1/84, PDHAA654)

20. R.E. Component Revisions: Not specified

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: October 1986 (jrl)

---------- AID RENEWABLE ENERGY DATA BASE ----------

1. Project Number: 3860465 2. Geo: INDIA

3. Title: TECHNOLOGIES FOR THE RURAL POOR

4. Project Life/PACD: 1978-81(extended to 86)/ June 30, 1986

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 2,000

   B. R.E. Components: 1,518

   (Sources: Grant Agreement, PDCAA548; Project Implementation Report, 9/85, PDCAM882)

7. Loan or Grant/Appropriation Category (US$000):

   G / SD / 2,000

   (Source: DIS)

8. Project Purpose:

   To increase Indo/US collaboration in the testing and application of science and technology as part of India's rural development effort. Special emphasis will be placed on technologies appropriate to rural settings.

9. Renewable Energy (R.E.) Outputs:

   Photovoltaic (PV) and biogas systems installed and tested; Five solar dryers designed, built, and tested; Research on parabolic point-focus dish solar concentrators undertaken; Parabolic solar concentrator for industrial application designed; Electronics controller for greater utilization of electricity produced by low-head and ultra low-head hydro plants developed; Hydro sites developed; Technical skills upgraded or enhanced; Socioeconomic studies on the acceptance and adaptation of new technologies performed.

10. R.E. Inputs:

    Technical assistance; Equipment and materials; Salaries; Training.

11. Summary of R.E. Components:

Grant provided to the Government of India (GOI) to finance seven subprojects to develop, test, and apply technologies pertaining to alternative energy sources, agriculture, conservation, nutrition, and health.

Four subprojects focus on renewable energy:

- Development and application of decentralized, nonconventional energy sources such as photovoltaic systems and biogas digestors;
- Solar drying systems for rice and other agricultural produce;
- Parabolic solar concentrators producing steam for industrial uses; and
- Development of micro and low-head hydro systems and hybrid loads for such systems.

Project is implemented in part by the Indo/U.S. Joint Commission for Indo/US Cooperation, a commission of U.S. and Indian scientists/technicians who meet annually to discuss and propose solutions to problems in the economic, commercial, scientific, technological, educational, and cultural fields. The GOI's implementing agent, the Department of Science and Technology (DS&T), authorizes expenditures and functions as secretariat for project administration.

12. R.E. Project Descriptors:

Biomass digestion; Biogas; Photovoltaic energy; Solar energy; Photovoltaic cells; Solar collectors; Crop driers; Hydroelectric power; Solar concentrators; Lighting; Electric power generation; Irrigation; Water pumps; Rice.

13. R.E. Technology Applications:

A. Salojipally Integrated Village Energy System (Subproject 1). Contractors: Bharat Heavy Electricals Ltd. (BHEL), an Indian parastatal firm in power equipment; Central Electronics Ltd. (CEL), a GOI research and development group; and U.S. Jet Propulsion Laboratory (JPL).

- A 200-watt PV array is generating electricity for a community television, radio, and four small fluorescent tube lamps. The output of the PV system, which has been operating continuously from February 1982 to time of evaluation (January 1985), is run through a battery bank.

- A 7.3 kW PV system comprised of both U.S. (Photowatt) and Indian (CEL) cells powers 30 street lamps and three irrigation pumps. This system also has a battery bank. At the time of the latest evaluation (January 1985), the system had been operating for 14 months (since November 1983).

- Some research on parabolic, point-focus, dish solar collectors was performed by BHEL, but a de-emphasis on solar dish technology in the U.S. Department of Energy's research program brought this work to a halt. The thermal dish/steam technology was too complex for remote installations.

- Since November 1982, a 60 cubic meter dome-type biogas plant has supplied biogas to a 3hp jet pump installed on a 30m borehole. BHEL modified the fuel delivery system of a single-cylinder 4.5 kW diesel engine-generator so that it could burn biogas. The engine can run on biogas alone but has been using an 80:20 biogas:diesel mixture. The engine was produced in India.

  Water from the borehole is pumped to a 5,000 gallon tank which supplies the community through eight taps. Four other boreholes with tested output in the 400-1,500 imperial gallons/hour range have been drilled. The water may be used for irrigation. Operation of the biogas plant has been intermittent because of an inadequate animal dung supply.

(Source: Evaluation, ARD, 1985, pp. 22-36, XDAAR453)

B. Solar Drying Systems for Agricultural Produce (Subproject 2). Contractors: Annamalai University (AU) in Tamil Nadu State and Colorado State University (CSU).

Five solar dryers were designed at AU and tested on rice:

- A sheet of black polyethylene on the ground has rice placed on top of it. The polyethylene absorbs additional radiation, while also protecting the rice from ground contaminants. Drying capacity is 1 kilogram of rice/square foot of plastic over a sunny 8-hour period. Efficiency (ratio of minimum energy required for drying to incident solar energy) is approximately 10 percent.

- The second model places a 3-inch layer of rice husks on top of the black polyethylene, then covers the rice husks with a sheet of rexin (rubberized plastic). This serves as an insulating layer to reduce downward heat losses. The rice to be dried is

spread on top of the rexin. This model can dry 1.5 kg of rice/square foot of plastic per day, with an efficiency of 15 percent.

- The third model is similar to the second, but adds a sheet of ultraviolet (UV) treated translucent polyethylene, supported by a bamboo frame, 3 inches above the rice to be dried. This model drys 2 kg of rice/square foot of plastic per day, at greater than 20 percent efficiency.

- An intermediate-sized dryer uses the polyethylene/ rice husk/rexin insulation layer described above and adds a 4.5m x 12m flat galvanized metal sheet on top of it. The metal acts as the principal absorber. A sheet of UV treated plastic is suspended over the metal. A fan circulates air from the absorber through a 2.4m x 1.5m x 0.6m bin holding the rice to be dried. Drys 250 kg of rice in 3 sunny hours, about 3.6 kg/square foot, per day. Efficiency is about 30 percent.

- The largest dryer uses a sheet metal absorber of the type described above, but with the size increased to 30.5m x 4.5m. Heated air to dry the rice is forced through the center of a vertical column dryer formed by two concentric cylinders of wire mesh, which hold the rice between them. The cylinder is covered on top, forcing the heated air to pass outward through the mesh-held cylinder of rice. The rice falls out of the bottom of the dryer into a funnel, then is sent by elevator to the top of the dryer for recirculation. The dryer has an output of 1.75 tons/day, with an efficiency of about 40 percent.

CSU developed a stationary dryer using more expensive but more durable components. It contains a 36.5 square meter roof-mounted solar air heater, consisting of 13 individual collectors connected in parallel, installed at a 20 degree tilt. Each collector is made of a single tempered-glass cover, aluminum absorber plate coated with an optically selective silicone paint, and fiberglass duct board back insulation. The solar heater was designed to remove approximately 100 kg of water per day from grains. A fan forces the hot air through a bin holding rice up to 2-feet deep. Air passes twice through each collector, first entering the upper air passage between the absorber plate and the glass cover, and then returns in the lower passage between the absorber plate and back insulation; nominal air flow is 40 l/s in each collector, resulting in a typical Reynolds number of 7000. The rice is mechanically stirred by devices powered by a 3-hp natural gas engine. Efficiency is 42

percent and capacity is one ton of rice in less than one day. Results from ten tests conducted at CSU are reported, indicating energy inputs (ambient, mechanical and solar energy), water removal and specific performance factors (collector efficiency and ratio of gross collector area employed per kg of water removed during the day-long test). Total cost of this "first of a kind" dryer was $4630 excluding overhead.

(Sources: Evaluation, ARD, 1985, XDAAR453; Comparison of Portable and Stationary Crop Dryers for Developing Countries, 1983, PNAAW993)

C. Line-Focusing Solar Concentrating Collectors (Subproject 3). Contractors: The Indian Institute of Science (IIS) in Bangalore and the University of Houston (UH), Department of Mechanical Engineering.

- Designed and developed a parabolic solar concentrator for producing medium-temperature steam at the government-owned silk printing plant at Mysore. Collectors are placed on a single north-south axis and a servo-motor drive mechanism moves the collectors to follow the sun on its east to west arch. Direct solar radiation is focused on a coolant water pipe. (UH developed black chrome selective coating for the receiver tubes.) The heated water is sent to a flash boiler and the resultant steam is added to that in a coal-fired boiler. The collector system is designed to produce 80 kg/hr of 150 degree Celsius steam, approximately one-third of the silk plant's total demand.

  (Source: Evaluation, ARD, 1985, pp. 37-57, XDAAR453)

- Developed a comprehensive computer-based method for the design and optimization of parabolic trough solar collectors based on qualitative information (such as technical capabilities of production), as well as quantitative information (relating to economics, technology, and geographical location).

  (Source: A Comprehensive Computer-Based Method for Design of Parabolic Trough Solar Collectors For Technically Less Developed Countries, 8/84, PNAAW995)

D. Micro-Hydro and Hybrid Systems (Subproject 4) Contractors: Alternative Hydro Energy Center (AHEC) of Roorkee University and Colorado State University until July 1983, then Boston University (BU).

- Developed an electronic controller to utilize more fully the electricity produced by low-head and ultra-

low-head turbines. Three experimental turbines will be installed: 100 kW Schneider engine turbine, 100 kW Voest alpine Low-Head turbine, and 100 kW BHEL tube turbine. In order to maximize load factors and avoid dumping excess electricity during peak generating times, productive electric (hybrid) loads will be added. Some proposed hybrid loads are: 125 kW rice husk pyrolysis and briquetting unit; a 3 kW electric arc nitrogen fertilizer unit; an electrically assisted upflow biomass gasification system; and a 60 kW water electrolysis unit for producing gaseous hydrogen and oxygen. As of January 1985, two of the three sites were nearly ready for turbine installation.

(Source: Evaluation, ARD, 1985, pp. 58-72, XDAAR453)

14. R.E. Technical Reports and Publications:

A. Optical and Thermal Analysis of Parabolic Trough Solar Collectors for Technically Less Developed Countries. Halil M. Guven, University of Houston, Houston, June 1984, 148 pp., PNAAW994.

Presents the findings of a study to develop a comprehensive performance model for analyzing different parabolic trough solar collector geometries. The model accounts for error parameters (operational, manufacture, assembly, materials, etc.) universal to all collector geometries, enabling the designer to analyze different geometries. The thermal behavior of parabolic trough collectors is also discussed.

B. A Comprehensive Computer-Based Method for Design of Parabolic Trough Solar Collectors for Technically Less Developed Countries. Halil M. Guven, Richard B. Bannerot, and Farrokh Mistree, University of Houston-University Park, Houston, August 1984, 215 pp., PNAAW995.

Presents a comprehensive method for the design and optimization of parabolic trough collectors for different design environments (economic, technical, and geographic). A two-level design structure is presented: a mathematical analysis at a macro level of design incorporating design decisions and optimization aspects based on capabilities and objectives of the design environment (e.g., production methods definition and selection of materials); and a seven-step procedure for analysis at a micro level of design for concentration ratio optimization based solely on technical considerations. Four uses of the design and optimization method are demonstrated.

C. Optical Designs for Non-Tracking Concentrators. Bing Man Kwan and Richard B. Bannerot, University of Houston-University Park, Houston, September 1984, 111 pp., PNAAW996.

This report studies the optical design of a non-tracking concentrator with a trapezoidal geometry in cross-section using a criterion of two reflections or less. A ray-tracing computer simulation evaluates collector designs resulting from this criterion. Annual tilt routines for non-tracking concentrators are also developed.

D. An Experimental Investigation of the Effect of Water Removal and Replacement on the Thermal Stratification in a Horizontal Water Storage Tank. Li-Yun Wu and Richard B. Bannerot, University of Houston-University Park, Houston, November 1984, 184 pp., PNAAW997.

Thermal stratification in a horizontal storage tank driven by a simulated solar thermosyphon water heater is investigated experimentally for two different tank plumbing configerations, two different output patterns at eight different load flow rates, and at different temperature levels. Extensive graphs are included.

E. Comparison of Portable and Stationary Crop Dryers for Developing Countries. C.C. Smith and V.R. Muthuveerappan. In J. Separ Proc. Technol., 4(4) 15-22, 1983. Paper presented at the International Symposium on Energy Savings in Drying Processes - Applications to Industry and Agriculture, Liege, Belgium, October 4-6, 1983, PNAAW993.

This paper describes a 36.5 square meter stationary solar grain dryer designed and built at Colorado State University (CSU) and provides summaries of costs and results of ten tests conducted at CSU. It also describes three 40-square meter low-cost portable solar dryers designed and built at Annamalai Univeristy (AU) in India. A summary of dryer performance and costs is given.

F. Development and Application of Decentralized Energy Systems Utilizing Non-Conventional Energy Sources - Salojipally Project - First Conference Report. Bharat Heavy Electricals Limited (BHEL), Hyderabad, and Central Electronics Limited (CEL), Sahibabad, May 30, 1981, 42 pp., PNAAW998.

This report contains the deliberations of a conference held at the U.S. Jet Propulsion Laboratory (JPL) from May 16-30, 1981, between JPL, BHEL, and CEL to initiate activities for the joint subproject to design, develop, install, and test solar thermal and PV systems for rural applications. It includes brief details of the tasks,

work schedule and milestones, manpower exchange schedule, and tentative general listing of hardware to be procured from the U.S.

G. Development and Application of Decentralized Energy Systems Utilizing Non-Conventional Energy Sources - Salojipally Project - Second Conference Report. Bharat Heavy Electricals Limited, Hyderabad and Central Electronics Limited, Sahibabad, February 20, 1982, 80 pp., PNAAW999.

This is a status report of the BHEL/CEL/JPL collaborative subproject, as presented at the joint conference held from February 2-20, 1982 in India. It contains the deliberations, including the progress of design activities, future work schedule, load distribution, load management concepts, manpower exchange schedule, a list of hardware to be procured from the U.S., as well as daily and monthly direct solar radiation data. Many tables and graphs are provided.

H. Development and Application of Decentralized Energy Systems Utilizing Non-Conventional Energy Sources - Salojipally Project - Solar Thermal Power Plant System Analysis. Dr. N.K. Giri, Bharat Heavy Electrical Limited, Hyderabad, July 15, 1981, 77 pp., PNAAX001.

Describes the selection of a thermodynamic cycle and subsystems/components for rural application and presents analysis of insolation data. The Rankine cycle is the technology selected. The power plant employs dish point focusing concentrators. No storage for non-sunshine use is contemplated. Nominal output rating is in the order of 12 kWe. Many diagrams, graphs, and tables are included.

I. Medium Temperature, High Efficiency Tracking and Non-Tracking Solar Energy Collectors for Rural and Industrial Application: Final Report. Richard B. Bannerot, University of Houston-University Park, Houston, March 1985, 25 pp., PDAAV573.

The University of Houston/Indian Institute of Science (Bangalore) collaborative solar collector project is described, focusing on the American contribution. A list of reports and publications resulting from the project are included in appendices.

J. The following non-technical progress reports on the collaborative University of Houston/Indian Institute of Science (Bangalore) solar collector project are available:

First Semi-annual Report: May to Dec 1981, PDAAV574.
Second Semi-annual Report: Jan to Jun 1982, PDAAV575.
Third Semi-annual Report: Jul to Dec 1982, PDAAV576.
Fourth Semi-annual Report: Jan to Jun 1983, PDAAV577.
Fifth Semi-annual Report: Jul to Dec 1983, PDAAV578.
Sixth Semi-annual Report: Jan to Jun 1984, PDAAV579.
Seventh Semi-annual Report: Jul to Dec 1984, PDAAV580.

15. Evaluations/Major Findings:

A. Project Evaluation Summary for the Period 7/78 - 3/81. Peter J. Bloom, Chief, Office of Project Development (OPD), and John Westley, Deputy Chief, OPD, USAID/New Delhi, March 1981, 13 pp., PDAAG572.

Provides an overview of the project, which was just beginning to implement subprojects at the time. Short descriptions of the three approved subprojects are included.

B. Project Evaluation Summary for the Period 4/81 - 3/82. R.K. Berry, Project Officer, OPD, and John Westley, Chief, Program Office, April 1982, 8 pp., PDAAJ833.

Seven approved subprojects are described; four concern renewable energy subprojects. Funding, duration, collaborative institutions, a summary description, and a report on current status and problems are included for each subproject.

C. Project Evaluation Summary for the Period 4/82 - 6/83. R. K. Berry, Project Officer, OPD, and Frank Young, (Acting) Chief, Program Office, June 1983, 13 pp., PDAAN204.

Outlines the status of the seven subprojects, four of which are renewable.

D. Project Evaluation Summary for the Period 8/78 - 12/84. R.K. Berry, Project Officer, OPD, and Peter Thormann, Mission Evaluation Officer, January 1985, PDAAR453.

Includes a brief summary and, as an attachment, a comprehensive project evaluation prepared by Associates in Rural Development, Inc., see below, XDAAR453.

E. Technologies for the Rural Poor Project: Findings of an AID/DNES Evaluation Team for the Period 8/78 - 12/84. John H. Ashworth and Richard W. McGowan, Associates in Rural Development (ARD), Burlington, Vermont; and G. D. Sootha, Department of Nonconventional Energy, New Delhi, India, January 1985, 79 pp., XDAAR453.

Provides a comprehensive look at the project's four renewable energy subprojects, updating their progress, examining their problems and successes, and recommending follow-on activities (see Technology Applications, above, for details). The report also examines the project as a whole, analyzing project design, project management, and fulfillment of project objectives.

16. Key Persons:

A. AID/Washington:

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B. AID/Mission:

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Dr. Joel Dubow, Chairman
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D. Host Country:

Maheshwar Dayal, Chairman
Commission for Additional Sources of Energy, Department of Nonconventional Energy Sources (DNES)

Dr. A. Gopalakrishnan, General Manager
Bharat Heavy Electicals Ltd. (BHEL)

Dr. T. K. Bhattacharya, Project Manager
Central Electronics Ltd. (CEL)

Prof. G. Ambalavanan, Joint Director of Regional Center for Extension Services
Annamalai University (AU)

Dr. S. Mohan, Senior Scientific Officer
Prof. M. Ramakrishna Rao, Chairman
Regional Instrumentation Center, Bangalore Indian Institute of Science (IIS)

Dr. V. K. Bansal
Alternate Hydro Energy Center (AHEC)

17. Obligations by Fiscal Year (US$000): Not specified

18. Host Country Funding of R.E. Components (US$000): 1,000

(Source: Project Implementation Report, 9/85, PDCAM882)

19. Summary of R.E. Costs (US$000):

A. By component:

SUBPROJECT	OBLIGATED
1) JPL/BHEL/CEL	751
2) AU/CSU	200
3) UH/IIS	400
4) AHEC/CSU/BU	167

TOTAL	1,518

(Source: Project Implementation Report, 9/85, PDCAM882)

B. By expense category:

CATEGORY	BUDGETED
Technical Assistance	975
Training	203
Commodities	755
Other, Communication, Misc.	67

TOTAL	2,000*

*For entire project; R.E. costs not specified separately.

(Source: Project Implementation Report, 3/86, PDCAP853)

20. R.E. Component Revisions:

A. PACD extended from September 30, 1981, to December 31, 1984.

(Source: Implementation Letter No. 9, 7/30/81, PDCAA554)

B. PACD extended from December 31, 1984, to December 31, 1985.

(Source: Implementation Letter No. 15, 2/7/85, PDCAK366)

C. PACD extended from December 31, 1985, to June 30, 1986.

(Source: Implementation Letter No. 16, 1/86, PDCAM882)

D. Funding for the JPL/BHEL/CEL subproject was increased from $560,000 to $770,500 to cover costs of unplanned technical support, additional labor costs, and more equipment.

(Source: PES, 6/83, PDAAN204)

E. Project title changed from "Application of Science and Technology to Rural Development" to "Technologies for the Rural Poor".

(Source: Implementation Letter No. 2, 9/13/78, PDCAA554)

21. Follow-On Activities:

Suggested new subprojects, should funds become available:

- Utilization of Solar Energy and Biomass Wastes in Agricultural Drying - To continue development work on solar dryers, and experiment with rice-husk fired steam boilers and biomass- or biogas-powered engines. Team recommends 4-year duration, mentioning Annamalai University and Charles Smith (U.S.) as key actors. In the meantime, AU is continuing work with solar drying development under Indian government sponsorship.

- Integrated Rural Development Projects to Couple With Planned Remote Micro-Hydro Installations - To work with communities to put the new electricity capacity to the best use. Roorkee University's AHEC would handle this proposed 5-year subproject.

- Wind Monitoring System for Agricultural and Community Power System - To establish a national wind monitoring network to identify potential sites for wind-powered water pumps. The water would be used for irrigation or drinking. The Wind Energy Center at the National

Aeronautical Laboratory at Bangalore is the suggested Indian contractor.

(Sources: ARD Evaluation, 1/85, pp. 77-79, XDAAR453)

22. Comments on the R.E. Components:

A. The lack of high quality UV inhibited plastic sheet is a problem for solar drying development in India. Visitors to CSU from the Indian Solar Energy Research Center indicate that initiation of production of this material in India is receiving top priority by them.

(Source: Letter of 10/21/86 from Charles C. Smith/CSU to Steve Hirsch/VITA)

23. Date/Data Preparer: June 1986 (mgz)
Revised January 1987 (jrl)
Revised February 1987 (jrl)

---------- AID RENEWABLE ENERGY DATA BASE ----------

1. Project Number: 3860474 2. Geo: INDIA

3. Title: ALTERNATIVE ENERGY RESOURCES DEVELOPMENT

4. Project Life/PACD: 1982-86(extended to 88)/June 30, 1988

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 5,000*

   B. R.E. Components: 3,000*

   *Telegram of 6/86 indicates that Mission proposes to increase LOP funding by $2 million, to be obligated in FY86, to cover expanded activities in coal conversion, and some additional training and anticipated cost overruns in the biomass subprojects.

   (Sources: Grant Agreement, 6/30/82, PDCAA642; State Department Telegram, 6/86, PDCAP821)

7. Loan or Grant/Appropriation Category (US$000):

   G / FN / 3,500
   G / SD / 1,500

   (Source: Action Memorandum, 5/21/82, PDCAA644)

8. Project Purpose:

   To expand India's technical capacity to use alternative energy resources and to develop selected energy technologies to the application stage.

9. Renewable Energy (R.E.) Outputs:

   Wood-fueled gasifier developed; Village-level gasifier developed; Small engines fueled by producer gas developed; Micro-hydro project undertaken; Planning model for nonconventional energy development created; Brookhaven National Laboratory polymer film solar collector tested; Renewable energy data base established.

10. R.E. Inputs:

   Technical assistance; Study tours; Commodities.

11. Summary of R.E. Components:

Project to expand the capacity of the Government of India (GOI) to exploit alternative energy sources and to develop selected technologies to the application stage. The recently created Department of Non-Conventional Energy Sources (DNES) is implementing the project, which has subprojects in both conventional (coal) and renewable energy.

Renewable subprojects include the following:

- Research and development of a wood-based gasifier by Jyoti Solar Energy Institute

- Development of a village-level gasifier by the Indian Institute of Technology (IIT).

- Production of producer gas-powered, small horse power utility engines by IIT.

- Micro/low head hydro project implemented by Roorkee University.

- Creation of a model for planning non-conventional energy development in India by Tata Energy Research Institute.

- Testing of Brookhaven National Laboratory (BNL) polymer film solar collector and components by the Department of Non-Conventional Energy Sources (DNES). BNL provided institutional technical support to the newly created Solar Thermal Energy Center (STEC) of the DNES through the transfer of instrumentation to measure collector thermal performance and through training of STEC staff. The equipment was being used by STEC to measure performance of solar equipment supplied by a number of manufacturers in India seeking product certification.

- Developing plantation stock through improved selection and production of woody biomass using short rotation intensive culture methods in semi-arid marginal lands. Winrock International will provide assistance over a 36-month period to Madurai Kamaraj University/Bharathidasan University (MKU/BU).

- Evaluating the biomass production and fuelwood properties of firewood tree and schrub species grown on substandard soil. Winrock International will assist the National Botanical Research Institute (NBRI) over a 36-month period.

To help DNES function as a data bank on all new and renewable energy sources, a formal link will be established between DNES and U.S. information sources through the Department of Energy, Solar Energy Research Institute, or other agency.

12. R.E. Project Descriptors:

Biomass; Solar collectors; Gasification; Energy planning; Hydropower; Firewood; Solar heating; Water heaters.

13. R.E. Technology Applications:

A. Flat-Plate Collectors

Built the first general concept low-cost, light-weight (BNL-1) flat-plate collector using a patented design referred to as monocoque construction, and tested it in a thermosyphon hot water system. Polymer films were used for the glazing and back seal, adhesively attached to a roll-formed aluminum sheet frame that mates with a rigid insulating polymer foam core. A conventional metal fin and tube absorber plate was used in this first generation model for the absorber-heat exchanger. The collector is approximately one-fourth to one-fifth the weight of the conventional collector made in India (weighing 12 kg versus 50-60 kg). A preliminary analysis revealed that the material costs at Indian prices were about half of those commonly used in the conventional design solar collector:

ESTIMATES OF COLLECTOR MATERIALS COST*
(Rs.)

	BNL DESIGN		CONVENTIONAL DESIGN
	Generation 1	Advanced Generation	
Glazing	150	25	950
Absorber plate	700	250	700
Insulation	120	120	120
Frame	100	100	250
Back seal	50	25	0
Other**	50	50	100
TOTAL	1170	570	2120

*Based on 2 square meter collector
**Mounting hardware, adhesives, etc.

(Sources: Commercialization of BNL Design Solar Collector in India: Phase I Report, 9/85, table from

p. 15, with total adjusted for accuracy, PNAAX003; Solar Thermal Technology Collaborative Research Program Report, 9/85, PNAAX002)

B. Commercialization of Flat-Plate Collector

Explored commercialization possibilities for BNL-1 collector. Market demand for solar thermal energy in India was examined. A tentative commercialization plan was prepared, calling for technology transfer of the BNL-1 collector from the Brookhaven National Lab through an American firm, Alkem Research and Technology (in which the main developer of the collector is one of the principals), to an Indian manufacturer(s). Concerning commercial readiness of the BNL-1 design, additional materials testing of Indian-manufactured polymer foam was considered necessary to test its thermal stability. Testing would also be required on Indian-produced adhesives to determine durability and thermal stability; however, these could be imported initially at little additional cost. A six month development effort was considered necessary for the tooling of the collector frame and the jigging needed for collector assembly, including the design of a special oven for the thermal shrinking of the polymer films onto the collector frame. It was envisioned initially that two of the six components needed for collector assembly, the selectively coated absorber plate and the fluorocarbon polymer film for glazing, would be imported, with complete use of indigenous materials resulting over a progressive period of three to five years. Succeeding generation designs could benefit from developmental work at BNL in the areas of thin materials designs for the heat exchanger and less costly polymers for the glazing.

(Source: Solar Thermal Technology Collaborative Research Program report, 9/85, PNAAX002)

C. Analysis of Domestic Solar Hot Water Systems

Performed a preliminary economic and financial analysis for domestic solar hot water systems, delivering 100 liters of water per day at 60 degree C. temperature, with common domestic electric resistance water heaters (which retail for about Rs. 1500 in New Delhi) providing comparable daily hot water volume and temperature. Retail consumer price of the solar system has been considered for three levels: Rs. 8000 (current technology price - typical current commercial systems that use conventional glass/metal collectors and sell for about Rs. 7000-8000); Rs. 5000 (price possible for current BNL collector design constructed using an intermediate technology); and Rs. 3000 (potential price

for an ultimate advanced design). Since both domestic solar hot water systems and domestic electricity prices are subsidized by the government, four different scenarios were analyzed:

RESULTS OF SOLAR DOMESTIC HOT WATER ANALYSIS
(Discount rate = 10%)

	Solar Cost (Rs.)	IRR (%)	Payback (years)	Net Present Value (Rs.)
SCENARIO I*				
	8000	4.8	8	-1354.4
	5000	20.1	5	1635.2
	3000	55.3	2	3628.2
SCENARIO II**				
	8000	14.2	6	459.6
	5000	47.4	3	2631.7
SCENARIO III***				
	8000	-5.2	greater than 10	-3526.5
	5000	6.3	8	-536.9
	3000	29.9	4	1456.1
SCENARIO IV****				
	8000	31.4	3	2631.7
	5000	83.9	2	4126.5

*Scenario I considers the unsubsidized solar hot water system capital cost and the unsubsidized, "shadow" or economic price of electricity, calculated as Rs. 1.25.
**Scenario II assumes the current 50% subsidy for the solar system and the current subsidized electricity price of about Rs. 0.75 per kWh (in Delhi).
***Scenario III considers unsubsidized solar with the current (subsidized) price of electricity.
****Scenario IV assumes the subsidized solar with the "shadow" price of electricity.

(Source: Solar Thermal Technology Collaborative Research Program Report, 9/85, PNAAX002)

14. R.E. Technical Reports and Publications:

A. Consultant Report on Research Program for Biomass Conversion. Virgil Flanigan, October 2, 1981, 85 pp., PDAAJ008.

Studies the present demands and projected needs for energy in the non-commercial sector. Energy supply in that sector is from conversion of firewood, crop residue, and animal dung. Appendices cover several aspects of village level gasification and biogas-powered small engines.

B. Consultant Report on Research Program for Woody Biomass Production. Charles Hatch, October 16, 1981, 147 pp., PDAAI865.

Focuses on production of woody biomass; program results are claimed to be applicable to both the commercial and non-commercial sectors. A seven-point research program on woody biomass production is laid out. Appendices on several biomass research topics are included.

C. Trip Report. Norman Brown, Asia/TR/STEP. December 11, 1980, 9 pp., PDCAA654.

Narrative trip report; attached is a report by Professor William Hughes (11/22/80) concerning biomass, but also touching on wind and micro-hydro activities.

D. Solar Thermal Technology Collaborative Research Program Report. Solar Thermal Energy Center, India, and Brookhaven National Laboratory, New York, September 1985, 84 pp., PNAAX002.

Reviews the progress of the Brookhaven National Laboratory (BNL) component, and provides a brief description and drawing of the BNL light-weight, low-cost solar collector design, including performance testing and results. A preliminary economic analysis is presented for a domestic solar hot water system. Appendices include a list of equipment provided to the Indian Solar Thermal Energy Center with numerous manufacturers' product sheets.

E. Commercialization of BNL Design Solar Collector in India: Phase I Report. William G. Wilhelm and Vinod Mubayi, Brookhaven National Laboratory, New York, September 1985, 31 pp., PNAAX003.

In assessing potential for commercialization of the BNL solar collector, this report reviews current and projected market demand for solar thermal energy in India. It includes a survey of installations showing the number of systems and total collector area installed by state, a sector breakdown, and extensive listing of individual systems in India. A comparison is made between the BNL collector and conventional commercial

Indian collectors. A tentative commercialization plan is presented.

F. Proceedings of First USAID/GOI Workshop on Alternate Energy Resources and Development: Coal Conversion and Biomass Conversion. New Delhi, November 1983, 548 pp. Available from NTIS, Springfield, VA, 22161, DE85017290, $42.95 plus handling.

Seven papers are included on biomass conversion: (1) "Indian Experience in Gasifying Agricultural Residues" by P.D. Grover; (2) "Small Internal Combustion Engines for Producer Gas Application" by H.D. Mathur; (3) "Wood Gasifier Program" by Surendra Kumar; (4) "Technology Development Through Biomass Conversion" by M.K. Sarkar; (5) "On the Combustion of Corncobs in Fluidized Bed" by A.K. Drona; (6) "Indian Biomass Conversion Experience" by R.C. Maheshwari; and (7) "Development of Small (3-5 kW) Producer Gas Plant Running on Locally Available Waste" by Anil K. Rajvanshi.

G. Second USAID/GOI Workshop on Alternate Energy Resources and Development: Coal Conversion and Biomass Conversion. New Delhi, February 1985, 430 pp. Available from NTIS, Springfield, VA, 22161, DE85017291, $36.95 plus handling.

Twelve papers cover biomass conversion: (1) "Development of a Village Level Gasifier" by P.D. Grover; (2) "Development of Small Size Gasifier - C.I. Engine System for Agricultural Energy Needs" by H.B. Mathur; (3) "Development of Wood-Based Gasifier Engine Systems" by M.B. Durgaprasad; (4) "A Comparative Study of FBC of Low-Grade Fuels" by Dr. A.K. Drona; (5) "Preliminary Experience with a Fixed-Bed Gasifier" by Dr. A.K. Rajvanshi; (6) "Biomass Gasification System" by Dr. R.C. Maheshwari; (7) "Biomass Research Thrust and Programmes" by Dr. S.B. Hukkero; (8) "Biomass Gasification" by Dr. K.S. Shah; (9) "Impact of Biomass Availability on Selection of Energy Systems" by Prof. P.R. Shukla; (10) "Gasifier - A Means of Cooking at No Cost" by Dr. C.S. Shah; (11) "Wood Gasifiers" by Prof. H.S. Mukunda; and (12) "Biomass as an Alternative of Energy for I.C. Engines" by Dr. (Mrs.) P.P. Parikh.

H. Third USAID/GOI Workshop on Alternate Energy Resources and Development: Coal Conversion and Biomass Conversion. New Delhi, December 1985, 552 pp., PNAAW992.

Seven papers cover gasification: (1) "Development and Operation of Biomass Gasification System for 5 HP Irrigation Pumps" by Siddhartha Gaur et al.; (2) "Field Implementation of Gasifier System for Irrigation" by M.B. Durgaprasad et al.; (3) "Preliminary Experience With a

Throatless Gasifier Engine Cum System" by Anil Rajvanshi; (4) "Experience With Gasifiers For 3.7 kW Engines" by S. Dasappa et al.; (5) "Gasification of Pulp and Paper Mill Waste to Replace Fossil Fuel in Lime Kiln" by Harish Dak; (6) "Studies on Biomass Characterization" by N. Anuradha et al.; (7) "Tar Production During Gasification" by P.P. Parikh et al.

15. Evaluations/Major Findings:

A. Project Evaluation Summary for the period 6/82 - 9/84. Diana Swain, Assistant Project Development Officer, and Peter Thormann, Mission Evaluation Officer, October 18, 1984, 5 pp., PDAAR445.

Provides a very general outline of project activities.

16. Key Persons:

A. AID/Washington:

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ANE/TR/ENR, 647-8274

Dave Devin
ANE/PD, 647-2476

B. AID/Mission:

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D. Host Country:

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D.P.D. Grover
Dr. H.B. Mathur
Dr. K.S. Gopal Krishnon
Indian Institute of Technology (IIT)

Mr. B.N. Sarup, Secretary
Department of Non-Conventional Energy Sources (DNES),
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India

Mr. Maheshmar Dayal, Secretary
Solar Thermal Energy Center (STEC) of the Commission for
Additional Sources of Energy (CASE), Government of India,
Technology Bhawan, New Delhi, India

Dr. A. Gnanam
Bharathidasan University
Tiruchirapalli

17. Obligations by Fiscal Year (US$000):

Projected disbursement schedule of total project funding:

FY 82	0
FY 83	1,200
FY 84	1,400
FY 85	1,500
FY 86	900

TOTAL	5,000

(Source: Project Paper, PDCAA641)

18. Host Country Funding of R.E. Components (US$000): 1,300

(Source: Grant Agreement, PDCAA641)

19. Summary of R.E. Costs (US$000):

A. By R.E. Component:

Biomass Production	1,700
Biomass Conversion	600
Information Exchange	700
TOTAL	3,000

(Source: Implementation Letter No. 9, 9/13/85, PDCAL542)

B. Subproject Costs:

JSEI Gasifier	223.1	
ITT Gasifier	251.8	
ITT Engines	230.9	
TATA Modeling	87.0	
BNL/DNES Solar Film	140.0	(plus 233.8*)
R.U. Hydropower	329.0	
TOTAL	1,261.8	

(Source: Implementation Letter No. 9, 9/13/85, PDCAL542; *PIO/T No. 386-0474-2-60033, 5/86, PDCAP825)

C. Winrock International contracts:

	MKU/BU	NBRI
Technical Assistance	92	69
Training/Study Tours	104	75
Equipment/Commodities	*	220
Others	22	20
TOTAL	218	384

*Attachment No. 1 to PIO/T No. 386-0474-3-20122, which lists $220,000 estimated budget for equipment for the NBRI subproject and increasing the PIO/T by this amount, also indicates estimated $184,000 for MKU/BU subproject; however no official amendment to PIO/T No. 386-0474-3-

20123 adding this amount is provided. Implementation Letter No. 10 indicates that the estimated cost for the MKU/BU subproject is $418,000.

(Sources: PIO/T No. 386-0474-3-20122, 6/86, PDCAP826; PIO/T No. 386-0474-3-20123, 6/86, PDCAP823; Implementation Letter No. 10, 1/14/86, PDCAP829)

20. R. E. Component Revisions:

A. PACD extended from June 30, 1986, to June 30, 1987.

(Source: Implementation Letter No. 7, 4/13/84, PDCAI501)

B. PACD extended from June 30, 1987, to June 30, 1988.

(Source: Implementation Letter No. 11, 2/3/86, PDCAM895)

C. Micro and Low-head Hydro Electric System project, a joint venture between Roorkee University and Boston University, was granted an extension from December 31, 1984, to December 31, 1985. To complete project activities, AID will provide additional $29,000 from the Information Exchange component of the subject grant.

(Source: Implementation Letter No. 8, 7/11/85, PDCAL542)

D. Project Paper puts total host country funding at $2,285,000 but Grant Agreement and subsequent documents specify $1,700,000.

(Source: Grant Agreement, 6/30/82, PDCAA642)

E. Responsibility within GOI for implementing project shifted from the Commission for Additional Sources of Energy (CASE) to the Department of Non-Conventional Energy Sources (DNES).

(Source: PES, 10/84, p. 2, Section 15, PDCAM894)

F. $220,000 was added to the NBRI subproject for the purchase of equipment/commodities.

(Source: PIO/T No. 386-0474-3-20122, 6/86, PDCAP826)

G. BNL was granted an additional $233,800 to assist the STEC over an 18-month period in developing new materials analysis capabilities for the BNL thin-film solar collector components and systems.

(Source: PIO/T No. 386-0474-2-60033, 5/86, PDCAP825)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: June 1986 (mgz)
Revised February 1987 (jrl)

1. Project Number: 3860475 2. Geo: INDIA

3. Title: MADHYA PRADESH SOCIAL FORESTRY

4. Project Life/PACD: 1981-87/March 31, 1987

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 25,000*

   B. R.E. Components: Not specified

   *Telegram of 6/86 indicates USAID/India intends to deobligate a total of $6,900,000; figure does not reflect this deobligation.

   (Sources: Project Implementation Report, 9/85, PDCAM897; State Department telegram, 6/86, PDCAP831)

7. Loan or Grant/Appropriation Category (US$000):

   L / FN / 24,000*
   G / FN / 1,000*

   *Telegram of 6/86 indicates USAID/India intends to deobligate $6,100,000 of loan funds and $800,000 of grant funds; figures do not reflect this deobligation.

   (Sources: DIS; State Department telegram, 6/86, PDCAP831)

8. Project Purpose:

   To create the institutional capability to assist villagers to manage communal and private lands for increased and sustained production of forest products through establishment of a forestry extension organization; institutionalization of communal plantations on village commons and government wasteland; and production and distribution of seedlings for reforestation on private lands.

9. Renewable Energy (R.E.) Outputs:

   Approximately 63,750 hectares of plantations planted to produce firewood, fodder, and poles; Estimated annual plantation production of 108,000 cubic meters of small timber and firewood and 150,000 metric tons of green fodder and grass; 135 nurseries established and 1,800 people trained

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for extension and nursery management; Social Forestry Directorate created to coordinate extension activities.

10. R.E. Inputs:

Financing for plantations and nurseries; Training; Technical assistance.

11. Summary of R.E. Components:

This social forestry project is designed to help villagers in Madhya Pradesh increase forest production on communal and private lands. The project will establish a Social Forestry Directorate (SFD) to coordinate extension activities. The first 2 years of this 6 year project focus on training, extension, and pilot planting. The final 4 years will be devoted to full-scale extension and planting operations covering 20,000 ha/yr.

Helped by 3,300 SFD personnel, villagers will establish mixed plantations (about 80% firewood species) supplying firewood, fodder, small timber, fruit, and other produce on 63,750 hectares of degraded land. The plantations are expected to produce 25% of the current annual firewood needs in 5,000 villages while also increasing fodder production. Community nurseries will be established to produce seedlings both for the plantations and for distribution to farmers using private lands.

The Project Evaluation Summary of December 1983 cites 176 community plantations established and 11,792 hectares (1983 target was 12,075) planted, with survival rates estimated at over 70%. The nurseries have distributed 3.5 million seedlings and 87,000 seed packs for private farmers. Demand for seedlings and seedpacks is currently outstripping SFD's ability to respond.

12. R.E. Project Descriptors: Firewood.

13. R.E. Technology Applications:

Tree species to be planted in four model plantations (groups I and II for western Madhya Pradesh, and groups III and IV for eastern Madhya Pradesh):

A. TREE SPECIES

GROUP I: HIGH VOLUME WOOD & TIMBER

Eucalyptus hybrid	1600/HA
Cleistanthus collinus	1600/HA
Gmelina arborea	1600/HA
Sesbania grandiflora	

GROUP II: FRUIT

Mangifera indica	600/HA
Tamarindus indica	600/HA
Emblica officinalis	600/HA
Zizyphus jujuba	30/HA
Anacardium occidentali	600/HA

GROUP III: BAMBOO

Dendrocalamus strictus	156/HA

GROUP IV: ALL PURPOSE

Leucaena leucocephala	1000/HA
Dalbergia sissoo	1000/HA
Prosopis juliflora	1000/HA
Acacia spp.	1000/HA
Albizzia lebbeck	1000/HA
Terminalia tomentosa	1000/HA
Pongamia pinnata	1000/HA

B. GRASS SPECIES

Schima neruosum
Andropogon spp.
Cenchrus ciliaris
Chrysopogon montanus
Dicanthium annulatum
Eremopogon foveolatus
Panicum antidotale

(Source: Project Paper, Annex 2, p.3, PDCAA656)

14. R.E. Technical Reports and Publications:

A. Outstanding Social Issues in the Proposed Madhya Pradesh Social Forestry Project. J. Gabriel Campbell, April 14, 1980, 21 pp., PDCAA674.

Research report examines the project's proposed treatment of the fundamental problems underlying the trends of deforestation and increasing scarcity of wood products and fodder. Ways in which the project could be refined are suggested.

15. Evaluations/Major Findings:

A. Project Evaluation Summary for the Period 9/81 - 11/83. Harold E. Fisher, Project Officer; John R. Westley,

Mission Evaluation Officer; and D.G. Sharma, Director, Social Forestry Directorate; December 1983, 26 pp., PDCAH330.

Recommendations are made on eight project-related issues, the project is summarized, and external factors, inputs, outputs, purpose, goals, and follow-on suggestions are discussed.

Major findings:

- o Panchayats are supporting the program, but they still view it as a government effort and are not yet willing to take on long-term management. Initiatives for starting plantations have so far come from the Social Forestry Directorate.

- o Demand for trees is growing among private farmers, so SFD should expand its farm forestry efforts focused on small and marginal farmers.

- o The demand for seedlings is growing, and the SFD should encourage establishment of private and institutional nurseries to meet the demand.

16. Key Persons

A. AID/Washington:

Dr. Robert Ichord
ANE/TR/ENR Room 4440 N.S., Washington, D.C. 20523, 647-8274

Ann MacDonald
ANE/SA/I-India, Desk Officer, 647-3516

B. AID/Mission:

Dave Heesen, Project Manager
Harold E. Fisher, Project Officer
USAID, American Embassy, West Building, Chanakyapuri, New Delhi 11021, India, Telephone: 690351

C. Contractors: None

D. Host Country:

D.G. Sharma, Director
Social Forestry Directorate

17. Obligations by Fiscal Year (US$000):

Scheduled disbursement of funds for entire project:

US FY	Loan	Grant	Total
82	2,300	100	2,400
83	3,400	200	3,600
84	4,300	200	4,500
85	5,200	200	5,400
86	5,800	200	6,000
87	3,000	100	3,100
TOTAL	24,000	1,000	25,000

(Source: Project Paper, PDCAA656)

18. Host Country Funding of R.E. Components (US$000): 25,000*

*For entire project; R.E. costs not specified separately.

(Source: Project Implementation Report, 9/85, PDCAM897)

19. Summary of R.E. Costs (US$000):

Distribution of funds obligated as of March 31, 1984:*

LOAN	
Staff	5,139
Operations	2,622
Nurseries	3,119
Plantations	9,042
Commodities	1,576
Construction	2,502
GRANT	
Technical Assistance	480
Training	520
TOTAL	
Loan	24,000
Grant	1,000
TOTAL	25,000

*For entire project; R.E. costs not specified separately.

(Source: Quarterly Status Report, 3/31/84, PDCAH329)

20. R.E. Component Revisions:

A. The 1983 project evaluation recommended that tree planting along roadsides should be dropped from the project because the practice is expensive and is being carried out by other agencies in Madhya Pradesh. Implementation Letter No. 8 affirmed elimination of the remaining 625 hectares of the roadside component.

(Sources: Project Evaluation Summary, 12/83, p. 1, PDCAH330; Implementation Letter No. 8, 3/21/86, PDCAQ200)

B. The farm forestry component was expanded and strengthened by the raising and distribution of 74.3 million seedlings.

(Source: Implementation Letter No. 8, 3/21/86, PDCAQ200)

C. A pilot program for promoting fuel saving devices, to be undertaken in collaboration with other groups already working in this activity, was added to the project with an operational budget of Rs. 5 lakh.

(Source: Implementation Letter No. 8, 3/21/86, PDCAQ200)

D. USAID/India indicated its intention to deobligate $6,100,000 in loan funds and $800,000 in grant funds after concluding, based on a pipeline analysis and recent evaluation, that these funds could not be spent by the PACD and that they could better be utilized by other projects.

(Source: State Department Telegram, 6/86, PDCAP831)

21. Follow-On Activities:

A. The AID project staff recommends a second project phase to assure continuity of tree planting efforts and the institutionalization of the SFD. No trees would be harvested before the present PACD, so the issue of equitable distribution of woodlot produce would have to be handled in the second phase.

(Source: PES, 12/83, PDCAH330)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: June 1986 (mgz)
Revised February 1987 (jrl)

1. Project Number: 3860478 2. Geo: INDIA

3. Title: MAHARASHTRA SOCIAL FORESTRY

4. Project Life/PACD: 1982-90/September 30, 1990

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 30,000

   B. R.E. Components: 25,000

   (Source: Project Implementation Report, 3/85, PDCAL555)

7. Loan or Grant/Appropriation Category (US$000):

   L / FN / 25,000
   G / FN / 5,000

   (Source: DIS)

8. Project Purpose:

   To develop the institutional capability of the Maharashtra Horticulture and Social Forestry Department (H&SFD) to assist villages in Maharashtra to manage communal and private lands for increased and sustained production of forest products.

9. Renewable Energy (R.E.) Outputs:

   Project to promote social reforestation program in 4,300 villages; 81,000 hectares of firewood, fodder, and fruit tree plantations planted; 54 district nurseries and 4,300 private nurseries established; 200 extension workers trained; 150 research reports anticipated.

10. R.E. Inputs:

    Local costs financing; Consultancies; Training; Research and evaluation.

11. Summary of R.E. Components:

    The project is designed to help the Horticulture and Social Forestry Department in the State of Maharashtra to promote a village reforestation program. The program, which will be

active in all 27 rural districts of Maharashtra, will promote planting of firewood, fodder, fruit, and other seedlings in 4,300 villages. Approximately 18.5 hectares will be planted in each village, 9 on government or community wasteland, the remainder on non-arable private land. A total of 81,000 hectares will be planted. The H&SFD has been strengthened with newly trained extension workers to carry out the program.

The H&SFD will establish 54 district nurseries to provide technical assistance and training so that a private, self-sustaining nursery can be established in each village. The district and village nurseries combined will produce 99 million seedlings annually. Of the 81,000 hectares to be reforested, 38,000 hectares will be block plantations producing firewood and fodder, 38,000 hectares will be on private lands, and the remainder will be for soil/water conservation and demonstration purposes.

12. R.E. Project Descriptors: Firewood.

13. R.E. Technology Applications: Not specified

14. R. E. Technical Reports and Publications:

    A. An Investment Analysis of the Proposed Social Forestry Project in Maharashtra. Lee Medema, New Delhi, May 5, 1982, 71 pp., PDCAA694.

       This report examines the investment feasibility of the project, according to (1) a financial perspective, in which market prices were used to value costs and benefits, and (2) an economic perspective, in which "shadow" prices were employed. The author deems the project "financially desirable."

    B. Technical Report. Report on file with Office of Agriculture and Rural Development in AID Mission, New Delhi.

       Pre-project paper report outlining tree and grass species suggested by design team. (Mentioned in project literature; copy not available for review)

15. Evaluations/Major Findings:

    A. Maharashtra Social Forestry Project: Mid-term Evaluation Report. Dr. Charles R. Hatch, et al., New Delhi, 2/19/86, 58 pp., PDAAT417.

       Major findings include:

       o Community and private tree planting activities have achieved or exceeded goals.

- Villager demand for both community plantations and private tree planting increasing; villages now approaching H&SFD to start plantations; demand for seedlings outstripping supply.

- H&SFD employees, who have traditionally opposed exploitation of forests, have been enthusiastic in extension efforts.

- H&SFD had planned to transfer responsibility for community plantations to rural leaders after fourth year, but villagers hesitant to accept it.

- H&SFD human resources shifted almost exclusively to extension activities.

- The assumption that fuelwood and fodder (as opposed to wood as a cash crop) would be sufficient incentive to get villagers to participate in program appears invalid.

Recommendations include:

- All villages be assigned motivators, who will be given special training and who will encourage the community to take over care of plantations.

- Private nurseries be expanded; government seedling distribution program be evaluated to remove disincentives.

- Three to five alternate plans for distribution of products from community plantations be developed; communities allowed to choose best plan for specific situation.

- Encourage women to operate small private nurseries adjacent to their homes.

Physical targets and achievements, as of date of evaluation:

PLANTATIONS	TARGET	ACTUAL
Block	15,035	14,723
Private	15,035	20,708
Watershed	240	129
Strip	1,290	1,691
Scheduled Castes	800	837
TOTAL	32,400	38,088

16. Key Persons:

A. AID/Washington:

Pat Matheson
ANE/PD/SA, 647-2476

B. AID/Mission:

Harold E. Fisher, Project Officer
USAID, American Embassy, West Building, Chanakyapuri, New Delhi, 110021 India, Telephone: 690351

C. Contractors: Not specified

D. Host Country:

D.G. Sharma, Director
Social Forestry Directorate

17. Obligations by Fiscal Year (US$000):*

US FY	Loan	Grant	Total
83	1,890	625	2,515
84	2,962	911	3,873
85	3,580	987	4,567
86	5,360	835	6,195
87	5,704	464	6,168
88	2,204	388	2,592
89	2,160	362	2,522
90	1,080	428	1,508
TOTAL**	25,000	5,000	30,000

*For entire project, R.E. costs not specified separately.

**Columns may not add due to rounding.

(Source: Project Paper, p.39, PDCAA695)

18. Host Country Funding of R.E. Components (US$000): 30,000

(Source: Project Paper, PDCAA695)

19. Summary of R.E. Costs (US$000):*

PROJECT ELEMENT	LC	FX	TOTAL
LOAN			
Plantations: Direct costs	14,190	---	14,190
Plantations: Indirect costs			
H&SFD Staff	7,876	---	7,876
Operations Costs	2,934	---	2,934
Subtotal, Plantations, Loan	25,000	---	25,000
GRANT			
Technical Support	500	800	1,300
Training			
Overseas	---	1,120	1,120
In-country	1,340	---	1,340
Research	1,140	50	1,190
Evaluation	---	50	50
Subtotal, Grant	1,980	2,020	5,000
TOTAL	27,980	2,020	30,000

*For entire project, R.E. costs not specified separately.

(Source: Implementation Letter No. 6, 4/19/85, PDCAL553)

20. R.E. Component Revisions:

A. The third and final payment of AID's contribution to the village block plantation reforestation program was accelerated from two years after planting to one year after planting. The payment becomes due upon presentation of a "survival report" by H&SFD.

(Source: Implementation Letter No. 5, 3/18/85, PDCAK378)

B. The Information and Technology Unit (ITU) was dropped from the project. The social and technical research necessary for project success fell to Indian state agricultural universities, to be supported by Indian and U.S. consultants.

(Source: Implementation Letter No. 6, 4/19/85, PDCAL553)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: June 1986 (mgz)

1. Project Number: 3860488 2. Geo: INDIA

3. Title: FORESTRY RESEARCH, EXTENSION AND TRAINING

4. Project Life/PACD: 1987-92/PACD not specified

5. Status: Planned

6. LOP Funding (US$000):

   A. Entire Project: 20,000

   B. R.E. Components: Not specified

   (Source: Incoming Telegram, 10/85, PDCAL572)

7. Loan or Grant/Appropriation Category (US$000):

   G / ARDN / 8,000
   L / ARDN / 12,000

   (Source: Incoming Telegram, 10/85, PDCAL572)

8. Project Purpose:

   To broaden India's institutional capacity to train forest managers, forest extension specialists, and forest scientists; and to generate appropriate technologies for use by forest managers and extension specialists in preparing and implementing forest development strategies.

9. Renewable Energy (R.E.) Outputs:

   A planning cell, under the direction of the Inspector General of Forestry, to enhance Government of India (GOI) ability to develop policy and fiscal strategy for forestry problems; Textbooks, film, course syllabi; Trained personnel; Research publications.

10. R.E. Inputs:

    Financial assistance.

11. Summary of R.E. Components:

    The Government of India, with the assistance of the World Bank, AID, and several other donors, will design a program to train personnel associated with forestry management, extension, and science activities. This effort will be

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concentrated at the National Forest Research Institute, forestry colleges, agricultural universities, and forestry technical schools throughout India. In addition to training, the program will provide support to forestry department research laboratories, universities, and public and private research institutes for development of appropriate technology for use in priority areas such as agroforestry and biomass energy plantations.

Direct and immediate beneficiaries will include village land owners participating in social forestry programs who will more fully meet their fuelwood, fodder, forest products, and cash income needs; forest workers who will be assured of more continuous employment from forest activities; forest industries which will be assured of a more sustained resource base; and land management agencies which will benefit from a staff trained to develop, adopt, and implement appropriate technologies into their management strategies.

12. R.E. Project Descriptors:

Firewood; Biomass.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

Dave Devin
Asia/PD

B. AID/Mission: Not specified

C. Contractors: Not specified

D. Host Country:

K.M. Tiwari, President
Forest Research Institute and Colleges, Dehra Dun, Uttar Pradesh, India

17. Obligations by Fiscal Year (US$000):

Initial obligation, FY87, $14,000

(Source: Incoming Telegram, 10/85, PDCAL572)

18. Host Country Funding of R.E. Components (US$000): Not specified

19. Summary of R.E. Costs (US$000): Not specified

20. R.E. Component Revisions: Not specified

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: June 1986 (mgz)

---------- AID RENEWABLE ENERGY DATA BASE ----------

1. Project Number: 3860495 2. Geo: INDIA

3. Title: NATIONAL SOCIAL FORESTRY

4. Project Life/PACD: 1985-90/July 31, 1990

(Source: Grant/Loan Agreement, p. 4, 6/26/85, PDCAL582)

5. Status: Active

6. LOP Funding (US$000):

A. Entire Project: 80,000*

B. R.E. Components: Not specified

*Telegram of 9/86 indicates additional budget allowance of $6.1 million.

(Source: Project Loan and Grant Agreement, 6/26/85, PDCAL582; State Department telegram, 9/86, PDCAQ202)

7. Loan or Grant/Appropriation Category (US$000):

G / FN/ 3,000
L / FN/ 77,000*

*Telegram of 9/86 indicates additional loan of $6.1 million.

(Sources: DIS; Project Loan and Grant Agreement, 6/26/85, PDCAL582; *State Department telegram, 9/86, PDCAQ202)

8. Project Purpose:

To develop effective government and private sector capacities in the states of Uttar Pradesh, Rajasthan, Gujarat, and Himachal Pradesh for carrying out alternative social forestry programs; To help build the capacities of the four states and the central government to evaluate the effectiveness of their different social forestry programs; To develop policies and government and private sector initiatives to meet India's long-term forestry needs.

9. Renewable Energy (R.E.) Outputs:

Alternative tree production programs; Institutional development; Central Social Forestry Support Office.

10. R.E. Inputs:

Loan funding for Alternative Tree Production Program, institutional development, staffing; Grant funding for training, technical assistance, and research.

11. Summary of R.E. Components:

India consumes forest products (primarily in the form of fuelwood, fodder, and small timber) at roughly four times the rate at which it generates these resources, and the problem is getting worse. Roughly 50% of India was forested at the turn of the century; the figure is now below 12%. In response, the Government of India (GOI) has instituted large scale "social forestry" programs to promote tree planting throughout the country.

This project contains three elements. First, support will be extended for several types of plantation programs including farm forestry, "tree tenure" schemes aimed at landless persons and marginal farmers, community-managed plantations on wastelands near villages, and plantations on government wastelands. Second, funds will be provided to the farm states participating in the project to expand staff, to develop research, extension, and training facilities, and to build effective monitoring, evaluation, and planning capabilities (small cookstove components may be included in state projects). Finally, the project will assist the GOI in exchanging information among states, carrying out national studies of need in social forestry, and fostering common and cost-effective approaches toward social forestry programs.

12. R.E. Project Descriptors:

Firewood.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications:

A. An Operational Guide to the Monitoring and Evaluation of Social Forestry in India. World Bank/FAO, 1982.

GOI requested the World Bank and FAO to develop guidelines for monitoring and evaluation which could be used in social forestry projects throughout India. After review and revision, the Guide was issued to the states for pilot testing. (This Guide was mentioned in the Project Paper but no copy was found amongst project literature.)

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

Peter Bloom
ANE/ASIA/ PD, Office of Project Development, Room 3310
N.S., Washington, D.C. 20523

B. AID/Mission:

A. Ray, Project Officer
USAID, American Embassy, West Building, Chanakyapuri, New Delhi 110021, India

C. Contractors: Not specified

D. Host Country: Not specified

17. Obligations by Fiscal Year (US$000):

Projection of disbursements for entire project:

FY	AID LOAN	AID GRANT	TOTAL
85	3,076.2	0	3,076.2
86	9,232.2	450.3	9,682.5
87	12,794.2	580.9	13,375.1
88	15,654.0	599.0	16,253.0
89	18,967.8	647.8	19,615.6
90	17,275.6	683.8	17,959.4
TOTAL	77,000.0	2,961.8	79,961.8

(Source: Project Paper, PDAAS397)

18. Host Country Funding of R.E. Components (US$000): 250,000*

*For entire project; R.E. costs not specified separately; includes $165.0 million provided by the International Development Association.

(Source: Grant/Loan Agreement, 6/26/85, PDCAL582)

19. Summary of R.E. Costs (US$000):

Illustrative Financing Plan*

	GRANT	LOAN
Training	2,685	
Technical assistance	134	
Special studies and evaluation	140	
Research operation and grants	41	
Alternative-tree production programs		
Nursery development and farm forestry		19,724
Tree tenure planting		5,048
Community forest		18,793
Wasteland plantation		19,643
Fuelwood saving devices		216
Staff salaries		13,576
TOTAL	3,000	77,000

*For entire project; R.E. costs not specified separately.

(Source: Project Loan and Grant Agreement, Attachment 1, 6/26/85, PDCAL582)

20. R.E. Component Revisions:

A. USAID/India indicated its intention to reobligate $5,700,000 in loan funds to the project. Three months later, AID/Washington informed mission that FY allowance was increased by $6.1 million.

(Sources: State Department telegram, 6/86, PDCAP915; State Department telegram, 9/86, PDCAQ202)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: June 1986 (mgz)
Revised February 1987 (jrl)

1. Project Number: 3880045.07 2. Geo: BANGLADESH

3. Project Title: PVO CO-FINANCING II. SUBPROJECT 07: ENERGY FROM RICE HUSKS

4. Subproject Life/PACD: 1981-84(extended to 86)/May 1986

5. Status: Subproject terminated

6. LOP Funding (US$000):

   A. Subproject: 925.737

   B. R.E. Components: 925.737

   (Source: Grant Agreement, Attachment A, p. 28, 6/22/81, PDAAH972)

7. Loan or Grant/Appropriation Category (US$000):

   G / 925.737

8. Project Purpose:

   To design, develop, and test a rice husk-fueled Stirling power system for providing motive power for small rural rice mills in Bangladesh.

9. Renewable Energy (R.E.) Outputs:

   A 5 h.p. Stirling power unit developed.

10. R.E. Inputs:

    Technical assistance; Commodities; Construction.

11. Summary of R.E. Components:

    A grant was provided to the Asia Foundation to develop a rice husk-fueled external combustion Stirling power unit suitable for manufacture in small local shops in Bangladesh. The unit would be used in local rice milling operations. A three-phase program was funded, with each phase setting performance criteria against which outputs could be reviewed and evaluated before project continuation.

    During Phase I, Sunpower Inc. carried out the design and provision of the original prototype engine. Accomplishments during Phases II and III included two redesign cycles at the

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Kumudini Welfare Trust in Bangladesh and continuous modifications of individual components, aimed principally at adapting the engine to indigenous materials, production methods, and skills. In 1986, a new design incorporating a stronger and simpler linkage was fabricated and underwent initial testing. A final proven design had not emerged by the end of the subproject, and the engine was never field tested. However, subsequent to the project, the engine was refined and is now being produced by Stirling Technology.

12. R.E. Project Descriptors:

Biomass; Rice husks; Rice; Stirling engines.

13. R.E. Technology Applications:

A. A prototype 5 horsepower rice husk fueled Stirling engine was developed and tested at Sunpower Inc.'s facility in Athens, Ohio, and shipped to Bangladesh. The prototype was redesigned to improve performance and especially to adapt to materials and skills available in small shops in Bangladesh. Two intermediate models were developed. Auxiliaries (blower, compressor, and cooling water pump) were designed and/or added to the system to replace the electric devices in the original prototype. An integral engine powered blower, started by a hand pulley, was developed. After two designs of a built-in air compressor failed to operate satisfactorily, a locally-procured compressor was mounted on the side of the engine and attached by belt to the jackshaft that drives the blower. Likewise, a water pump purchased in the local market was mounted on the side of the engine and attached by belt to the jackshaft to cool the engine. The engine was adapted to be made principally of cast iron, while the heater, the most critical component, was made mostly of 304 stainless steel. Engine characteristics are as follows: 720 rpm engine operating speed; 650 degrees C. heater operating temperature; air (the operating fluid) pressurized to 3-5 bar; displacement of over 7 liters; and 4-5 h.p. power production.

Two specialized methods were adopted for production of the in-field intermediate models: explosive forming for making the heater dome and displacer dome; and furnace brazing of the external fins and internal corrugated heat exchanger of the heater. A natural draft gas fired brazing furnace was constructed of locally available insulating and refractory bricks. Subsequent modifications to the engine, however, eliminated the need for furnace brazing.

At the end of 1985, problems still existed in the second intermediate model, including leaking of the porous

aluminum cast cooler; porosity in the cast iron cylinder liner causing a slight leak; slight ovality of the cylinder liner toward the end in which the displacer runs; the need for crankcase modification if a horizontal position is maintained, or furnace modification if a vertical orientation of the crankcase is selected; and need for improved durability of the displacer drive linkage.

(Source: Second Interim Report: Rice Husk Energy Project, 11/85, PDAAV016)

B. Development of the external combustion Stirling engine by the project led to a refined design by Stirling Technology, a firm founded by former employees of Sunpower Inc. This occurred out of the context of the AID-funded project. The 200-kg ST-5 multifuel Stirling engine provides over 5 HP of shaft power (3 kW electric) at 650 RPM; consumes 38 kW of heat (approximately 10 kg/hr of wood); has dry bearings; uses air as the working fluid with 5 bar of working pressure, self-pressurizing; has heater head temperature of 650 degrees centrigrade; has minimum expected life of 10,000 hours; and has a 2,000 hour expected overhaul time, with bearings and seal to be checked and replaced if necessary. Two burners are available: a cyclone burner for small particle fuels such as sawdust or other shredded biomass and a two-stage wood burner.

(Source: The ST-5 and Total Energy Independence, brochure, Stirling Technology, Inc., 9 Factory St., Athens, OH 45701, (614) 594-2277)

14. R.E. Technical Reports and Publications:

A. Second Interim Report: Rice Husk Energy Project. L. Merrick Lockwood, The Asia Foundation, Dhaka, Bangladesh, November 1985, 92 pp., PDAAV016.

This report details the activities undertaken by the subproject to develop a rice husk fueled Stirling engine. Design and fabrication avenues that were explored and either adopted or abandoned are discussed. Appendices include production cost projections, sample data sheets with limited engine runs, photographs of the intermediate models developed, and design drawings for the second intermediate model. This report is intended especially for researchers, rather than manufacturers, since a fully developed model suitable for manufacture had not yet been achieved; drawings do not represent a final design, and work was proceeding at the time of report writing to overcome problems and modify the engine design.

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington: Not specified

B. AID/Mission: Not specified

C. Contractors:

Gwendellyn Bevis, Bangladesh Desk Officer
The Asia Foundation
(415) 982-4640

L. Merrick Lockwood
33b Road 36, Gulshan
Dhaka, Bangladesh
604860

William Beale
Sunpower, Inc.
6 Byard Street
Athens, Ohio 45701
(614) 594-2221

Craig Kinzelman
Stirling Technology, Inc.
9 Factory Street
Athens, Ohio 45701
(614) 594-2277

D. Host Country:

Kumudini Welfare Trust of Bengal
Narayanganj, Bangladesh

17. Obligations by Fiscal Year (US$000):

YR 1	477.709
YR 2	244.745
YR 3	203.283

(Source: Grant Agreement, Attachment A, p. 28, 6/22/81, PDAAH972)

18. Host Country Funding of R.E. Components (US$000): 200.708*

*Illustrative amount.

(Source: Grant Agreement, Attachment A, p. 28, 6/22/81, PDAAH972)

19. Summary of R.E. Costs (US$000):

SUMMARY OF AID BUDGET COSTS

Design costs	240.000
Facilities	37.400
Personnel	338.714
Equipment	70.050
References & publishing costs	7.800
Asia Foundation program management costs	63.595
Indirect costs	168.178
TOTAL	925.737

(Source: Grant Agreement, Attachment A, p. 28, 6/22/81, PDAAH972)

20. R.E. Component Revisions: Not specified

21. Follow-On Activities:

A. In 1984, Stirling Technology, a company formed by two former employees of Sunpower Inc., entered into a joint venture with a newly established firm in Madras, India, to manufacture a refined version of the Stirling engine developed under the project. This was a small-scale industry, far larger than the local-level production attempted in Bangladesh. A factory was built and the engine redesigned, incorporating patented features (which was not allowed under the AID project) and more sophisticated materials than those found in the Bangladesh design. Power, reliability, and fuel consumption requirements have been met. Early production machines are being produced and delivery is just starting. Arrangements are being made to upgrade production facilities to meet market demand.

(Source: The ST-5 and Total Energy Independence, brochure, Stirling Technology Inc., 9 Factory St., Athens, OH 45701, (614) 594-2277)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: May 1987 (jrl)

---------- AID RENEWABLE ENERGY DATA BASE ----------

1. Project Number: 3910366 2. Geo: PAKISTAN

3. Title: INSTITUTIONAL GRANTS

4. Project Life/PACD: 1974-78/September 30, 1978

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 240

   B. R.E. Components: Not specified

   (Source: DIS)

7. Loan or Grant/Appropriation Category (US$000):

   G / EH / 240

   (Source: DIS)

8. Project Purpose:

   To enhance the capability and performance of the Institute for Educational Research and the Engineering College of the University of Peshawar through continuing linkages with U.S. educational and research institutions.

9. Renewable Energy (R.E.) Outputs:

   Solar energy seminars and workshops conducted; Cooperative research undertaken in renewable energy fields.

10. R.E. Inputs:

    Grant funds.

11. Summary of R.E. Components:

    This project supported cooperative programs between the Engineering Faculties of the University of Peshawar (UP) and Colarado State University (CSU), and between the Institute for Educational Research (IER) in Lahore and Indiana University (IU). Activities included faculty exchanges, short-term consultancies, graduate student exchanges, cooperative research, joint seminars and conferences, and the acquisition of library material and instruments and lab equipment.

100

The IER/IU collaboration concentrated on the field of education and did not concern renewable energy.

The UP and CSU jointly conducted a national seminar and workshop on Solar Energy Applications at Peshawar in March 1976 and an international seminar on Solar Energy in March 1977. Ten experts from the U.S. and developing countries and 60 Pakistani experts participated in the 1976 workshop. George Lof, Director of CSU's Solar Energy Applications Laboratory, was the keynote speaker for the 1976 seminar and workshop. Dr. S. S. Karaki, Associate Director of the Solar Energy Applications Laboratory, helped organize and participated in the 1977 seminar. The two consultants also advised the Director of Research and the faculty of UP in development of research programs in solar energy applications.

Cooperative research between UP and CSU involved renewables. This varied from research work undertaken in pursuit of graduate student theses to that conducted for outside organizations. Specific research topics, planned at CSU and conducted at UP, included the following: low-cost, small-scale water turbines, solar water pumps, and solar grain dryers. Other topics dealing with solar energy and biogas were identified. Funding support for the research came from outside sources.

12. R.E. Project Descriptors:

    Solar energy; Water pumps; Crop driers; Biogas; Hydroelectric power; Turbines.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings:

    A. Joint Review of the Institutional Grants. USAID, Peshawar, January 21, 1976, 6 pp., PDAAD184.

       This report contains the minutes of the joint review meeting held at Peshawar on January 14, 1976. It summarizes discussions held concerning project activities undertaken in 1975 by the Faculty of Engineering/ University of Peshawar and Colorado State University. The major focus is on problems with availability of local funds and on actions needed to resolve the problems. The renewable energy activities are not discussed.

    B. Final Evaluation Report: Institutional Grants Project (UP/CSU Subproject), Faculty of Engineering, University

of Peshawar and College of Engineering, Colorado State University, 76 pp. plus 7-page PES, PDAAD183.

The evaluators judged that the project was 70% successful in attaining its original goals: more than 50% of the faculty exchange objective was achieved; only 30% of the short-term consultancies took place, due to the inability of CSU to arrange for senior faculty members to visit PU for 2-4 week periods; 70% of the library exchange occurred; at least 90% of the graduate student exchange took place; 70% of the cooperative research was conducted; at least 95% of seminars, workshops, and conferences took place; at least 95% of senior staff/administrator exchange occurred; and 90% of the equipment and instruments activity was achieved. The National Advisory Board activity was only partially successful; the In-Service Study activity was rated at about 10% successful. The evaluation recommended that (1) the Faculty of Engineering be made a full-fledged "Engineering University" in order to achieve a certain degree of autonomy and (2) a reward system and structure be created to encourage faculty to be hard working and creative and to strive to make the university a "Center of Excellence."

16. Key Persons:

A. AID/Washington:

Marvin E. Hurley, NESA/TECH

B. AID/Mission:

Charles D. Matthias, Project Director

C. Contractors:

Dr. Maurice L. Albertson, Project Co-Director
Colorado State University
Solar Energy Applications Laboratory, Foothills Campus,
Fort Collins, CO 80523
(303) 491-1101

D. Host Country:

Dr. M. Atahullah, Dean, Faculty of Engineering and Project Co-Director
Professor Iqbal Shah, Director of Research, Faculty of Engineering
University of Peshawar

17. Obligations by Fiscal Year (US$000):

DISBURSEMENTS TO COLORADO STATE UNIVERSITY*

FY 76	FY 77	FY 78	TOTAL
50	52.5	17.5	120

*Only figures available.

(Source: Third Annual Project Implementation Plan, 5/77, PDAAD184)

18. Host Country Funding of R.E. Components (US$000): Not specified

19. Summary of R.E. Costs (US$000): Not specified

20. R.E. Component Revisions: Not specified

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: October 1986 (jrl)

---------- AID RENEWABLE ENERGY DATA BASE ----------

1. Project Number: 3910478 2. Geo: PAKISTAN

3. Title: ENERGY PLANNING AND DEVELOPMENT

4. Project Life/PACD: 1983-88 (extended to 90)/July 31, 1990

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 30,000

   (Source: Project Implementation Report, 11/84, PDCAK163)

   B. R.E. Components: 2,649

   (Source: Project Paper, 5/23/83, PDAAN203; these funds may have been transferred to other components, see Revisions, below)

7. Loan or Grant/Appropriation Category (US$000):

   G / ES / 30,000

   (Source: DIS)

8. Project Purpose:

   To assist the Government of Pakistan (GOP) to formulate and implement plans and programs to assess, develop, and use Pakistan's indigenous energy resources and to improve the efficiency of energy use.

9. Renewable Energy (R.E.) Outputs:

   Energy needs survey describing the user market for renewable energy technologies completed; Six solar monitoring stations installed; Long-term solar plan completed and three or more solar demonstration systems in place; two to four small hydro generators with test instrumentation installed; Wood survey report completed and up to 50 demonstration high-efficiency stoves in operation; Design and field testing of biogas digesters; Up to 20 GOP personnel trained in the United States.

10. R.E. Inputs:

   Technical assistance; Training; Commodities.

11. Summary of R.E. Components:

Energy planning and development in Pakistan will be promoted by upgrading the Government of Pakistan's ability to conduct energy analyses, support coal resource development, and promote conservation and the use of renewable energy. The Ministry of Planning and Development (MOPAD) will coordinate GOP project implementation.

The Renewable Energy Assessment and Development sub-component will operate through a National Renewable Energy Activities Coordinating Committee. Energy needs and "renewable" applications will be surveyed. This will include updating a residential and small commercial energy needs survey and assessments and demonstrations for a number of specific renewable technologies, including solar energy, small-scale hydro, energy-efficient wood stoves, and other biomass technologies.

In solar energy, up to six small commercially-available solar monitoring stations will be installed to augment the current capability. Candidate demonstration projects include solar thermal industrial systems, photovoltaic systems, and passive solar applications, e.g., in the textile and tobacco industries. Passive heating and cooling systems may be evaluated.

In small-scale hydro, key staff will be familiarized with worldwide experience so that they minimize duplication of effort in adapting technologies for manufacture and implementation in Pakistan. Assistance will include small scale hydro system technology assessment and design, monitoring of systems already installed, and installation of selected demonstration projects.

In energy-efficient wood stoves, activities will include a technology assessment and market analysis for efficient wood stoves in Pakistan followed by a pilot project and test marketing activity. A pilot project will examine the adaptability and marketability of alternative wood stove designs in various regions of the country.

For other biomass technologies, markets will be identified and projects designed to demonstrate the feasibility and marketability of biomass applications.

To date, however, no renewable activities have been implemented (see Revisions, below).

12. R.E. Project Descriptors:

Energy planning; Solar energy; Energy conservation; Biogas; Hydroelectric power; Firewood; Stoves; Biomass.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified.

16. Key Persons:

A. AID/Washington:

James A. Bever, Project Officer
Robert Archer, ANE/TR/ENR, Rm. 4440 NS, 647-9734
Patricia Matheson, ANE/PD Rm. 3327A NS, 647-2476

B. AID/Mission:

Jeffery A. Malick, PDM(A)
Leland L. Hunsaker, EXO

C. Contractors: Not specified for renewable activities.

D. Host Country:

ENERPLAN Managing Director
Ministry of Finance, Planning and Development

17. Obligations by Fiscal Year (US$000):

PROJECTED SUMMARY OF COSTS FOR ENTIRE PROJECT

	AID	GOP
FY83	13,000	1,075
FY84	5,000	1,700
FY85	6,000	1,245
FY86	6,000	1,020
FY87	0	1,255
TOTAL	30,000	6,295

(Source: Project Paper, p. 167, 5/23/83, PDAAN203)

18. Host Country Funding of R.E. Components (US$000): 6,295*

*For entire project, R.E. costs not specified separately.

(Source: Project Implementation Report, 3/31/86, PDCAQ394)

19. Summary of R.E. Costs (US$000):

RENEWABLE ENERGY TECHNOLOGIES COMPONENT	
Commodities	608
Technical Assistance	1,668
Training	373

TOTAL	2,649

(Source: Project Paper, pp. 169-170, 5/23/83, PDAAN203)

20. R.E. Component Revisions:

A. Because of technical and institutional problems in implementing renewable activities, the mission is reprogramming R.E. funds to conservation and other components. In the interim, limited renewable activities are to be covered through the energy analysis and manpower development component.

(Source: Project Implementation Report, 3/31/85, PDCAK990)

B. PACD extended to July 31, 1989.

(Source: Project Implementation Report, 3/31/85, PDCAK990)

C. PACD extended one year to July 31, 1990.

(Source: Project Implementation Report No. 21, 7/29/85, PDCAM240)

21. Follow-up Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: October 1986 (jrl)
Revised February 1987 (jrl)

1. Project Number: 3910481 2. Geo: Pakistan

3. Title: FORESTRY PLANNING AND DEVELOPMENT

4. Project Life/PACD: 1983-91/ September 30, 1991

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 25,000

   B. R.E. Components: Not specified

   (Source: Project Implementation Report, 3/31/85, PDCAL026)

7. Loan or Grant/Appropriation Category (US$000):

   G / ES / 25,000

   (Source: DIS)

8. Project Purpose:

   To enhance the capabilities of Government of Pakistan (GOP) institutions in designing and implementing plans and programs for increasing the production of fuelwood and timber in Pakistan; To demonstrate the economic, technical, and social feasibility of producing tree crops on privately owned farm and range lands.

9. Renewable Energy (R.E.) Outputs:

   Institutional capability and manpower; Studies on the role of timber and fuelwood in Pakistan's development; Research program in support of farm and energy forestry; Assessments of alternative farm and energy forestry systems and of fuelwood demand, supply, and marketing systems; Establishment of farm woodlots; Improvement, extension, and conversion of Sind forest plantations; Production of fuelwood, timber, and fodder.

10. R.E. Inputs:

   Grant funds; Long-term, short-term, and Joint Career Corps technical assistance; Long-term professional, short-term professional, and farmer training.

11. Summary of R.E. Components:

This project is designed to achieve energy self-sufficiency and reduce deforestation in Pakistan by increasing national abilities to design and implement forest and fuelwood development strategies and by demonstrating the feasibility of producing tree crops on private farm and range lands. Pakistan's Office of the Inspector General of Forests (OIGF) and Provincial Chief Conservators of Forests (PCCFs) will implement the project.

Institutional capabilities will be developed through training, technical assistance, and the establishment of permanent forest and fuelwood planning units and monitoring and evaluation units in OIGF and the PCCFs; farm and energy forestry units will also be set up in OIGF and in Punjab, Northwest Frontier, and Baluchistan provinces. OIGF will prepare a farm and energy forestry development program and coordinate efforts with PCCFs and with other programs in the energy and agricultural sectors.

Assistance will be given to the Pakistan Forest Institute (PFI) to develop training and research programs in farm and energy forestry. Professional curricula will be designed and at least five studies will be conducted (by PFI, PCCFs, and agricultural universities) on such topics as the economics of farm and range land tree management, sociocultural factors affecting adoption of farm forestry, and the design and yield of farm forestry systems.

To demonstrate the feasibility of producing tree crops on private lands, seedlings (particularly Acacia arabica) will be distributed to some 20,000 small farmers for planting on plots of 2-10 acres each. In the rainfed Punjab and Northwest Frontier provinces, where activities will be centered, farm forestry will enable families to achieve fuelwood self-sufficiency and produce fodder and timber for farm use. Plantings in irrigated Nasirabad and Baluchistan provinces and in forested Sind province will produce timber for coal mines as well as on-farm benefits. In each province, farmer advisory groups will be organized and opinion leaders chosen as motivators; extensive training will be provided to farmers.

Overall, 427 forestry and related professionals will be trained in-country and overseas; 273 work-months of TA will be provided to OIGF, PCCFs, and PFI staff.

12. R.E. Project Descriptors:

Energy farming; Firewood.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

Dan Deely
AID/S&T/FNR, 503C SA-18, 235-2245

Patricia Matheson
ANE/PD/SA, 3327A NS, 647-2476

B. AID/Mission:

Albert Merkel, Project Officer
Alejandro Sundermann, Chief O/Eng.
USAID/Islamabad

Donor M. Lion, Mission Director
USAID/Pakistan

C. Contractors:

D.S. Athwal, Vice President
International Agricultural Development Service (IADS)
(now Winrock International)
Rosslyn Plaza, 1611 N. Kent Street, Suite 600, Arlington, VA
22209, (703) 525-9430

D. Host Country:

Mr. W.A. Kermani, Inspector General of Forests/Additional Secretary
Office of Inspector General of Forests (OIGF)

Mr. Mahmood Iqbal Sheikh, Director General
Pakistan Forest Institute (PFI), Peshawar

Ch. Nazir Hussein Khan, Chief Conservator of Forest
Government of Punjab, Rawalpindi

Mr. T.A. Ansari, Chief Conservator of Forest
Government of Sind, Hyderabad

Mr. Muhammad Rafiq, Chief Conservator of Forest
Government of Baluchistan, Quetta

Mr. Abdul Rahman Khan, Chief Conservator of Forest
Government of NWFP, Southern Circle, Peshawar

(Source: PIL No. 9, PDCAM283)

17. Obligations by Fiscal Year (US$000):

PROJECTED COSTS FOR ENTIRE PROJECT

	AID	GOP
FY83	3,115	205
FY84	358	1,094
FY85	5,326	1,336
FY86	540	1,622
FY87	7,456	1,958
FY88	88	2,287
FY89	7,974	2,689
FY90	0	3,109
FY91	143	0
TOTAL	25,000	14,300

(Source: Project Paper, 8/83, PDAAN336 or PDCAF697)

18. Host Country Funding of R.E. Components (US$000): 14,300*

*For entire project, R.E. costs not specified separately.

(Source: Project Implementation Report, 3/31/85, PDCAL026)

19. Summary of R.E. Costs (US$000):

TOTAL PROJECT COSTS BREAKDOWN:*

Technical Assistance	9,243
Training	3,288
Operational Activities	8,690
Commodities	1,621
Evaluation	374
Contingency	1,784
TOTAL	25,000

*For entire project; R.E. costs not specified separately.

(Source: Grant Agreement Amendment 1, 12/17/83, PDCAG848)

20. R.E. Component Revisions:

A. Full-scale project implementation was held up due to delays in meeting certain Conditions Precedent and to lack of formal approval of the GOP's planning document.

(Sources: Project Implementation Letter No. 5, 3/4/84, PDCAI270; Action Memorandum for the Assistant Administrator, Bureau for Asia, PDCAL022; Incoming Cable, 8/85, PDCAM281; Project Implementation Report, 9/30/85, PDCAN434)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: July 1986 (jrl)

---------- AID RENEWABLE ENERGY DATA BASE ----------

1. Project Number: 4920262 2. Geo: PHILIPPINES

3. Title: TIWI GEOTHERMAL GENERATION AND TRANSMISSION PROJECT

4. Project Life/PACD: 1973-77/PACD not specified

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 3,007*
   6,204**

   B. R.E. Components: 3,007*
   6,204**

   (Source: *DIS; **Capital Assistance Paper, 6/15/73, PDAAR168)

7. Loan or Grant/Appropriation Category (US$000):

   L / DL / 3,007

   (Source: DIS)

8. Project Purpose:

   To construct a pilot generating plant to facilitate the introduction of an electric power generating source in the Philippines using geothermal energy as an alternative to fossil fuel (which must be imported) and to assist in the electrification of Southern Luzon provinces of Camarines Sur, Albay, and Sorsogon by constructing a 69 KV transmission network to connect this area to the Luzon Grid system.

   (Source: Capital Assistance Paper, p. 1, 6/15/73, PDAAR168)

9. Renewable Energy (R.E.) Outputs:

   A 10.5 MW geothermal electric power generation facility with approximately 317 kilometers of 69 KV transmission line and required substations.

10. R.E. Inputs:

   Technical assistance; Training; Commodities.

11. Summary of R.E. Components:

A loan will provide the foreign exchange required to construct a 10.5 MW geothermal electric power generation facility at Tiwi, Albay, in Southern Luzon and approximately 317 kilometers of 69 KV transmission line and required substations. The transmission system will interconnect the Tiwi geothermal facility with load centers in Southern Luzon and a 230 KV line connecting the Manila area with Naga City in Southern Luzon.

In addition to equipment, technical assistance and training will be provided to the National Power Corporation, the project implementing agency.

(Source: Capital Assistance Paper, 6/15/73, PDAAR168)

12. R.E. Project Descriptors:

Geothermal energy.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington: Not specified

B. AID/Mission: Not specified

C. Contractors: Not specified

D. Host Country:

National Power Corporation

17. Obligations by Fiscal Year (US$000):

Projected Schedule of Disbursements:

YEAR	FX	LC	TOTAL
1973	195	80	275
1974	940	960	1900
1975	2705	940	3645
1976	298	86	384
TOTAL	4138	2066	6204

(Source: Capital Assistance Paper, p. 21, 6/15/73, PDAAR168)

18. Host Country Funding of R.E. Components (US$000): Not specified

19. Summary of R.E. Costs (US$000):

	FX	LC	TOTAL
A) Production and Transmission Plants			
1. Structure & improvements	45	183	228
2. Turbo generator unit	1547	211	1758
3. Accessory electrical equip.	184	38	222
4. Misc. power plant equip.	71	6	77
5. Substation equipment	120	16	136
6. Direct costs (items 1-5)	1967	454	2421
7. Engineering	345	47	392
8. Contingency 10%	231	50	281
9. Escalation 14%	323	70	393
10. Interest during construction	-	243	243
Subtotal	2866	864	3730
B) Transmission Lines and Substations			
1. 69 KV lines/317 km	570	773	1343
2. Substations (3)	387	59	446
3. Land and land rights		15	15
4. Transportation equipment	40	3	43
5. Direct costs (items 1-4)	997	850	1847
6. Engineering	57	102	159
7. Contingency 10%-Escalation 5%	158	142	300
8. Interest during construction	-	108	108
Subtotal	1212	1202	2414
C) Training	60	-	60
TOTAL	4138	2066	6204

(Source: Capital Assistance Paper, p. 10, 6/15/73, PDAAR168)

20. R.E. Component Revisions: Not specified

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: July 1986 (jrl)

---------- AID RENEWABLE ENERGY DATA BASE ----------

1. Project Number: 4920264 2. Geo: PHILIPPINES

3. Title: FEASIBILITY STUDIES, ECONOMIC DEVELOPMENT

4. Project Life/PACD: 1973-76/PACD not specified

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 1,913

   B. R.E. Components: Not specified

   (Source: DIS)

7. Loan or Grant/Appropriation Category (US$000):

   L / DL / 1,913

   (Source: DIS)

8. Project Purpose:

   To assist the Government of the Philippines (GOP) in the effective management of its limited economic resources by providing the foreign expertise needed to perform professional studies, analyses, and other similar professional services related to projects and other activities to be carried out in conjunction with the GOP's Three Year Economic Development Plan (1974-1976).

9. Renewable Energy (R.E.) Outputs:

   Feasibility studies.

10. R.E. Inputs: Not specified

11. Summary of R.E. Components:

    The loan provided under this project was to be used to finance the foreign exchange costs of (1) prefeasibility, feasibility, sectoral, and market studies and (2) consulting services, including engineering services, directly related to capital projects in the Philippines. The National Economic and Development Authority (NEDA), in charge of overall planning and policy formulation in the economic field for the GOP as well as coordination of official assistance, had overall responsibility for implementation of project activities.

The Capital Assistance Paper of 5/7/73 indicated seven prospective studies and activities most likely to be financed by the loan. One was complementary studies and activities related to the Bicol Geothermal Power System. Little project documentation is available, and it is not clear if project funds were ever expended on the Bicol Geothermal Power System or any other renewable energy technology.

12. R.E. Project Descriptors:

    Geothermal energy

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

    A. AID/Washington:

       Dennis M. Chandler, formerly ASIA/EA/P, now AFR/SWA, 3491 NS, 647-5990

    B. AID/Mission: Not specified

    C. Contractors: Not specified

    D. Host Country:

       National Economic and Development Authority (NEDA)

17. Obligations by Fiscal Year (US$000): Not specified

18. Host Country Funding of R.E. Components (US$000): Not specified

19. Summary of R.E. Costs (US$000): Not specified

20. R.E. Component Revisions: Not specified

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: September 1986 (jrl)

1. Project Number: 4920294 2. Geo: PHILIPPINES

3. Title: NONCONVENTIONAL ENERGY DEVELOPMENT

4. Project Life/PACD: 1978-83 (extended to 86)/ December 31, 1986

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 7,150

   B. R.E. Components: 7,150

   (Source: Project Implementation Report, 9/30/85, PDCAN619)

7. Loan or Grant/Appropriation Category (US$000):

   G / SD / 3,297.9
   L / SD / 3,852.1

   (Sources: Project Implementation Report, 9/30/85, PDCAN619; Project Authorization Amendment No. 2, 8/86, PDCAQ557)

8. Project Purpose:

   To determine the technical and economic feasibility of exploiting nonconventional energy resources as an alternative to imported fossil fuels, with emphasis on technologies appropriate for low-income rural areas.

9. Renewable Energy (R.E.) Outputs:

   Working field projects in the areas of solar energy, wind energy, and biomass conversion; Participant training; Information sharing conference and workshops; Energy library/information center; Functioning solar and wind monitoring and test centers.

10. R.E. Inputs:

    Technical assistance; Training; Commodities.

11. Summary of R.E. Components:

    This project provides a grant and a loan to the Philippine Government (GOP) to determine renewable energy applications capable of reducing dependence on imported fossil fuels and

meeting the needs of rural and remote areas. Pilot demonstrations financed under the loan portion are aimed at testing applications of solar, wind, and biomass conversion to meet energy requirements of the poor. Grant funds are targeted for support of GOP studies of rural energy requirements, experiments and facilities training, dissemination efforts, and consultant services. Activities include performing an energy survey and gathering solar/wind data.

The Bureau of Energy Development (BED) within the Ministry of Energy was the original executing agency. Primary responsibility for project management lay within the Center for Nonconventional Energy Development (CNED), a research arm of BED. Midway through the original project life, the CNED was renamed the Energy Research and Development Center (ERDC) and reorganized under the Philippine National Oil Company (PNOC), a semiautonomous company within the Ministry of Energy.

Many problems plagued the first few years of the project, causing activities to be seriously delayed; however, positive changes occurred in 1980-81, and a number of subproject proposals were developed and/or approved. Subprojects cover the following areas: solar water heating; solar cooling; solar drying; solar distillation; photovoltaic water pumping systems; passive cooling; tests and standards for solar devices; wind for electricity generation; biogas; agricultural waste utilization; alcohol production; integrated village energy systems; hot-springs for drying and power generation; surface natural gas utilization; stirling engines; and rice hull thermal plants.

12. R.E. Project Descriptors:

Biomass; Agricultural wastes; Solar energy; Photovoltaic energy; Wind energy; Windmills; Biogas; Hydroelectric power; Silviculture; Solar heating; Solar cooling; Crop driers; Water pumps; Electric power generation; Rice husks; Alcohols; Natural gas; Stirling engines.

13. R.E. Technology Applications: Not specified

14. R.E. Reports and Publications: Not specified

15. Evaluations/Major Findings:

A. Philippines Nonconventional Energy Development Project: An Evaluation-Executive Summary. Development Sciences Inc., Sagamore, Massachusetts, December 1981, 36 pp., PDCAC742.

See 15.B, below, for summary.

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B. Philippines Nonconventional Energy Development Project: An Evaluation. Development Sciences Inc., December 1981, 124 pp., PDCAC738.

The evaluation team found the first three years of this five-year project very disappointing. By all measures, the project was severely behind schedule. Only three of the nine individual subprojects were underway at the time of the evaluation, and these were six months to one year behind schedule. Less than 14% of the AID loan funds had been committed to subprojects; the percentage of AID grant funds committed was 42%. In sum, only about 20% of total AID funds had been committed. Few of the original project activities had been started.

The team found many reasons for the delays, the chief ones being:

- Nonexistence of an entity in the Philippines to carry out the project, and the resultant need to expend much time and money on institutional development, which was given little priority in the Project Paper;
- The "spin-off" of subprojects (the centerpiece dendro thermal and two small hydro subprojects) to other agencies, after the CNED had already expended valuable time and manpower resources;
- Poor fiscal management on the part of both AID and the GOP;
- An adversarial rather than a cooperative relationship between the original project coordinator and CNED staff; and
- Lack of institutional maturity of the Ministry of Energy and the BED, both young organizations.

A new project coordinator and improved development of subproject proposals offer hope for a turn-around in the project. Renaming of the "CNED" to the "Energy Research and Development Center" (ERDC) and reorganization under the Philippine National Oil Co. (PNOC) should improve fiscal capabilities of the new ERDC. It remains to be seen, however, if ERDC will remain committed to renewable energy technologies under PNOC tutelage.

Also considered critical were the quick development and approval of quality subproject proposals. Therefore, the evaluation team recommended that (1) a short-term subproject development and approval schedule be agreed upon by AID, ERDC, and the subproject implementors; (2)

a team of U.S. consultants be hired to help in subproject proposal development and to assist the implementors by coordinating across subprojects; and (3) ERDC should add a senior technical staff person to each subproject implemented by an entity other than ERDC.

C. Nonconventional Energy Development Project, Audit Report No. 2-492-82-14. USAID/Regional Inspector General for Audit, Manila, Philippines, August 31, 1982, 23 pp., PDAAL626.

This audit covers the period from May 3, 1978, to March 31, 1982, for project disbursements; and to May 31, 1982, for general project implementation. The findings of the auditors closely resemble those of the Development Sciences Inc. evaluation team. The five-year project was severely behind schedule. As of March 31, 1982, with about one year remaining in the original project life, just over 5% of the loan and 54% of the grant funds had been expended, compared with projections of about 95% and 78% respectively.

Major reasons found for delays in project implementation were:

- Reassignment of several planned subprojects to other Philippine agencies necessitating the Ministry of Energy to identify new subprojects; and

- Lack of ability of the Ministry of Energy to adequately implement the project.

In May 1982, the audit team inspected two of the six water-pumping windmills installed by the Farm Systems Development Corporation (FSDC) under the Windmill Dispersal Subproject and found that they were not operating properly. The windmill in Cebu, intended to provide potable water to a village and reportedly completed six months prior to the team's inspection, was pumping water onto the ground. It was used only by a few houses nearby due to the lack of a pipe connecting the windmill with the water storage tank and the village 300 meters away. The windmill in Negros Oriental, intended for irrigation purposes, was not functioning because of damage to one of the four cloth sails by a typhoon in March 1982. The farmers had not replaced the broken sail, presumably because they did not like the "color" of the replacement, which was a different color than the original sail. During the inspection, the windmill operator replaced the broken orange sail with a blue one to demonstrate how the windmill should operate.

The auditors recommended that USAID/Philippines and the Ministry of Energy develop a revised and realistic implementation plan for the project, including an assessment of the implementing agencies' capabilities. They further recommended that excess funds not needed by the revised plan be deobligated, and that a procedure be established to periodically deobligate funds not used in accordance with the revised plan. Nine additional recommendations were made.

16. Key Persons:

A. AID/Washington:

Peter Bloom
ANE/PD, 3319 NS, 647-5829

B. AID/Mission:

Richard S. Stevenson, Project Officer
Lawrence J. Ervin, Senior Energy Advisor
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D. Host Country:

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17. Obligations by Fiscal Year (US$000):

Projection of Expenditures:

FY	AID LOAN	AID GRANT	GOP
79	218	301	239
80	3,871	358	1,016
81	1,439	316	1,378
82-83	124	245	215
	---	---	---
Subtotal	5,652	1,220	2,848
Inflation (15%)	848	198	427
Contingencies (10%)	565	132	285
	---	---	---
TOTAL	7,065	1,550	3,560

*Does not reflect reduction in loan authorization from $7,100,000 to $5,600,000.

(Source: Project Paper, p. 41, 3/17/78, PDAAF442 or PDCAC716)

18. Host Country Funding of R.E. Components (US$000): 3,014

(Source: Project Implementation Report, 9/30/85, PDCAN619)

19. Summary of R.E. Costs (US$000):

A. Summary, by component:

Technical assistance	805
Training	323
Commodities	148
Biomass tech.	5,874

TOTAL	7,150

(Source: Project Implementation Report, 9/30/84, PDCAJ023)

B. Summary of AID loan, by R.E. activity:

LOAN*

Subprojects	U.S.	GOP
1. Direct Solar Energy		
a. Solar dryers	143	15
b. PV water supply	56	39
2. Integrated Village Energy Systems	175	330
3. Wind energy		
a. Small-scale dispersal program	168	5
b. Medium-scale wind systems	474	330
4. Biomass energy		
a. Stirling engines	183	30
b. Rice hull thermal	549	50
c. Fuel interchangeability	256	65
d. Densified rice hull	220	56
e. Direct heat gasifier	136	37
f. Cogeneration system & power interconnection	682	33
g. Biomass refrigeration	342	300
h. Alcohol fuels distillation	931	259
5. Energy education/graduate program	889	550
6. Research and project assistance equipment and consultancy	148	200
Cost escalation and contingency	248	265
TOTAL	5,600	2,564

*Does not reflect reduction in loan funding.

(Source: Loan and Grant Agreement Amendment No. 3, 12/4/84, PDCAJ981)

C. Summary of AID grant, by R.E. activity:

	GRANT*			
	U.S.	GOP	TOTAL	FX
Project coordinator	434.200	59.10	493.30	390.00
Short-term consultants	370.576	65.10	435.676	315.00
Participant training	323.040	34.10	357.14	323.04
Energy survey	118.350	120.00	238.35	25.00
Solar/wind monitoring equipment	148.279	16.60	164.879	148.279
Public information seminars	155.555	102.00	257.555	40.00
Subtotal	1,550.000	396.90	1,946.90	1,241.319
Inflation/contingency		53.1	53.1	
TOTALS	1,550.000	450.00	2,000.00	1,241.319

*Does not reflect increase in grant funding.

(Source: Loan and Grant Agreement No. 2, Annex I, p.2, 10/14/82, PDCAC721)

20. R.E. Component Revisions:

A. The centerpiece of the project--the dendrothermal silvicultural subproject--accounting for $3.6 million (50% of total AID loan funds) was "spun off" to the National Electrification Authority, as were two small hydro subprojects, accounting for an additional loss of $1.28 million (18% of loans) of potential subprojects.

(Source: Evaluation Report Executive Summary, 12/81, PDCAC742)

B. The initial project coordinator officially resigned in September 1980 and was replaced by another in December 1980.

(Source: Evaluation Report, p.II-6, 12/81, PDCAC738)

C. In October 1981, the CNED was renamed the Energy Research and Development Center and reorganized under the Philippine National Oil Co.

(Source: Contract, p.5, 12/81, PDCAC738)

D. PACD extended from April 30, 1983, to April 30, 1986.

(Source: Amendment No. 2, 10/14/82, PDCAC721)

E. Loan authorization reduced from $7,100,000 to $5,600,000.

(Source: Amendment No. 2, 10/14/82, PDCAC721)

F. GOP contribution modified from $3,595,000 to $3,014,000.

(Source: Project Implementation Report, 9/30/85, PDCAN619)

G. PACD further extended until December 31, 1986, to permit completion of three subprojects.

(Source: Incoming cable, 3/85, PDCAN617; PIR, 9/30/85, PDCAN619)

H. The level of grant funding was increased from $1,550,000 to $3,297,901.69, and the level of loan funding was reduced to $3,852,098.31.

(Source: Project Authorization Amendment No. 2, 8/86, PDCAQ557)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: July 1986 (jrl)
Revised February 1987 (jrl)

1. Project Number: 4920343 2. Geo: PHILIPPINES

3. Title: PROJECT DESIGN

4. Project Life/PACD: 1980-84(extended to 89)/September 30, 1989

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 18,000 (-3,300*)

   (Source: Project Authorization Amendment, 6/19/85, PDCAM399; *State Department telegram, 6/86, PDCAQ469)

   B. R.E. Components: 2,020*

   *Does not include Coco charcoal making project under Rural Enterprise Sector Study.

   (Sources: Project Evaluation Summary, 3/15/83, PDAAP030; Amendment No. 1 to the Project Agreement, 8/8/81, PDCAD110)

7. Loan or Grant/Appropriation Category (US$000):

   G / ES / 18,000 (-3,300*)
   G / FN / 42**

   (Sources: Project Data Sheet, 6/19/85, PDCAM399; *State Department telegram, 6/86, PDCAQ469; **DIS)

8. Project Purpose:

   To support planning, design, and training activities for economic development projects/subprojects; To support the management of the Economic Support Funds (ESF); To provide technical assistance to rural energy development activities under the ESF program.

   (Source: Project Authorization Amendment, 6/19/85, PDCAM399)

9. Renewable Energy (R.E.) Outputs:

   Site surveys; Prefeasibility and feasibility studies; Environmental assessments; Planning studies relating to renewable energy projects (especially geothermal and biomass resources); Charcoal production training programs; Construction of charcoal kilns.

10. R.E. Inputs:

Technical assistance; Commodities; Training; Maintenance and secretariat operating expenses.

11. Summary of R.E. Components:

Grant is provided to the Government of the Philippines (GOP) to design development projects and activities to be financed with Economic Support Funds (ESF) in areas in or surrounding former U.S. military bases. The GOP's ESF Management Advisory Committee under the Ministry of Human Settlements will be the implementing agency, acting through its Development Projects Fund Secretariat (DPFS). Provinces surrounding the Clark Air Force Base and the Subic Naval Base, which have recently been returned to GOP jurisdiction, will be the project's target areas. Contractors will be used by the DPFS to conduct feasibility studies in support of planned project activities.

In addition to support for planning and design, the project covers costs associated with the management and monitoring of the ESF program, as well as finances pilot project activities to be replicated using ESF.

Proposed studies included a dendrothermal feasibility/design study for three dendrothermal wood-fired electric generating plants for three provinces bordering the Clark Air Force Base and a study to determine the feasibility of developing the Mt. Pinatubo geothermal resource in the southwest corner of the Clark reservation.

Among completed studies supported by project funds are the Rural Enterprise Sector Study (which includes a Coco charcoal study) and the Rural Energy Development Project-Tree Farms Analysis. The latter project supported Philippine biomass production efforts to increase energy resource availability in rural areas, while reducing fossil fuel imports. It included a Charcoal Production Program, whose objective was to produce charcoal for industrial, commercial, and household uses. The program was implemented by the Farm Systems Development Corporation (FSDC).

The Reforestation/Rural Energy Technical Assistance Package (RETAP) furnished technical assistance, training, commodities, and general assistance to FSDC and the National Electrification Administration (NEA), which are the implementing agencies for the Dendrothermal Program, the Irrigation Gasifiers Program, and the Charcoal Program of the

Rural Energy Development Project (4920375). RETAP focused mainly on the forestry and wood transport and handling aspects of these programs. RETAP also conducted field research to develop and refine a body of knowledge and techniques on the production and use of biomass energy in order to implement, modify, and improve the charcoal production program mentioned above. Charcoal production training programs were provided.

As of mid 1986, the change in government and the uncertainty in the status of the ESF counterparts at both national and local levels was greatly hindering project implementation.

(Sources: Project Paper, Annex 1, PDCAD108; PIO/T, 12/7/82, PDCAD117; Amendment No. 1 to the Project Agreement, 8/8/81, PDCAD110; Project Implementation Report, 7/2/86, PDCAQ471)

12. R.E. Project Descriptors:

Charcoal; Kilns; Biomass; Geothermal energy; Firewood; Pyrolysis; Gasification; Electric power plants; Electric power generation.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings:

Project Evaluation Summary for the Period 7/80 - 12/82. William L. Riley and Franklin Bakin, Manila, Philippines, March 15, 1983, 25 pp., PDAAP030 or PDCAJ086.

The project has completed six feasibility studies, including the Rural Enterprise Sector Study (whose Coco Charcoal Making project was operational as of December 1982) and the Rural Energy Development Project. No study results are reported.

Recommendations:

- Avoid the teaming of consulting firms on studies to lessen costs and speed completion;
- Reexamine equipment needs of the secretariat; and
- Speed the liquidation of cash advances and determine the need for future GOP contributions.

16. Key Persons:

A. AID/Washington:

Ms. McNamara

B. AID/Mission:

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James R. Meenan
Thomas L. Rishol
John Tenant
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C. Contractors:

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D. Host Country:

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Mr. Roberto L. Abling, Executive Director
Development Projects Funds Secretariat
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Mr. Antonio M. Ollero, Chief of Operations
Economic Support Fund Secretariat, 17th Floor, Strata 100 Bldg., Emerald Avenue, Pasig, Metro Manila, Philippines

General Pedro Dumol, Acting General Manager
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Mr. Teodoro C. Rey, Administrator
Farm Systems Development Corporation (FSDC)

17. Obligations by Fiscal Year (US$000): Not specified

18. Host Country Funding of R.E. Components (US$000): 5,400*

* For entire project; R.E. costs not specified separately.

(Source: Project Authorization Amendment No. 2, PDCAM399)

19. Summary of R.E. Costs (US$000):

Reforestation/Rural Energy Technical Assistance Package	2,000
Rural Energy Development Project	20.480
TOTAL	2,020.480*

*Does not include Coco charcoal making project under Rural Enterprise Sector Study.

(Sources: Project Evaluation Summary, 3/15/83, PDAAP030; Amendment No. 1 to the Project Agreement, 8/8/81, PDCAD110)

20. R.E. Component Revisions:

A. PACD extended from December 31, 1984, to December 31, 1985.

(Source: Grant Agreement Amendment No. 1, 8/8/81, PDCAD110)

B. PACD extended from December 31, 1985, to September 30, 1989.

(Source: Grant Agreement Amendment No. 3, 9/17/85, PDCAM400)

C. LOP funding increased by $2 million in grant funds to a level of $7 million.

(Source: Project Authorization Amendment No. 1, 8/26/82, PDCAD109)

D. Level of planned obligations increased by $11 million to a level of $18 million.

(Sources: Project Authorization Amendment No. 2, 6/19/85, PDCAM399)

E. References in the grant agreement to the "Ministry of Human Settlements (MHS)" were replaced by the "Office of the President;" references to the "Management Advisory Committee (MAC)" were replaced by "Economic Support Funds Council;" and references to the "Development Fund Secretariat" were replaced by the "Economic Support Fund Secretariat."

(Source: Grant Agreement Amendment No. 3, 9/17/85, PDCAM400)

F. FY 1986 budget allowance for the project was decreased by $3,300,000 ESF grant funds and funds reallocated to the Budget Support Program project 4920404.

(Source: State Department telegram, 6/86, PDCAQ469)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: July 1986 (jrl)
Revised February 1987 (jrl)

1. Project Number: 4920375 2. Geo: PHILIPPINES

3. Title: RURAL ENERGY DEVELOPMENT PROJECT

4. Project Life/PACD: 1982-90/December 31, 1990

   (Source: Project Implementation Report, 9/30/85, PDCAN667)

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 13,000

   B. R.E. Components: 13,000

   (Sources: PIR, 9/30/85, PDCAN667; subsequent reductions are indicated, but not confirmed, see PIR, 7/2/86, PDCAQ731)

7. Loan or Grant/Appropriation Category (US$000):

   G / ES / 13,000

   (Source: Project Implementation Report, 9/30/85, PDCAN667)

8. Project Purpose:

   To provide funds resulting from the amended Military Bases Agreement of 1947 to assist the Government of the Philippines (GOP) with the economic and environmentally sound production and use of biomass energy resources and conversion technologies in the following areas: wood-fired power plants; gasifiers for irrigation; and charcoal production.

9. Renewable Energy (R.E.) Outputs:

   - Wood-fired Power Plants: power plant equipment installed; transport system in place; local production units organized and trained; seeds and other tree-producing inputs delivered; land access assured.

   - Gasifiers for Irrigation: gasifiers installed; fuel production units organized and trained; seeds and other tree-producing inputs delivered; land access assured.

   - Charcoal Production: kilns constructed; charcoal producer associations organized and trained; seeds and

other tree-producing inputs delivered; land access assured; transport system in place; market analysis completed.

10. R.E. Inputs:

- Wood-fired Power Plants: technical assistance; training; National Electrification Administration (NEA) and Rural Electric Cooperative management and oversight; equipment (local and imported) and materials; construction services.

- Gasifiers for Irrigation: technical assistance; training; Farm Systems Development Corporation (FSDC) management and oversight; equipment and materials.

- Charcoal Production: technical assistance; training; FSDC management and oversight; tools and materials.

11. Summary of R.E. Components:

This project is designed to support biomass energy development and production in the Philippines by (1) constructing wood-fired power plants, (2) converting diesel-powered irrigation pumps to systems incorporating wood-fed gasifiers, and (3) increasing production of charcoal. The Ministry of Human Settlements is the executing agency, with overall project management responsibility.

Under the first component, funds will be provided to procure boilers, turbo-generators, and control systems for three 5-MW wood-fired power plants to be built in Visaya and to hire the services of a U.S. architectural and engineering consultant and a U.S. building contractor. Each site will also include a tree farm operated by tree farmer associations. The National Electrification Administration will implement this subproject. As of early 1985, the plants were still in the planning stage.

Under the second component, credit will be provided to convert 495 diesel-driven irrigation pumping systems to hybrid systems incorporating wood-fed gasifiers and to develop approximately 500 woodlots to produce wood chips to feed the gasifiers. The Farm Systems Development Corporation is the implementing agency. Although some progress had been made, as of early 1985 this component was at a standstill, due to the inability of FSDC to acquire counterpart funds from the national government to cover program management and implementation, and inability to reach an agreement with the Economic Support Fund (ESF) Secretariat concerning additional funding for these costs.

Under the third component, credit will be provided to develop

19,500 ha. of tree farms to grow feedstock for charcoal production and to construct the kilns needed for charcoal manufacture. The Farm Systems Development Corporation is the implementing agency. As of early 1985, the charcoal conversion devices were performing well, but institutional and management problems and low yields from woodlots were slowing progress. Low growth yields were attributed to soil acidity, the droughts of 1982 and 1983, and very high planting densities. Of the 40 identified charcoal projects, 29 had been implemented (prior to funding) by 1984, with the remaining 11 deferred primarily because of law and order problems. Of these 29 projects, 12 were approved for project funding (although one of these was later recommended for cancellation due to repeated fires at the site); 10 were recommended for deferral/cancellation due to unsatisfactory tree growth; and 6 were still under review in 1985. Since 1981, 7,712 hectares of giant ipil-ipil (Leucaena leucocephala) had been planted, but only 1,168 hectares, or 15.1%, had been established.

12. R.E. Project Descriptors:

Charcoal; Firewood; Electric power plants; Gasification; Irrigation; Biomass.

13. R.E. Technology Applications:

A. Dendro Thermal Power Plants

Economic and financial analysis were performed for the proposed Bohol and Masbate dendro thermal power plants and their complementary plantations. Generation costs were calculated for the two plants and compared with comparable diesel generation costs:

DENDRO THERMAL GENERATION COSTS

	BOHOL		MASBATE	
Plantation size	1520 hectares		1000 hectares	
Plant size	2.0 MW		0.7 MW	
Generation	10.5x1,000,000 kWh		3.68x1,000,000 kWh	
	Economic Analysis	Financial Analysis	Economic Analysis	Financial Analysis
Generation cost (Pesos/kWh)	1.45	1.50	2.25	2.27
Diesel Generation cost (Pesos/kWh)		2.04		2.48

Economic costs/benefits are estimated as follows:

	BOHOL	MASBATE
Rate of Return without shadow prices	26.1%	23.2%
Benefit-Cost Ratio @ 20% without shadow prices	1.4	1.15
Rate of Return with foreign investment shadow-priced @ 20%	22.5%	20.2%
Benefit-Cost Ratio @ 20% with foreign investment shadow-priced @ 20%	1.1	1.00

Consult source for futher details.

(Source: Feasibility Reassessment, 4/2/85, PNAAV326)

B. Charcoal Gasifiers

FSDC installed 319 GEMCOR (Gasifier and Equipment Manufacturing Corporation) IS 30/60 downdraft gasifiers at 283 of their irrigation projects. As of December 1984, FSDC reported that only 128 of the units were operational, and only 32, or 10%, were actually in use. The low percentage was attributed to the high cost of charcoal, time of year, typhoon damage, as well as a number of problems including maintenance problems, lack of spare parts, lack of diesel fuel, system operation difficulty, increased demands on operator's time, lower fuel substitution percentages, mismatches between engines and gasifiers, need for training program, and high turnover rate among trained mechanics. Fifty-seven of the nonoperational units had defective or damaged diesel engines. Technical gasifier problems included constriction of the charcoal feed area in front of the gasification tuyeres; possible difficulty in defining the proper air introduction path into the reactor; a cyclone/scrubber system in need of a number of improvements; and engine problems believed to be due to tar and carbon in the gas possibly resulting from an ineffective gasifier/clean-up unit design.

A comparison was made of the fuel, operating, and total costs of the charcoal IS 30/60 gasifier versus those of an all-diesel 50-HP engine. Assumptions included 27% diesel engine efficiency, based on 1984 FSDC assessment

results of fuel flow of 0.26 liters/Bhp-hr for 50 HP diesel engine; gasifier efficiency of 70%; 50% diesel fuel substitution; and charcoal costs varying from P1 to P4 per kilogram. Results indicated that total costs are equal for 50% diesel fuel substitution at a charcoal price of P2.05 per kilo for 0% fines and P1.68 for 20% fines loss. The saving at P1.2 per kilo is only 15% for 0% fines loss. In view of this poor economic performance, another set of curves was produced assuming 70% diesel fuel substitution; economic performance was only slightly improved, with break-even at P2.19 for 0% fines and P1.73 for 20% fines loss. Consult source for graphs.

(Source: Feasibility Reassessment, 4/2/85, PNAAV326)

C. Wood Chip Gasifier

Estimated capital investment costs and calculations concerning fuel, operating, and total costs are made for a planned wood-chip gasifier. Consult source for details.

(Source: Feasibility Reassessment, 4/2/85, PNAAV326)

D. Charcoal Production

Yields from the charcoal kilns indicate a conversion of 4.9 - 5.8 metric tons (8.9 - 10.6 cubic meters) of ipil-ipil (Leucaena leucocephala) wood to one metric ton of charcoal, or, an efficiency of 17%-20%. A FSDC charcoal project assessment report indicates kilns have a rated capacity of 5 tons per cycle with 32 cycles per year, and cost P27,500.00 per unit. The kilns appear to be Brazilian beehive or similar design. Capital investment costs for charcoal production from a 100-acre plantation are approximately $49,000.

The Internal Rate of Return (IRR) of the fuelwood production alone, assuming foreign exchange shadow-priced at 20%, was calculated at 15%; economic benefit-cost ratio at a 20% discount rate was less than 1. The IRR was said to improve considerably if intercropping provides cash crops each year and/or the price of fuelwood is higher than P120 per cubic meter, both considered plausible assumptions. The IRR for the charcoal component alone was calculated at over 100%. The IRR for combined charcoal and fuelwood production is 39%, without shadow pricing, and 30% with shadow pricing of foreign exchange at 20%. The economic benefit-cost ratio, with the stream of costs and benefits discounted at 20%, is 1.68.

(Source: Feasibility Reassessment, 4/2/85, PNAAV326)

14. R.E. Technical Reports and Publications:

A. Operational Planning for NEA Dendrothermal Plantation Projects: CENECO, Negros Occidental; ILECO, Iloilo; BOHECO 1, Bohol. Ministry of Human Settlements, Metro Manila, 77 pp., circa early 1982, PDCAD266.

Although this publication was produced before the Grant Agreement for project 4920375 was signed, it describes many of the assumptions that influenced formulation of the implementation plan. The study analyzes various issues related to the plantation development aspects of the project for the three chosen sites, covering plantation establishment and management to harvesting of fuelwood. It does not cover the entire spectrum of dendrothermal power generation and thus does not attempt to determine the feasibility of the three plants.

15. Evaluations/Major Findings:

A. Feasibility Reassessment of the Philippines Rural Energy Development Project. Associates in Rural Development, Inc., Burlington, VT, April 2, 1985, 282 pp., PNAAV326.

The reassessment team found that both the current economic situation and the institutional and administrative problems experienced by the agencies involved in the project required considerable changes in the project for progress to be made.

The team visited two of the three proposed dendro thermal sites and considered them economically attractive; however, satisfactory plantation yields and adequate institutional support were prerequisites for power plant design. Overall coordination of electrical power supply and demand in the Philippines should be addressed before proceeding with the plants on Bohol and Masbate.

The charcoal-burning gasifier was found to be unviable economically, given present charcoal and diesel fuel prices, and there is a need to find an economical substitute for charcoal or a different gasifier that uses a less expensive fuel. Problems were found in the design of the gasifier/clean-up unit and recommendations made for design improvements. Operating instructions supplied with the gasifiers presented incorrect information; the team recommended that the manufacturer, GEMCOR, test the gasifier and adjust it before shipping to match the demands of the engine it will be attached to.

A wood chip gasifier was judged to be economically and

technically feasible, but would require a research and development effort. Improvement of FSDC technical and management capabilities and development of a secure supply of wood chips would be needed for this component to become successful.

Economic analysis showed that charcoal production was the most economically attractive component. The team considered the kilns to be a good design, well-constructed, and properly operated. Nonetheless, institutional and management support would be needed to improve low plantation yields. FSDC was ill-equipped from the start to undertake the charcoal production component. A comprehensive study of fuelwood and charcoal markets in the Philippines would be helpful.

The report also discusses the general status of dendro power plants in the Philippines (French and British as well as US units), and provides supply, demand, and prices/rates for electricity, firewood, and charcoal.

Appendices provide details on financial flow for a 1,000 hectare tree plantation, fuelwood harvesting and transportation, the IEM Program on Gasifier Technology, and assumptions for financial analysis of gasifiers. A charcoal production project assessment report is also included.

16. Key Persons:

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B. AID/Mission:

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Abraham Grayson, Power Plant Coordinator, Project Officer
Carlton Terry, Gasifiers Coordinator, Project Officer
Edward Rice, Charcoal Coordinator, Project Officer

C. Contractors:

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D. Host Country:

Teodoro C. Rey, Administrator
Farm Systems Development Corporation (FSDC)

National Electrification Administration (NEA), 1050 Quezon Avenue, Metro Manila, Philippines

17. Obligations by Fiscal Year (US$000):

Projected AID Obligations*

FY 82	11,000
FY 83	9,000
FY 84	5,000
TOTAL	25,000

*Does not reflect $12 million deobligation.

(Source: Project Paper, 8/82, p. 34, PDCAD247)

18. Host Country Funding of R.E. Components (US$000): 21,370

(Source: Project Implementation Report, 9/30/85, PDCAN667)

19. Summary of R.E. Costs (US $000):

Projected Cost Estimates by Component*

	AID	GOP	TOTAL
Wood Fired Power Plants	10,000	12,570	22,570
Gasifiers for Irrigation	3,380	3,920	7,300
Charcoal Production	11,370	4,880	16,250
Evaluation	250	0	250
TOTAL	25,000	21,370	46,370

*Does not reflect $12 million deobligation.

(Source: Project Paper, 8/82, PDCAD247)

20. R.E. Component Revisions:

A. The original LOP funding was for $25 million. This dropped to $13 million after $12 million was deobligated (leaving $6 million obligated and $7 million mortgaged).

(Source: Project Implementation Report, 9/30/85, PDCAN667)

B. In 1984, with the exception of limited training, maintenance of equipment, and the project assessment, the project essentially came to a halt until the AID Mission and the GOP could determine the revisions to the work and implementation plans required in view of the $12 million deobligation.

(Source: Project Implementation Report, 9/30/85, PDCAN667)

C. This project was conceived originally in the PID as a subproject of the Livelihood Development Fund Project, but it was funded as a separate project.

(Source: PID, 5/27/81, PDCAD246)

D. The State Department notified the Mission in May 1986 of a Congressional Notification to deobligate $2.5 million in ESF grant funds from the project. In a separate telegram, the State Department also notified the Mission that only $1,919,000 was available.

(Source: State Department telegrams, 5/86, PDCAQ730)

E. The Project Implementation Report of 7/2/86, indicating progress as of 3/31/86, shows an approved LOP funding level of only $6 million, revised from $13 million. However, no additional deobligations are noted.

(Source: Project Implementation Report, 7/2/86, PDCAQ731)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: July 1986 (jrl)
Revised February 1987 (jrl)

1. Project Number: 4930304 2. Geo: THAILAND

3. Title: RENEWABLE NONCONVENTIONAL ENERGY

4. Project Life/PACD: 1979-84/October 31, 1984

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 4,500

   B. R.E. Components: 4,500

   (Source: DIS; Implementation Letter No. 50, 7/10/84, PDCAI798)

7. Loan or Grant/Appropriation Category (US$000):

   G / FN / 4,500

   (Source: DIS; Implementation Letter No. 50, 7/10/84, PDCAI798)

8. Project Purpose:

   To prepare appropriate, cost-effective, and non-environmentally destructive energy technologies for dissemination in the rural areas by testing and evaluating their technical, economic, and cultural feasibility in Thailand and by adapting them as necessary; To develop and test methodologies and technologies for dissemination throughout Thailand; To develop the institutional capability and trained personnel to enable the Royal Thai Government (RTG) to engage in resource assessment and analysis.

9. Renewable Energy (R.E.) Outputs:

   National Energy Information and Documentation Center Thailand (NEIDCT) and Regional Energy Centers (RECs) established; Resource assessment and analysis for solar, biomass, and micro-hydro conducted; Energy Master Plan developed; Village level surveys conducted; Photovoltaic and windmill water pumping systems installed and demonstrated; Gasifiers built and tested; demonstration pyrolysis systems installed in rice mills; Micro-hydro plants installed in four villages; Laboratory tests conducted on anaerobic fermentation of waste water from five different industries; Research undertaken with solar dryers, solar stills, and a

solar thermal water-ammonia refrigerator-freezer; Charcoal production processes and kilns investigated and charcoal producers trained; Critical physical parameters of cookstoves investigated and five improved stoves developed and produced; Approximately 1.2 million trees planted in community woodlots.

10. R.E. Inputs:

Technical assistance; Training; Commodities; Workshops.

11. Summary of R.E. Components:

The project had fourteen components, ten of which focused on specific R.E. applications: solar thermal processes, rice husk pyrolysis, solar and wind energy assessments, village woodlots, improved charcoal production, improved cook stoves, industrial biogas, waterlifting, micro hydropower, and biomass gasification. Three components focused on institution building: support of an Energy Master Plan, establishment of a National Energy Information Center to collect energy data and coordinate a broad range of activities, and establishment of four Regional Energy Centers to demonstrate new technologies, coordinate planning, and train workers. A final component was to conduct four sets of village level surveys: a preparatory survey, a baseline survey of energy use, transitional surveys gauging the impact of newly introduced R.E. technologies, and evaluation surveys to assess the impact of these technologies on the pattern of energy use and supply.

12. R.E. Project Descriptors:

Solar energy; Wind energy; Charcoal; Stoves; Solar drying; Pyrolysis; Rice husks; Biogas; Biomass; Gasification; Firewood; Hydroelectric power; Water pumps; Methane; Waste treatment; Photovoltaic energy; Crop driers; Tobacco; Distillation; Wood; Ice; Solar cooling; Solar radiation; Data collection; Agricultural wastes; Wood chips; Kilns; Solar stills; Refrigerators.

13. R.E. Technology Applications:

A. Biomass Gasification

Six biomass gasifier units (some built prior to the project) were proposed for testing at Chulalongkorn University:

- A 500 W static bed gasifier to convert wood chips, charcoal, or crop residue;
- A 7 hp gasifier system to convert crop residues;

- A 16 hp downdraft gasifier to convert wood chips or corn cobs (this unit has been tested at Prince of Songkia University);

- A direct-fired fluidized bed gasifier to convert any crop residue;

- A 20-50 kW gasifier, designed at U.C.-Davis, to convert wood chips or low ash content crop residue; and

- A 40 kW rice husk gasifier.

At the end of the project, 12 gasifiers with capacities ranging from 500 watts to 25 kW and using five major gasification system types had been built and tested to some degree. Some were still under development, others had been tested extensively, and one had undergone field testing.

The project identified priorities for future research and an implementation strategy through a proposal for a Gasification Technology Development Center. At the same time, the UNDP/World Bank Gasifier Monitoring Program conducted preliminary studies of rice husk fueled gasifiers in Thailand, and the World Bank developed a scope of work for NEA to undertake data collection and initial monitoring of these systems. In sum, the project helped to link groups working on gasification in the private, academic, and public sectors. A considerable amount of experimental data was generated. This has not led as yet to any significant reduction in fossil fuel consumption, but has contributed to increased awareness of the potential of gasification as an alternative to conventional power production. Applying the information to stimulate adoption of gasifier technology has still to be accomplished. The most attractive applications for gasification are industrial uses (where biomass is produced as a byproduct) and direct combustion (where higher efficiency or control is required).

(Sources: Evaluation, 9/82, PDCAD799 or PDAAQ512; Evaluation, 12/30/86, pp. 52-54, PDAAU900)

B. Pyrolysis of Rice Husks

Tests were conducted by the Thai Institute of Scientific and Technical Research (TISTR) on a pilot plant vertical bed reactor to convert rice husks to char, gas, and oil. The pyrolysis system consisted of a one-ton capacity vertical reactor, screw feeder, "airgitator," cyclone separator, jet condenser (for oil), water condenser, gas

condenser, gas purifying units, gas mixing tank, mixer (for char), and briquetting machine. The system converted one ton of husks per day. Lower air-to-feed ratios and lower reactor temperatures favored production of char, while higher ratios and temperatures produced a greater percentage of gas and oil. Average yields were 37% char, 47% gas, and 16% oil.

Two demonstration systems were installed in rice mills. Operating conditions were the same as for the pilot plant reactor except that the reactor temperature was kept in the lower end of the range and the air-to-feed ratio was decreased significantly (from 0.68-0.73 kg/kg to 0.36-0.37 kg/kg). These conditions produced more char (45%) and less gas (43%) and oil (5%). (There is some loss in the process, so these percentages do not total 100.) The hourly production yields from the system are: char, 24.3 kg; gas, 23.2 kg; and oil, 2.6 kg. Energy recoveries per hour are 95,499 kcal, 27,144 kcal, and 15,496 kcal, respectively.

The pyrolytic system performed well in the two demonstration mills, and other mill owners expressed interest. The briquettes produced from the char burn satisfactorily. System oil was blended with furnace oil to an optimal 40:60 ratio and used in furnaces. Cleaned gas was used successfully as a diesel fuel supplement or substitute, replacing as much as 35% of the diesel fuel used in the rice milling process.

Despite TISTR calculations of positive financial gains (internal rate of return = 57%), rice millers converted back to all-diesel at the end of the project. Project evaluators considered pyrolytic systems as more expensive and operationally more complicated than diesel and gasification alternatives.

In addition, charcoal briquettes formed from charred rice husks were considered inferior in quality to those from rice husks briquetted by a simpler and cheaper method also developed by TISTR and being used at several rice mills and sawmills. The evaluators concluded that this method seemed to be more attractive than pyrolysis for rice husk disposal. And, since the oil and char byproducts of pyrolysis do not appear to have a ready market, the simpler gasification process is also preferred.

(Sources: Feasibility Study on Rice Husk Pyrolysis Technology for Rice Mill Applications in Thailand, 1984, PNAAS521; Evaluation, 12/30/86, pp. 81-82, PDAAU900)

C. Micro-Hydroelectric Power Plants

Micro-hydropower plants were installed by the National Energy Administration at four villages. This is the only project component in which a technology was installed, operated, and maintained by villagers. The four sites are:

- Kam Pong: Two sets of turbines, generators, and switchboards; installed capacity 40 kW with design discharge of 0.12 cubic meters per second and effective head of 60m; catchment area at weir six square kilometers; system features step-up and step-down transmission line, 2m high concrete gravity weir, asbestos pipe headrace and penstock. The system supplied 118 households. Construction costs, excluding labor and local contributions, were US$115,000. The benefit:cost ratio (B:C) of 1.98:1 was favorable.

- Mae Ton Luang: One turbine, generator, and switchboard; installed capacity 35 kW with design discharge of 0.1 cubic m/s and effective head of 60m; catchment area 19 square kilometers; system features similar to Kam Pong. The system served 230 households. Construction costs were US$112,050, with the villagers supplying labor. The B:C of 1.82:1 was favorable.

- Huai Pui: One turbine, generator, and switchboard; installed capacity of 50 kW, with 0.1 cubic m/s discharge and 85m design head; catchment area 11.6 square km; system features same as those at above sites. The system served 250 households in Tambon Long Khod. (Estimates of the households served vary: a 1976 evaluation reported that 700 households from seven villages were being served by the Huai Pui facility; a 1984 NEA report (cited in the evaluation) noted that 1,094 households with a population of 4,261 were to be served.) Construction costs were US$129,217, with the villagers supplying labor. The B:C at 2.09:1 was favorable.

- Bo Kaeo: Two sets of turbines, generators, and switchboards, each with installed capacity of 100 kW; total installed capacity 200 kW; system features similar to above sites, however, pipes are larger. The system supplies power to a tin mine operation. Construction costs were US$267,065. The B:C was as high as 3.64:1.

The first three installations, all built with villager labor and in-kind contributions, were functioning well in late 1986 at the time of the final evaluation. The installations were operated intermittently, generally only during the night. Electricity was used for lighting (displacing kerosene), cooking rice, and operating radios & TVs (replacing battery charging). Electric wood-working equipment was being powered in the villages supplied by the Kam Pong and Huai Pui plants. In Huai Pui, the system also supplied power for vaccine refrigeration to two clinics serving seven villages; to power a public address system for announcements by the village headman; for several individual refrigerators; and for a communally-owned water pump supplying drinking water from a well. The Kam Pong installation also powered a cold-storage unit used at a Royal mushroom-growing project.

In all three cases, women played an important role, supplying up to 50% of the labor and taking part in the cooperative councils. Collection rates were reported to be very high, in most cases approaching 100%, and cooperative revenues appeared in all cases to be sufficient to cover operation & maintenance expenses. Revenues and expenses are reviewed below:

ESTIMATED REVENUES AND OPERATIONAL COSTS FOR VILLAGE MICRO-HYDROELECTRIC PROJECTS

	KAM PONG	MAE TON LUANG	HUAI PUI
# Households	118	230	250
	----------total Baht/yr----------		
Revenue (a)	42,480	82,800	90,000
Costs (b)	65,840	66,068	74,060
Net Revenue	- 23,360	16,732	15,940

Notes:

a. Assumes average monthly electric bill of 30 Baht/month/household.

b. Based on NEA's 1984 estimate of 3% of capital expenditures. Kam Pong's data are adjusted to reflect installation of only one 20-kW generator. Note that with installation of the second generator, revenues would probably double, with costs increasing only slightly because the cost of all of the civil works have already been included. Thus, net revenue for Kam Pong would very likely be positive.

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Cooperatives were either accumulating funds or using them for village improvement projects (road maintenance, or in Huai Pui for roofing a village library). All installations were approached by other villages or households for hook-up. All three systems had positive financial benefits to the government, and considerable positiv net economic and social benefits to the villages and villagers. The Bo Kaeo installation never realized its potential because the tin mine closed shortly after the installation was completed.

(Sources: Development of Kam Pong, Mae Ton Luang, Huai Pui, and Bo Kaeo Micro-Hydropower Projects, 1984, PNAAS534; Evaluation, 12/30/86, pp. 1-2, 26-37, PDAAU900)

D. Industrial Biogas

The National Energy Administration applied anaerobic fermentation processes to the treatment of industrial wastewater, simultaneously treating waste streams and producing methane gas. Preliminary analyses were conducted on wastes from five processes: food canning, milk packing, tapioca production, noodle production, and sodium monoglutamate production. Further analysis was conducted for tapioca and sodium monoglutamate wastes, which had promising chemical and biological characteristics.

Two processes were tried in the laboratory. An anaerobic filter process was used with sodium monoglutamate wastes. A 1.5m high cylindrical column packed with 0.5-1 inch diameter media was used as the vessel. Organic loading strength was varied from 0.175-0.90 kg. chemical oxygen demand (COD)/day; the retention time in the system was 15 days. With COD concentration of feed adjusted to 150,000-200,000 mg/liter, gas production at steady state was 12 liters/day, or 0.27 cubic meters of gas per cubic meter of filter per day. The gas produced was less than 30% methane, too low in terms of heating value. The poor quality and small quantity of the gas makes the process unattractive.

With tapioca waste, an anaerobic contact process was used. The volume of the polyvinyl chloride digester was 30 liters, with an operating volume of 25 liters. The contents were stirred continuously by a 150 rpm agitator; the temperature was controlled. Organic loading strength was in the range 0.025-0.075 kg COD/day; hydraulic retention time, 5 days; solid retention time, 15 days. The system produced 0.45 cubic meters of gas per cubic meter of digester per day, with a methane composition of 75%.

The anaerobic contact process was economically viable, but the minimum digester size to realize a return is 2,500 liters; even a 5,000 liter digester using this process would have a 12-year payback. It was concluded that biogas produced from tapoica waste was not competitive with fuel oil. More research was justified, however, because tapioca production waste must be treated in any case, and anaerobic systems are probably the most cost-effective option.

The NEA analyses of technical and economic feasibility of producing biogas from industrial wastes (which also received support from the Belgian firm Biotim) led to 12 distilleries in Thailand reportedly expressing interest in pursuing biogas production in conjunction with waste water treatment. According to NEA, Thai Alcohol may be willing to build a biogas system in collaboration with Biotim.

(Sources: Industrial Biogas: A Feasibility Study of Waste Utilization from Agro-Industry in Thailand, 1984, PNAAS531; Evaluation, 12/30/86, pp. 45-46, PDAAU900)

E. Resource Assessment on Solar and Wind Energy

The Meteorological Department assessed solar and wind resources in Thailand. Six solar radiation stations and ten wind stations were established; data were collected on real-time dataloggers for later analysis, a preliminary solar map of the country was created. Data continues to be recorded by these instruments. Generation of detailed solar and wind energy profiles was hampered by delayed instrumentation. A Center for Solar Radiation and Wind Calibration was established; existing instruments were calibrated. New data revealed that, except for some coastal sites, solar energy had higher value than wind energy. A training course was given to officials from the Meteorological Department, the Department of Science Service, Electricity Generating Authority of Thailand, and NEA, and this type of training continued after the PACD. Data collected under the project have been processed and analyzed at King Mongkut's Institute of Technology Thonburi and the Asian Institute of Technology, and the results have been published. (See 14.Z and 14.AA, below.)

(Sources: Solar and Wind Energy Resource Assessment for Thailand, 1984, PNAAS524; Evaluation, 12/30/86, pp. 78-80, PDAAU900)

F. Solar Process Heat (Drying and Distillation)

King Mongkut's Institute of Technology (KMITT) received a grant of $50,000 to conduct research on five solar thermal processes: solar tobacco curing, forced convection hut drying, natural convection cabinet drying, solar distillation, and solar refrigeration. Each is described below:

o Solar tobacco curing.

The prototype drying system had four components:

-- The solar collector was an air-heater type with single glass glazing. Air flowed through a rectangular channel formed by corrugated sheet metal on top and flat metal sheets on the bottom. The collector had a surface area of 38.5 sq.m (6.8m x 5.6m) and eight flow channels 0.7m wide each. The collector, which faced south with a 30 degree tilt, was designed for heating 0.47 cubic meters per second of 50 degree air to 60 degrees (on a clear day in January at ten o'clock).

-- The rockbed thermal storage was 1.8m x 1.8m x 1.8m, filled with 0.05m diameter river gravel. Fiberglass insulation was used all around, 0.25m thickness on the top and 0.1m thickness elsewhere. Air ducts were insulated also.

-- The curing barn was one-ton capacity, 3.6m x 3.6m x 4.8m, and insulated with 0.013m thick fiberglass sheets. Lignite-fired or LPG-fuel modes were installed to supplement solar heat.

-- The air-flow system sent returned air from the barn and rockbed into the rectangular channels described above. A 0.75 kW (1hp) or a 1.5 kW (2 hp) centrifugal blower circulated the collector's hot outlet air through the barn and rockbed. The main insulated air ducts had 0.36m x 0.36m cross sections and were coated with Flintcoat. Fresh air entered the system through a port in the return duct.

System variables were well monitored and the data were collected for later analysis. Twenty-five type T thermocouples were distributed through the system to monitor wet and dry bulb temperatures at various levels inside the barn, across walls, at the collector's outlets and inlets, and ambient. All thermocouple points were attached to dataloggers; ice

points were used for references. Four dial thermometers (Teddington type, KDA/A/20) were installed in the rockbed to monitor temperature at different depths. A DISA hot wire anemometer (probe type 55P11/bridge type 56C10) was originally used to monitor air flow from the collector, the rockbed, and the barn roof, with data collected by a logger. The delicate nature of the probes and their limited supply forced a switch to U tube manometers. An EXO heat flux probe was used to measure heat loss through the metal barn roof. Global solar radiation was measured by a Kipp and Zonen pyranometer (model CM5) connected to a Watanabe 2-channel chart recorder and a Kipp and Zonen solarimeter integrator (model CC1). LPG consumption was measured by weight loss of a 100 kg LPG cylinder. Moisture reduction rates from the tobacco leaves were measured by weighing a sample of pre-weighed leaves every hour during drying. All fresh and cured leaves were weighed before and after drying. Diagrams of system components and data collection devices can be found in PDAAS525.

Analysis indicated that solar-assisted tobacco drying was technically viable, and the observed energy savings of 20% (with LPG as the fuel) could be raised to 30-40% when more experience is gained. However, further analysis showed that solar drying of tobacco could not compete with other alternatives to LPG or fuel oil:

REPORTED ENERGY PRODUCTION COSTS FOR TOBACCO CURING (DRIED LEAF)

FUEL	Baht/kg
LPG, Fuel Oil	12
Solar/LPG	7
Lignite	3-4
Fuelwood	2-3

(Sources: Solar Thermal Processes in Thailand: A Study on Solar Assisted Curing of Tobacco Leaves, 1984, PDAAS525; Evaluation, pp. 49-50, 12/30/86, PDAAU900)

- Solar drying of paddy, forced convection.

A vertical bed, batch dryer (1.2 x 1.2 x 1.3m) with a wet paddy capacity of one ton (1.5 cu.m) was used to dry newly harvested rice. Solar heated air was forced through the dryer bed by a centrifugal fan. The air-heater, a 19 square meter solar absorber, was made of galvanized metal sheets, with a 20mm gap for

air flow between the metal and a layer of styrofoam insulation. The efficiency of the collector was 31%. During a field test, one ton of paddy with an initial moisture content of 21.2% dry bulb was dried to a moisture content of 16.3% over 21.5 hours of ventilation (from morning to morning).

Global solar radiation, wind velocity, system air flow, temperatures inside and outside the dryer, and other system variables were monitored. Diagrams of the solar collector, the dryer, and temperature probe locations can be found in PDAAS526.

The forced-air convection dryers were not found to be commercially viable. High investment costs, short seasonal usage, and changes needed in labor skills more than offset the small improvement in product quality (amounting to 10% price increase). Consequently, the KMITT began work, supported by Australian assistance, on the development of forced-air dryers which incorporate storage with drying and have multiple crop drying capability.

(Sources: Thermal Solar Processes in Thailand: A Study on Forced Convection Hut Drying, 1984, PDAAS526; Evaluation, 12/30/86, p. 49, PDAAU900)

o Natural convection cabinet drying.

Cabinet dryers used solar heated air to dry four food and agricultural products: bananas, salted fish, salted beef, and sweet coconut chips. Experiments were conducted comparing (1) glass and plastic on the solar collecting surface, (2) dryer performance with and without a supplemental air heater, and (3) the performance of six separate air heater units. The cabinet used in laboratory trials was 1.0 x 0.8 x 1.1 m, held five trays of wire mesh, had a black plywood back, and had side, front, and top covers made of either 3mm thick glass sheets or black polyethylene sheets. Four combinations of components were tried in laboratory tests:

-- Dryer with glass cabinet and glass air heater cover,

-- Dryer with plastic cabinet and plastic air heater cover,

-- Dryer with glass cabinet and no air heater, and

-- Dryer with plastic cabinet and no air heater.

Conclusive results proved the glass cabinet with glass-covered heater most efficient, since glass suppressed the loss of infrared radiation better. Inclusion of an air heater increased the drying rate 13%. Within the dryer, the top tray had the highest drying rate, the middle trays the lowest. Six different types of air heaters were tried in the laboratory, using the glass cabinet dryer each time:

-- Glass cover and mild black steel sheet in center of air gap,

-- Glass cover and black metal lathe on floor of air heater,

-- Acrylic cover and black mild steel sheet in center of air gap,

-- Acrylic cover and black metal lathe on heater floor,

-- Fiber-reinforced plastic cover and black mild steel sheet at center of air gap, and

-- Fiber-reinforced plastic cover and black metal lathe on floor of heater.

The first model, with a glass cover and metal sheet at the center, had the highest drying efficiency and was used in the field tests. Its dimensions were enlarged, and fiber-reinforced plastic sheets were used on the cabinet sides and front in place of glass.

The cabinet dryer provided clean, hygienic products and protection from animals. For salted beef and coconut chips, the dryer was excellent and reduced drying times by 20 percent. Some problems were experienced with salted fish and bananas, such as unequal color. Early analysis indicated that the dryer seemed inappropriate for industrial application or for very small scale drying, but appeared well suited to medium scale drying of agricultural products.

KMITT calculated the costs of energy production for the solar cabinet dryers: US$0.025/kWh for dryers with glass coverings and air heaters and US$0.032/kWh for dryers with plastic coverings and air heaters. Costs fell to US$0.019 and US$0.025 per kWh, respectively, for the same dryers without air heaters. On the other hand, electricity costs were estimated at US$0.075/kWh. (It was noted, however, that comparison should be made with air drying,

rather than with electric drying, since most commercial producers simply air-dry their products.)

Investment costs for the dryers were more than quadruple traditional costs for trays and a frame, which normally cost less than 1,000 Baht. This fact, coupled with low utilization rates for the dryers, created high unit costs and made the dryers prohibitively expensive for small producers. Therefore, contrary to earlier expectations, it was the large producers who were most interested in solar dryers, and research shifted toward the design of larger dryers. Large-scale vegetable growers near Bangkok and food-processing factories producing papayas, longans, and chrysanthemum tea showed interest in the dryers.

(Sources: Solar Thermal Processes in Thailand: A Study on Natural Convection Cabinet Drying, 1984, PNAAS527; Evaluation, 12/30/86, pp. 48-49, PDAAU900)

- Solar distillation of water.

Three types of stills were built and tested: two basin-type horizontal stills and a vertical still.

In the first type of horizontal still, the galvanized steel basin was lined. Charcoal chips were selected over butyl rubber as lining because they were inexpensive and available locally. The cover was a 3mm thick acrylic sheet. Black cotton cloth covered the back wall and improved daily distillation rate by 13%, to 1.93 liters per square meter per day.

The second horizontal still had a 0.6 x 1.8m basin constructed of fiber-reinforced plastic walls with aluminum sheet lining. Small pieces of charcoal were placed in the bottom to enhance absorption. The cover was plastic. The daily distillation rate was 1.8 liters per square meter per day.

The vertical still design was tested with both glass and acrylic as the cover material. Glass was selected because of 10% higher distillation rates. The glass casing was 0.43 x 0.43 x 1.2m; black cotton cloth sheets, 0.28 x 1.1m, were used as vertical wick absorbing plates. System temperatures and solar radiation were well monitored. The level of solar radiation determined the optimum vertical still orientation. When daily horizontal global radiation exceeded 20 MJ/sq. meter, the stills facing

east-west produced more distilled water; north-south orientation yielded more distilled water with radiation below 20 MJ/square meter-day.

All three stills produced distilled water inexpensively. Further technical information and diagrams are available in the source.

(Source: Solar Thermal Processes in Thailand: Studies on Solar Distillation and Refrigeration, 1984, PNAAS520)

- Solar refrigeration for ice-making.

  A field model ice-maker with a 15 kg/day capacity was built and tested. A shell and tube heat exchanger with hot water on the tube side and aqua-ammonia on the shell side was the heart of the model. The 26 steel tubes were 5.08 cm in diameter, 91.4 cm long, arranged in square pitch. The steel shell was 19.2 cm in diameter. Two tubes with a longitudinal copper fin served as a rectifier. The coil used to condense ammonia vapor to liquid ammonia had three sections: an air-cooled tube with external copper fins, a water-cooled tube, and a water-cooled tube with fins. A 21.91 cm diameter receiver, a flood-type evaporator, a five-tube, vertical absorber, and a water cooling tank completed the unit. Water for the heat exchanger was solar-heated. Compound parabolic concentrators were tested, as were solar ponds. Both produced sufficiently hot water.

  Ice was produced successfully at 15 kg/day by the field unit after months of trials. Necessary modifications were made and a prototype unit was constructed, but the trials were not completed before the end of the project. Detailed technical information and diagrams appear in the source.

  (Source: Solar Thermal Processes in Thailand: Studies on Solar Distillation and Refrigeration, 1984, PNAAS520)

G. Waterlifting

The National Energy Administration examined four technologies to be applied to waterlifting in rural settings: photovoltaic (PV) pumping, wind turbine pumping, gasification, and biogas pumping. Results are as follows:

- A 700-Wp PV pump was installed at Ban Tha Yiam to pump water for domestic water supply from a ground

well to a 10 cu. meter storage tank. The pump was designed to deliver 10 cu. meters/day at 21.5 meter total head. It consisted of 18 PV modules, a screw type pump with 3.5 inch shaft tube, and a 90-volt, 1 HP SR53-series DC motor. Approximately 6.0 cu. meters per day were pumped during the testing period. The total investment was US$15,600. The benefit: cost ratio was 0.49:1. The pump was not considered economically feasible, as the capital costs were too high.

The system was subsequently increased to 840 peak watts. It includes a 10 cubic meter storage tank connected by pipe to four gravity-fed 1.5 cubic meter distribution tanks situated throughout the village. It supplies drinking water to 61 households (about 350 people) from a sealed well 18 meters deep. It is shut down twice annually for repair of the pump, which is performed by a mechanic from the Maha Sarakham REC, with parts supplied by the REC and labor by the village. The village appreciates the convenience of the pump and the clean water it provides (since the well is now sealed). The NEA calculated that the cost for the entire solar pump system would need to be reduced by 60-70% for the solar system to break even with a diesel pumping system.

- One 4,300-watt PV system consisting of four separate 32-module arrays with a D.C. induction motor and an ARCO Solar CSB 100D model centrifugal pump connected to each array was installed at Ban Sukorn to pump water from the Pradok Reservoir into an irrigation canal. It was designed to pump a minimum of 480 cubic meters per day at 5m head. The total investment was US$47,600. The B:C was calculated at 0.42:1. The system was not economically feasible, as capital costs were too high.

  One farmer refused to provide land access rights for the water distribution system, and NEA removed the solar pump and placed it in storage, awaiting a suitable use.

- Two multiple blade windmills, designed and produced by a Bangkok company that markets windmills in Thailand, were installed at Ban Samoh to pump water for irrigation. One windmill had a 10-foot diameter "bicycle-wheel" turbine, the other a 14-foot fan-wheel with a greater number of smaller blades than a similar American-type windmill. Each was connected to a single-stroke 7.5-cm piston pump with a 7.5-cm stroke, mounted in a dug well with a 4.5 meter depth

water table. Test results from one indicate a monthly output of 274 cubic meters at 2 m/s mean wind speed; the output increased to 667 cubic meters at 6 m/s mean wind speed. Overall system efficiency reached a maximum of 14% at 2 m/s mean wind speed. One windmill cost US$3,500, the other US$2,400. With a B:C of about 0.50:1, the system was not considered economically feasible.

At the end of 1986, one windmill had been removed for repair (but it was uncertain if the repair would occur) and the other had the turbine rotating and pump rod functioning, but no water was being pumped (although the adjacent well had an adequate water level). Field interviews revealed that the villagers viewed the windmills as part of a government project, did not wish to initiate repairs, and did not wish to reclaim the land provided because it was of poor quality and ill-situated. Poor technical design of the windmills and/or pumps, lack of an organized social system for management, and poor economics compared to diesel water pumping were cited as significant obstacles to windmill acceptance. In addition, there was no collection of revenues for maintenance.

- A VITA windmill and PVC ladder pump were installed at Ban Samoh for irrigation. Tests indicated a monthly output of 5,500 cubic meters at 3 m/s mean wind speed; the output increased to 12,500 cubic meters at 6 m/s mean wind speed. The system starts pumping with the wind at 4 m/s, but it continues pumping down to 2 m/s. Overall system efficiency was 3.3% at 3 m/s mean wind speed. The total cost was US$2,000. With the B:C at 0.8:1, the system was not considered economically attractive.

  In late 1986, the windmill and associated ladder pump were found in shambles, with some blades broken and others missing. See discussion of multiple blade windmills, above, for villager attitudes toward the windmill installations and reasons for non-acceptance.

- As of 1984, NEA had purchased, but not installed, a 20 kW continuous, 30 kW intermittent (with 5 kW minimum continuous) North American gasifier with Ford Model 2.3L, continuous duty 38 HP engine (with 60% of rated horsepower for low Btu gas). Design performance is 20 kW, 25 shaft horsepower at 2,000 rpm, and 50 lbs. wood per hour fuel consumption. Fuel characteristics are 15% optimum moisture content, 30% maximum moisture content, and optimum

size is 1 cubic inch minimum, 4 cubic inch maximum. Gas components are 5% hydrogen, 3% carbon dioxide, 1% oxygen, 1% methane, 62% nitrogen, and 28% carbon monoxide, with no tar content and 100% moisture content at ambient temperature. This is a new product that eliminates tar production, designed specifically for Third World applications where technical expertise is at a minimum and operational conditions are the most severe. Price was US$18,115.10 total F.O.B., and US$21,231.00 including freight and insurance. As of 1986, the gasifier was not installed.

- NEA also designed a biogas pumping system to be installed in Maha Sarakharm Province. The biogas digester consisted of three 3.3-meter-diameter cylindrical digestion tanks with stainless steel covers, a 0.50 x 11.30m distribution channel with 5% slope, and 0.06m high, 3.00m long, 1.20m wide slurry mixing trough; a benzene engine with 10 HP capacity; and a self-priming centrifugal pump with a discharge rate of 200 liters/minute and with a lifting head of 25 meters. The engine and pump are to be installed on the same base connected with a belt drive. As of 1986, the digester was not installed.

(Sources: A Feasibility Study of Waterlifting Technology in Thailand, 1984, PNAAS533; Evaluation, 12/30/86, pp. 38-43, PDAAU900)

H. Improved Charcoal Production

The Royal Forestry Department conducted a survey on charcoal production, distribution, and consumption in Thailand and evaluated 13 charcoal production techniques. Nine promotional training programs, presented to 307 trainees from rural development organizations, villages, and charcoal manufacturers, encouraged the construction of 34 demonstration kilns. A Charcoal Research Center was established. Three training sessions on improved kiln construction and use were held at the Center.

The following variables of the charcoal production process were studied: kiln type; firing techniques; kiln temperature; smoke temperature; wood species and moisture content; charcoal quality and quantity; and production rates. Eleven wood species were tested. Three classes of kiln were studied: permanent (brick beehive, brick Brazilian modified, brick hot tail, brick hot tail modified, mud beehive); mobile (metal Mark V, metal Tongas, single drum, double drum); and nonpermanent (rice husk, saw dust, and earth mound).

Observations include:

- Permanent kilns, especially brick and mud beehives, provide the highest charcoal yield and efficiency (efficiency defined as the product of yield and charcoal heat content divided by the drywood raw material heat content).

- Mobile kilns have the fastest production rate but yield is lowest and quality is poor.

- Increasing the rate of heating through 30-400 degrees Celsius range enhances charcoal output significantly.

- Extension of chimneys reduces operating time.

- Moisture content had very little influence on charcoal yield or conversion efficiency, but it did affect operating time.

- Specimens from various wood species produced differing charcoal quality and quantity, but within a small range.

Diagrams of kilns and tabulated data from the trials are available in PNAAS529.

Results noted in the 1986 evaluation indicate that NEA medium-sized improved kilns (8 and 20 cubic meter capacity) have a 1-3 year payback period, based on 5-16% increase in charcoal yield.

As of 1986, the charcoal component had very little impact on rural energy use, since few producers had adopted the new technologies/techniques. (The project undertook little extension.) Government restriction on charcoal production was one of the hindrances to larger acceptance of improved charcoal production. The laws governing the production and distribution of charcoal are being assessed in view of the desire to promote better charcoal production methods.

(Sources: Charcoal Production Improvement for Rural Development in Thailand, 1984, PNAAS529; Charcoal: Kiln Experiments, 1982, PNAAQ555; Evaluation, 12/30/86, pp. 68-71, PDAAU900)

I. Improved Cooking Stove

The Royal Forestry Department produced five improved cooking stoves: charcoal bucket stove, wood stoves with and without chimneys, and rice husk stoves with and without chimneys. Laboratory tests on 80 different

stoves identified the critical physical parameters: stove weight; exhaust gap/area; combustion chamber capacity; rim design for proper fit of pots; grate-to-pot distance; grate characteristics, such as thickness, hole size, area, and distribution; height of chimney; and height of flue gas baffle. Water boiling tests were conducted to determine stove efficiency or Heat Utilization (HU), a modification of PHU (Percent Heat Utilization). HU is defined as the ratio of the heat consumed in heating and boiling water to the total heat input into the system.

Results include:

- Improved charcoal stove: HU efficiency of 28.15, achieving a comparative efficiency increase of 26% over average commercial models; more durable refractory materials than present commercial models; meets criteria for users' acceptance.

- Improved non-chimneyed wood stove: HU efficiency of 28.7, 35% comparative efficiency increase over commercial models; charcoal burns inefficiently in this stove; comes with or without insulation.

- Improved chimneyed wood stove: HU efficiency of 19.1, a comparative efficiency increase of 58% over commercial models; limited use, not popular in rural areas.

- Improved chimneyed rice husk stove: HU efficiency of 10.4, a 100% increase over average commercial models; insulation lining of husk ash-clay mixture very effective; inexpensive to build; gaining some acceptance but not as popular as wood and charcoal stoves.

- Improved non-chimneyed rice husk stove: based on "Meechai" stove; also uses husk ash-clay insulation; HU efficiency of 19-20, a 16% increase over existing models; application is limited to rice-producing areas.

As of 1984, charcoal bucket stove and non-chimneyed wood stoves were the most popular. Costs of these improved stoves were twice that of the poorest quality commercial models but 25-30% less than top quality charcoal stoves sold in the market.

As of 1986 (after the component PACD), NEA, through the RECs, was still providing training to stove users and manufacturers. Stove fabrication techniques were taught to a large audience: individuals, commercial producers,

and cooperatives or village groups consisting partly or largely of women. Costs of the improved and traditional stoves were reported:

REPORTED PRODUCTION COSTS, PROFIT, AND RETAIL PRICES FOR NEA IMPROVED VERSUS TRADITIONAL CHARCOAL STOVES

COST COMPONENT	COST (BAHT/STOVE)	
	New	Traditional*
Bucket	25	-
Labor	9 - 20	-
Clay liner & grate	3 - 6	-
Other material**	1	-
Total Production	39 - 52	15 - 16
Profit	18 - 31	1 - 2
NEA Wholesale/Retail	70	
Commercial wholesale	75 - 85***	16 - 18
Commercial retail	80 -150****	20 - 25

Notes:

*For Chinese model
**Includes materials such as rice husk, sand, cement, and/or clay.
***One commercial manufacturer with an adaptation of the NEA design produced stoves for 100 Baht/stove in 1986, but has a newer 1987 version that can be sold for 85 Baht/stove.
****High price reflects Bangkok sales.

Traditional stove sales greatly outnumber the sales of improved models, but the latter are slowly increasing. Lifetime of the improved model is reportedly twice the one-half to one-year lifetime of the traditional stove, although this needs to be verified.

(Sources: Improved Biomass Cooking Stoves for Household Use, 1984, PNAAS530; Stoves: Experiments and Cooking Observations, 1982, PNAAQ560; Evaluation, 12/30/86, pp. 72-77, PDAAU900)

J. Village Woodlots

The Royal Forestry Department planted 6,000 rai (1 rai = 0.16 hectare) of Eucalyptus camaldulensis, red river gum, over the life of the project. This species is fast growing, has high survival potential, resists flood and drought, and grows well in saline or infertile soil.

Survival rate for the trees, which were planted on public, school, and monastic land, was 83%. Tree spacing was 2m x 4m; economic cash crops--cassava, corn, groundnuts and tobacco--were planted between trees. Approximately 1.2 million trees were planted in community woodlots. Although only 2m x 4m spacing was used in these trials, 1m x 1m and 1m x 2m spacing would be acceptable if the planting site is not suitable to agroforestry systems.

Suggested uses for the trees after they reach maturity in 5 years include: fuelwood and charcoal burning; fences; furniture; cabin walls; posts; tools; flooring; handicrafts; woodchips; and fuel for electric generators. This project was terminated at 3-year-old plantation stage.

(Sources: The Village Woodlot: Its Implementation in Thailand, 1984, PNAAS528; Evaluation, 12/30/86, PDAAU900)

K. Biomass Collection and Analysis

Results of biomass surveys are as follows:

- Average daily animal dung production measured in terms of dry matter:

adult buffalos	5.8 kg	young buffalos	2.5 kg
adult cows	2.2 kg	young cows	1.7 kg
adult pigs	0.6 kg	young pigs	0.5 kg

- Average calorific value of animal dung (kilocalories per kilogram oven-dried matter):

adult buffalos	2,672	young buffalos	3,051
adult cows	3,129	young cows	2,788
adult pigs	3,498	young pigs	3,747

(Source: Biomass Samples: Collection and Analysis, Tables 1 & 3, 2/82, PNAAQ269)

L. Rural Energy Centers (RECs)

The following prototypes were installed at the Maha Sarakharm and Phitsanulok RECs (funder indicated in parentheses):

- one solar hot water heater (USAID),
- two solar distillers, one fixed and one portable (RTG),
- two solar dryers, different types (USAID),

- one photovoltaic (PV) unit (USAID),
- one charcoal gasifier (USAID),
- two biogas digesters (RTG),
- three different types of efficient cooking stoves (RTG),
- two different types of efficient charoal kilns (RTG), and
- three water-pumping windmills, at Maha Sarakharm REC only (wind not sufficient at Phitsanulok REC) (RTG).

Additionally, the RECS were involved in the following activities:

- Planted five rai of Eucalyptus camaldulensis and one rai of oilseed trees at both Maha Sarakharm and Phitsanulok, and introduced 20,000 Eucalyptus camaldulensis plants to village plantation in Maha Sarakharm and 50,000 in Phitsanulok.
- Distributed 42 family-size biogas digesters for cooking and lighting to villages in Maha Sarakharm, one-third of which were subsidized, and promoted 50 of these in Phitsanulok; training in biogas digester construction was conducted 7 times for 35 participants in Maha Sarakharm, followed by demonstration and promotion classes, and 10 times in Phitsanulok for 50 participants.
- Trained participants in the construction of charcoal kilns (mud and brick type) and on charcoal production methods in Maha Sarakharm and Phitsanulok.
- Introduced efficient charcoal-, wood-, and rice husk-burning cooking stoves to 70 trainees in Maha Sarakharm and to 70 trainees in Phitsanulok.
- Installed one PV unit, one biogas digester, and three types of efficient cooking stoves at the Ratchaburi REC.

(Source: The Establishment of Regional Energy Centers for Rural Development in Thailand, undated, PNAAS523)

14. R.E. Technical Reports and Publications:

A. Solar Thermal Processes in Thailand: A Study on Solar Assisted Curing of Tobacco Leaves. National Energy Administration, Bangkok, 1984, 130 pp., PNAAS525.

This report describes efforts to use solar collectors to heat air for drying tobacco, an important cash crop. The report reviews available literature on tobacco drying, describes the experimental solar system used for these trials, outlines data collection and processing techniques, and analyzes and evaluates the results. See Section 13.F, above, for further details.

B. Thermal Solar Processes in Thailand: A Study on Forced Convection Hut Drying. National Energy Administration, Bangkok, 1984, 110 pp., PNAAS526.

This report reviews efforts to dry paddy with forced, solar-heated air. After reviewing the existing literature on the subject, the author formulates a mathematical model for a solar air heater. The model is used to size solar collector area and to estimate paddy drying capacity. Diagrams are included of the solar dryer. Test results are analyzed, showing excellent agreement between the empirical data and the simulated data for inlet temperatures approaching ambient. Annexes contain meteorological data and a technical and economic evaluation of the solar paddy dryer. See Section 13.F, above, for further details.

C. Solar Thermal Processes in Thailand: A Study on Natural Convection Cabinet Drying. National Energy Administration, Bangkok, 1984, 108 pp., PNAAS527.

The report discusses use of natural convection dryers to dry four food and agricultural products: bananas, salted beef, salted fish, and sweet coconut chips. The report reviews available literature and describes the cabinet dryer and the laboratory and field drying tests. The dryer seems best suited to medium-scale drying of agricultural products. Opinions of users are included. The annexes contain cost information, graphic presentation of field data, comparisons of the performance of cabinet dryers with indirect dryers (cabinet dryers with attached separate solar heaters), and background on the development of the solar air heater dryer component. See Section 13.F, above, for further details.

D. Solar Thermal Processes in Thailand: Studies on Solar Distillation and Solar Refrigeration. National Energy Administration, Bangkok, 1984, 155 pp., PNAAS520.

The first section of this report covers solar distillation of water for drinking or for laboratory uses. Two basin-type stills and a vertical still were tested. A literature review and a discussion of the theory of distillation precede a review of the still designs. Test procedures are outlined and results are presented graphically.

The second section covers solar refrigeration. An ice-maker with a 15 kg per day capacity was tested. Thermodynamics of the system, the design of the project, a review of the test procedures, a discussion of the results, and diagrams of the system are included.

See Section 13.F, above, for further details.

E. Feasibility Study on Rice Husk Pyrolysis Technology for Rice Mill Applications in Thailand. National Energy Administration, Bangkok, September 1984, 168 pp., PNAAS521.

The Thai Institute of Scientific and Technological Research applied pyrolysis technology (PT) for conversion of rice husks to oil, gas, and charcoal briquettes as energy sources for rice mills. The report traces the development of the technology from the preliminary literature review through early design and pilot plant stage to field trials in two rice mills. PT looks promising for this and other applications. Results of pilot plant and field trials are discussed, followed by an economic analysis. Appendices address distribution of rice mills and results from studies on attitudes toward using pyrolysis products. See Section 13.B, above, for further details.

F. Solar and Wind Energy Resource Assessment for Thailand. National Energy Administration, Bangkok, 1984, 176 pp., PNAAS524.

The report describes the Meteorological Department's solar and wind resources assessment, which was to specify a reliable way to determine and monitor those resources. A Center for Solar Radiation and Wind Calibration and 16 field monitoring stations were established. The report describes the methods used to establish stations, calibrate instruments, and gather and analyze data. Existing data are evaluated, and results of the evaluations of new and old data are presented. The authors recommend continued and expanded monitoring of solar and wind resources.

G. The Village Woodlot: Its Implementation in Thailand. National Energy Administration, Bangkok, 1984, 192 pp., PNAAS528.

The report describes the efforts of the Royal Forestry Department to plant woodlots as sources of fuelwood in areas of high consumption. After presenting background information on the project and this component, the report reviews literature and examines agricultural aspects of forestry development and silviculture. Economic and land use issues related to woodlots are discussed. A sociological review includes attitudes of villagers, monks, and teachers toward the project. Uses for the wood produced are outlined. See Section 13.J, above, for further details.

H. Charcoal Production Improvement for Rural Development in Thailand. National Energy Administration, Bangkok, 1984, 163 pp., PNAAS529.

Surveys of the charcoal market and experiments conducted on charcoal kilns are presented. Thirteen types of kilns were tested. The report reviews existing literature on charcoal production, discusses production processes, and compares nonpermanent, mobile, and permanent kilns. Diagrams are included. Charcoal quality, conversion efficiency, appropriate tree species, production costs, and related topics are addressed. See Section 13.H, above, for further details.

I. Charcoal: Kiln Experiments. Damrongchai Pumsanguan and John Arnold Jr., Meta Systems Inc., 10 Holworthy Street, Cambridge, MA, 02138, February 1982, 82 pp., PNAAQ555.

The report presents a study of village charcoal-making activities, which was part of a baseline survey. Three types of kilns are examined: rice husk mound, earthen mound, and permanent mud or clay kilns. Charcoal production and comparative performance of the kilns are discussed. Extensive photographs are included.

J. Improved Biomass Cooking Stove for Household Use. National Energy Administration, Bangkok, 1984, 323 pp., PNAAS530.

This report documents the development of five new cooking stoves that use wood, charcoal, and rice husks as fuel. Existing stove models and previous research on cooking stoves are extracted in a literature review. Methods of testing new stoves, the many variables considered, and the test results are discussed at length. Extensive tabular and graphical data are presented. Photographs of many of the tested stoves and diagrams of the five new

stoves are included. See Section 13.I, above, for further details.

K. Stoves: Experiments and Cooking Observations. Siluvk Ponnoum, Arre Wongopalert, and John Arnold Jr., Meta Systems Inc. Thai Group, 10 Holworthy Street, Cambridge, MA, 02138, February 1982, 106 pp., PNAAQ560.

This report presents results from experiments on stove efficiencies. Wood and charcoal stoves were examined. Observations were made in homes as typical Thai meals were prepared; cooking process variables were measured and recorded but experiments were not controlled. Relationships between these variables were sought. This study generated baseline data for the anticipated Improved Cooking Stove component of the project.

L. Industrial Biogas: A Feasibility Study of Waste Utilization from Agro-Industry in Thailand. Prakarn Bunchueydee, National Energy Administration, Bangkok, 1984, 137 pp., PNAAS531.

This report examines the feasibility of using industrial wastewater with high organic concentration to produce biogas. Five wastewater feed streams are tested, and technical and economic analyses are performed. Chapters on project design and experimental procedures follow a brief presentation of anaerobic digestion theory. Conclusions and recommendations are provided. Several diagrams of process layout and equipment are included. Annexes contain plant design calculations, cost analysis, and a summary of project budget and activities. See Section 13.D, above, for further details.

M. A Feasibility Study of Waterlifting Technology in Thailand. Oran Rutanaprakarn and Winai Liengcharernsit, National Energy Administration, Bangkok, 1984, 140 pp., PNAAS533.

Four types of water pumping systems are considered: solar PV array, wind turbine, gasifier, and biogas. Background literature is presented for each. Only two technologies, solar and wind, were installed. Descriptions of systems, results of field trials, economic analyses, conclusions, and recommendations are presented for both. Tabular and graphical data included. See Section 13.G, above, for further details.

N. Development of Kam Pong, Mae Ton Luang, Huai Pui, and Bo Kaeo Micro-Hydropower Projects. Winai Liengcharensit, National Energy Administration, Bangkok, 1984, 202 pp., PNAAS534.

This report describes installation of micro-hydropower plants in four villages. Literature is reviewed and design considerations covered. Design and construction of the four sites are described. Economic and social aspects are examined as well. See Section 13.C, above, for further details.

O. Rural Industry: Survey Results. Sompong Aiemjoy and John Arnold, Jr., Meta Systems Inc. Thai Group, 10 Holworthy Street, Cambridge, MA, 02138, February 1982, 99 pp., PNAAQ268.

This report presents the findings of fuel use surveys of rural industries, including building materials, crop processing, and household materials. The surveys included structured interviews, observations of the production process, physical measurements of the fuel quantities used and products produced, and collection and analysis of samples of biomass (in the cases where this was the fuel) for moisture content. Fuel consumption, labor intensity, and yield are presented in tabular/graphical form for 47 rural industries; more than half used either fuelwood, charcoal, bagasse, or sawdust as fuel. In addition, 162 home industries were surveyed by means of two-page questionnaires dealing with uses and sources of fuel, raw materials, and labor. Results are presented, revealing that 24 home industries used biomass fuels. Includes photos.

P. Biomass Samples: Collection and Analysis. Buaphan Pukting and John Arnold, Jr., Meta Systems Inc. Thai Group, 10 Holworthy Street, Cambridge, MA, 02138, February 1982, 63 pp., PNAAQ269.

Results from the collection and analysis of a variety of biomass sources are provided, and methodologies are explained. Biomass included buffalo, cow, and pig dung, fuelwood, and charcoal. Graphs, tables, and matrixes present energy content, moisture content, production estimates, and uses of biomass residues by application for various areas. See Section 13.K, above, for further details.

Q. Trees: Production, Uses and Needs. Lertchai Kwankonchim and John Arnold, Jr., Meta Systems Inc. Thai Group, 10 Holworthy Street, Cambridge, MA, 02138, February 1982, 96 pp., PNAAQ270.

Data is presented from a baseline survey on the supply of and demand for fuelwood (including wood for making charcoal). Results are based on household interviews,

discussions with "village botanists," and land use surveys and are presented in tabular and matrix forms. Includes species preferences of villagers.

R. Energy Use. John Arnold, Jr., Meta Systems Inc. Thai Group, 10 Holworthy Street, Cambridge, MA, 02138, February 1982, 119 pp., PNAAQ271.

This volume summarizes the results of a survey of 50 villages concerning the amount and type of fuels used for domestic cooking, lighting, and heating. Results are based both on direct measurement of quantities of fuel used over a given period of time and on household interviews. Extensive matrixes, graphs, and tables are included.

S. Household Survey: Questionnaires. Meta Systems Inc. Thai Group, 10 Holworthy Street, Cambridge, MA, 02138, February 1982, 149 pp., PNAAQ559.

This report contains the final questionnaire for the Household Survey, a major component of the baseline survey (described in 14.T, below). It also contains related forms and guidelines.

T. Survey Overview and Guide to Data. Meta Systems Inc. Thai Group, 10 Holworthy Street, Cambridge, MA, 02138, February 1982, 33 pp., PNAAQ554.

This is an overview of the baseline survey, undertaken at the project's initiation to provide general data on village activities and energy use patterns, and expanded to include measurements such as biomass samples analysis, stove efficiencies, charcoal kiln efficiencies, and animal dung production. These data were to assist site selection and introduction of R.E. technologies and to ascertain the impact of the technology introductions by comparison with the baseline conditions.

U. Rural Village Surveys in Thailand. National Energy Administration, Bangkok, undated, 183 pp., PNAAS532.

This report describes the baseline surveys mentioned in 14.T, above, which were undertaken in two phases in 1980 in 65 villages in preparation for field trials of the project's R.E. technologies. They represent a collection of energy data concerning sources of energy, energy usage, energy needs, economic and social factors, availability of raw materials, and the moral support and physical participation of villagers expected to be involved in the R.E. technology installations. The report also includes transitional surveys on the woodlot, biogas, micro-hydro, windmill water pumping, and

photovoltaic water pumping components; these surveys reviewed the level of cooperation among technicians, analysts, villagers, and local officials after the energy technologies had been selected for installation. Due to time constraints, only the baseline data from Phase I, which included charcoal and firewood as cooking fuels, are analyzed.

V. The Establishment of the National Energy Information Center in Thailand. National Energy Administration, Bangkok, undated, 417 pp., PNAAS522.

This report describes the establishment, organization, resources, services, and operation of the National Energy Information Center (NEIC), which was supported by this project. It also contains brief recommendations for upgrading the NEIC. Extensive annexes include lists of NEIC's library tools, energy serial titles, worldwide energy information systems and data bases, etc.

W. The Establishment of Regional Energy Centers for Rural Development in Thailand. National Energy Administration, Bangkok, undated, 125 pp., PNAAS523.

This report provides background on the six Regional Energy Centers (RECs) planned by the project, describes their activities in disseminating a wide variety of R.E. technologies, reviews the accomplishments and problems to date of the four RECs already established, and provides general recommendations for improvements. Photos, tables, and charts are provided. Included also are a brief review of R.E. activities in Thailand and a listing of the Thai agencies concerned with R.E. technologies.

X. Sectoral Energy Planning Models: Supporting Studies of Thailand's Energy Master Plan. National Energy Administration, Bangkok, undated, 217 pp., PNAAS535.

This report reviews the following linear programming models used for macro-economic planning purposes: (1) the Energy Master Plan Model, (2) Energy Master Plan Submodels (EMPS), which include the Rural Energy Use Model, and (3) the Rural (Household Energy and Rural Community Development) Energy Models. Recommendations are made concerning the EMPS and Rural Energy Models.

Y. An Evaluation of Rural Electrification Policy: Thailand, A Case Study. J. Scott McDonald, Northern Illinois University, Dekalb, Illinois, May 1980, 584 pp., PNAAS964.

Through analysis of data from household surveys undertaken in 28 villages, this Ph.D. dissertation looks

at the impacts of rural electrification on basic needs, industrial development, and resource conservation. It also examines costs of rural electrification and alternative energy systems, as well as the Thai rural energy bureaucracy. Appendices include survey instruments, maps, basic indicators, and a selected bibliography.

Z. Solar and Wind Energy Potential Assessment for Thailand. B. Suwantrakul, W. Watabutr, K. Sitathani, V. Tia and P. Nampraki, Meteorological Department of Thailand, Bangkok, 1984.

Not available for review. Mentioned on p. 80 of the 12/30/86 Evaluation.

AA. Solar and Wind Energy Data of Thailand. R.B. Exell and Dusadee Sulsawat, Meteorological Department of Thailand, Bangkok, 1983, 90 pp.

Not available for review. Mentioned on p. 80 of the 12/30/86 Evaluation.

15. Evaluations/Major Findings:

A. Thailand Renewable Nonconventional Energy Project: An Evaluation for the Period August 1979 to July 1982. James Westfield and Ulrich Ernst, Development Sciences Inc., Sagamore, MA, September 1982, 120 pp., PDCAD799 or PDAAQ512.

This major mid-term evaluation analyzed overall project objectives and design, the nature and status of individual project components, and the institutions involved. The project was deemed appropriate for Thailand at the time, but overly ambitious. Evaluators recommended clarifying contractual obligations between USAID, the Thai National Energy Administration, and Meta Systems, Inc. They also recommended the creation of an overall work plan to coordinate individual component work plans. Finally they suggested invigorating the training component, particularly through in-country training. Most of the planned energy resource assessments had been eliminated. Some new technologies had replaced others proposed originally. Appendixes include reviews of individual project components and a review of other renewable energy research activities in Thailand at the time of the evaluation.

B. Renewable Energy Systems Installed in Asia: Current Successes and the Potential for Future Widespread Dissemination. John H. Ashworth, Associates in Rural Development Inc., Burlington, Vermont, April 1985, 98 pp.

PNAAW825.

Focusing on experience gained in Nepal, India, Philippines, and Thailand, this report examines several renewable energy technologies that have been introduced successfully in Asia. For Thailand, rice husk pyrolysis and micro/mini hydro power were analyzed.

C. Final Accomplishment Report for the Renewable Nonconventional Energy Project. National Energy Administration, Bangkok, 1984, 182 pp., PNAAS518.

This report reviews all project activities, providing background, conclusions, and recommendations. It also has a chapter on the dissemination, diffusion, and adoption of renewable energy technologies.

In a chapter on the general findings of the village surveys, the author notes that electricity, even when available, is used only for lighting in rural households because of the expense. Micro hydropower and photovoltaics are the technologies most likely to supply these modest needs, but initial investment costs remain high and care needs to be taken when applying technologies. Windmills are an option only for higher income households involved in irrigation. Wood and charcoal remain important fuels, and the need to expand village woodlots is cited. These energy options are attractive because of the social benefit of self-reliant communities.

D. Evaluation of Renewable Nonconventional Energy Project, Thailand (4930304). Norman L. Brown, Marcia M. Gowen, Chalio Buripakdi, and Kirtland M. Barker, International Science and Technology Institute, Inc., December 30, 1986, 115 pp., PDAAU900.

The evaluation team concluded that the most impressive results came from the micro-hydro, improved cookstoves, and village woodlots components.

Total national and village benefits from the micro-hydro component were very positive. Community involvement in construction, management, operation, and maintenance was very successful, not only to the project activities, but toward fostering greater community cooperation in development and toward skills enhancement. Overall operation and maintenance costs for the micro-hydro systems were reduced. Moreover, the project contributed toward the development of an indigenous micro-hydro turbine/generator manufacturing base. The evaluators recommended that NEA clarify policies governing the sale of excess electricity to the Provincial Electric

Authority; that NEA promote rural industries using electricity to provide income generation benefits and improve rural productivity; and that the Ministry of Agriculture and Cooperatives devise a simpler financial accounting system to facilitate collection of electricity fees.

One of the important contributions of the woodlot component was the change in attitude between the villagers and the Royal Forestry Department, from adversarial to much more cooperative. The project had an educational impact through activities on temple and school grounds, resulting in heightened awareness on the part of both parents and students, and stimulating tree-planting programs. With tree planting, communal lands took on a new usage. Ownership and harvesting rights, however, are uncertain and must be resolved. There is also a question of how many of the trees planted will be used for energy purposes, since there is a higher economic value of wood for other uses. The technologies developed under the project have been taken up by a number of groups and individuals in the private, academic, and public sectors for continued development and direct implementation. Although the project was successful in disseminating seedlings and establishing stands, it did not reach the stage of providing forestry management, basic forestry extension in such areas as harvesting and transportation, and forest products utilization. It is recommended, among other things, that the Forestry Department explore market development of the forestry resources; clarify the land and tree ownership question; diversify, and examine other species; cooperate with other groups working in forestry activities; and incorporate agroforestry into forestry projects.

The evaluators viewed the cookstoves program as being at a critical stage needing continued RTG support, although not necessarily at a high level of funding. They recommended NEA assistance in marketing, through development of more wholesalers or other marketing alternatives.

Numerous other recommendations and conclusions concerning the National Energy Information Center, the Regional Energy Centers, the Energy Master Plan, the village survey, and the water-lifting, biomethanation, solar thermal, gasification, improved charcoal production, solar/wind resource assessment, and pyrolysis of rice husks components are included.

16. Key Persons:

A. AID/Washington:

Peter Bloom
ANE/ASIA/PD
647-5829

B. AID/Mission:

John Neave, Project Officer
USAID/Thailand

C. Contractors:

Robert Vernstrom, Resident Coordinator
Meta Systems, Inc., 10 Holworthy Street, Cambridge, MA 02138
(617) 868-8660

Khun Yiam Wongvanich
Thai Consultants Co. Ltd., 61/1 Lunsuan Road, Bangkok, Thailand

D. Host Country:

Sompangse Chantavorapap, Project Manager
Prakarn Bunchueydee, Component Leader
Oran Rutanaprakarn, Component Leader
Sawad Hemkamol, Component Leader
National Energy Administration (NEA), Kasatsuk Bridge
Bangkok 10500, Thailand

Dr. Aroon Chomcharn
Khun Komol Prakthong
Royal Forestry Department (RFD)

Dr. Woraphat Arthayukri
Chulalongkorn University (CU)

Khun Soranee Sangmit
Meteorological Department (MET)

Khun Preecha Ploypatarapinyo
Thai Institute of Scientific and Technological Research (TISTR)

Dr. Prida Wibulswas
King Mongkut's Institute of Technology (KMIT)

Mr. Pairach Woravech, Component Leader-Regional Energy Centers

Maha Sarakharm Regional Energy Center
Maha Sarakharm-Kosumpisai Road, No. 151 Ban Non Tae, Group 4, Ta Song Kon Township, District Capitol, Maha Sarakharm Province

Phitsanulok Regional Energy Center
Phitsanulok-Watboat Road, No. 73, Group 3, Ban Wang Rae, Makhamsoong Township, District Capitol, Phitsanulok Province

Ratchaburi Regional Energy Center
Ratchaburi-Jombueng Road, Hin Kong Township, District Capitol, Ratchaburi Province

Nakhon Sithammarat Regional Energy Center
Asia Road #41, Nong Hong Township, Toong Song District, Nakhon Sithammarat Province

17. Obligations by Fiscal Year (US$000):

YEAR	AID	RTG	TOTAL
1st	774.0	240.1	1014.1
2nd	1934.2	760.9	2695.1
3rd	1463.75	807.25	2271.0
4th	597.8	776.7	1374.5
5th	230.25	564.95	795.2
TOTAL	5000.0	3149.9	8149.9

(Source: Project Paper, Table 2, p.35, PDCAD787)

18. Host Country Funding of R.E. Components(US$000): 3,150*

*See Section 19, below, for distribution.

(Source: Evaluation, 9/82, PDCAD799 or PDAAQ512)

19. Summary of R.E. Costs (US$000):

A. By Component

	IMPLEMENTING AGENCY	USAID	RTG	TOTAL
1. National energy info center	NEA	356	238	594
2. Regional energy centers	NEA	459	1,329	1,788
3. Energy master plan support	NEA	132	70	202
4. Surveys	NEA	353	78	431
5. Micro hydro	NEA	320	208	528
6. Water lifting	NEA	307	83	390
7. Biogas	NEA	125	39	164
8. Solar drying/ distillation	KMIT	106	86	192
9. Gasification	CU	192	39	231
10. Village woodlots	RFD	554	395	949
11. Charcoal improvement	RFD	182	131	313
12. Stove improvement	RFD	208	151	359
13. Solar/Wind resources assessment	MET	254	16	270
14. Pyrolysis	TISTR	90	74	164
Technology monitoring	NEA	35	-	35
Training	NEA	500	90	590
Coordinating consultant	META	670	-	670
Contingency		157	123	280
	TOTAL	5,000*	3,150	8,150

*Does not include 500 deobligation.

(Source: Evaluation, 9/82, Table II-1, p. 5., PDCAD799 or PDAAQ512)

B. By Input Category

Technical assistance	2,159.9
Training	104.3
Equipment (procurement and services)	2,015.5
Workshop and others	70.9
Contingency	149.4
TOTAL	4,500.0

(Source: Implementation Letter No. 50, 07/10/84, PDCAI798)

20. R.E. Component Revisions:

A. On May 27, 1982, upon the departure of Dr. Roderick MacDonald, responsibilities as USAID Project Officer were delegated to Khun Mintara Silawatshananai, Engineer (General).

(Source: Implementation Letter No. 19, 5/27/82, PDCAD794)

B. John Neave, Chief Engineer, assumed responsibilities as USAID Project Officer in February 1983. Mr. Silawatshananai continued to provide backstopping support.

(Source: Implementation Letter No. 26, 2/14/83, PDCAD794.

C. PACD extended from July 1, 1984, to September 30, 1984. The three month extension was requested to allow completion of two components, training, commodity procurement, printing of reports, and a final workshop. USAID and the Thai National Energy Administration also agreed to deobligate $500,000 in excess funds that could not be spent before the new PACD.

(Source: Implementation Letter No. 47, 6/18/84, PDCAH734)

D. PACD extended from September 30, 1984, to October 31, 1984, for completing and printing the Final Accomplishment Reports of the various project components.

(Source: Implementation Letter No. 52, 9/28/84, PDCAI798)

E. The mini hydro installation planned for Mae Su was canceled because the site did not meet project objectives for need and for local participation in management, construction, operation, and maintenance. Three other sites were proposed, but the need for the entire component was questioned because mini hydro was a well-demonstrated technology and other agencies were involved in the dissemination.

(Source: Evaluation, 9/82, Appendix on Individual Component Evaluations, PDCAD799 or PDAAQ512)

F. Several renewable and nonrenewable energy assessment surveys were eliminated from this project for various reasons: similar surveys were being funded under other projects (micro-hydro, geothermal); adequate information was already available (biomass); or the survey seemed inappropriate for the project (lignite, tarsands, and shale oil).

(Source: Evaluation, 9/82, p. 14, PDCAD799 or PDAAQ512)

G. Proposed project components dealing with industrial conservation and conversion system integration were deemed inappropriate and dropped. They were replaced with components on gasification and industrial biogas. The criteria for the decision were not explicitly stated.

(Source: Evaluation, 9/82, p. 14, PDCAD799 or PDAAQ512)

H. Meta Systems Inc. was not retained as coordinating contractor after the completion of the initial contract on January 31, 1983.

(Source: Letter from Robert Vernstrom to K. Y. Wongvanich, 12/3/82, PDCAD798)

21. Follow-On Activities:

A. The micro-hydro component stimulated (1) greater investment by the Royal Thai Government in small hydro installations and (2) development of a local industry involved with manufacture of small hydro equipment.

(Source: Evaluation, 12/30/86, pp. 1-2, PDAAU900)

B. Following the study of production of biogas from industrial wastes, several alcohol distilleries are investigating its feasibility for treating their wastes. Thai Alcohol may agree to build a biogas system in collaboration with the Belgian firm Biotim.

(Source: Evaluation, 12/30/86, pp. 2, 46, PDAAU900)

C. Following training and promotion of improved charcoal production techniques, private producers are beginning to build the improved kilns.

In addition, work undertaken under the charcoal production component was continued by NEA, with support from FAO. A workshop sponsored by FAO was scheduled for October 27 - November 7, 1986 at the Charcoal Research Center. The World Bank is considering using the results in a proposed fuelwood energy project in Thailand.

(Source: Evaluation, 12/30/86, pp. 2, 68-71, PDAAU900)

D. After the project PACD, the NEA (through the RECs) continued to support cookstove dissemination by training stove users and manufacturers. Stoves are being exported to Burma. Village groups, often owned and operated by women, are producing and marketing the improved wood and charcoal cookstoves. A new company devoted to manufacturing and improving the new stoves has been established. Traditional stove producers have adopted the new models. The World Bank is preparing a major effort aimed at accelerating and expanding stove dissemination. Although the improved stoves make up a small share of total stove production, there are signs that sales are expanding and that the stoves are gaining acceptance throughout the country.

(Source: Evaluation, 12/30/86, p. 2, 72-77, PDAAU900)

E. The solar dryer study concluded that single-product dryers were too expensive, due to their low utilization rate. King Mongkut's Institute of Technology Thonburi continued with Australian assistance to conduct research on solar drying after USAID funding was completed, investigating multi-product dryers.

(Source: Evaluation, 12/30/86, p. 48, PDAAU900)

F. The project identified priorities for future research and an implementation strategy through a proposal for a Gasification Technology Development Center. The UNDP/World Bank Gasifier Monitoring Program has conducted preliminary studies of rice husk fueled gasifiers in Thailand, and the World Bank has developed a scope of work for NEA to undertake data collection and initial monitoring of these systems.

(Source: Evaluation, 12/30/86, pp. 52-54, PDAAU900)

G. Experience gained under the village woodlot component has led to many activities, including the following:

- The FAO has implemented a 2-year Regional Wood Energy project which expands on the USAID project and uses some of its facilities.

- The NEA has continued to develop activities initiated under the project. The Maha Sarakham REC budget contains funds for growing trees.

- Kasetsart University, working with a number of donors, has continued with many fuelwood and social forestry activities related to some extent to the project.

- Private enterprise has used the overall experience and results of technical studies to further develop and implement technologies developed under the project.

- Planting of Eucalyptus on temple and school grounds has had a considerable educational impact, among both students and parents, and has stimulated tree-planting programs.

- Many private plantations have been established, and trees have been planted in home gardens, along fence rows, and between paddy fields.

(Source: Evaluation, 12/30/86, pp. 58-67, PDAAU900)

22. Comments on R.E. Components: Not specified

23. Date/Data Preparer: July 1986 (mgz)
Revised February 1987 (jrl)

---------- AID RENEWABLE ENERGY DATA BASE ----------

1. Project Number: 4930324 2. Geo: THAILAND

3. Title: MICRO/MINI HYDROELECTRIC PLANTS

4. Project Life/PACD: 1982-87/September 30, 1987

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 8,230

   B. R.E. Components: 8,230

   (Source: Action Memorandum, 6/26/85, PDCAL980)

7. Loan or Grant/Appropriation Category (US$000):

   L / ARDN / 8,000
   G / ARDN / 230

   (Source: Action Memorandum, 6/26/85, PDCAL980)

8. Project Purpose:

   To determine the optimum investment mix for small hydroelectric plants in Thailand; To determine the economic viability of these plants in areas that are isolated from, or feed into, the national grid.

9. Renewable Energy (R.E) Outputs:

   Development of an analytical capacity and method that will permit the Royal Thai Government (RTG) to improve small hydro planning, analysis, and construction techniques and procedures; Construction of up to 12 micro/mini (0-1,000 kW) hydroelectric generating systems.

10. R.E. Inputs:

    Technical assistance; Equipment; Final engineering design; Civil works construction; Power plant procurement; Evaluation.

11. Summary of R.E. Components:

    To exploit the abundant hydropower potential in Thailand, the National Energy Administration (NEA) set out to install 12 micro and mini hydroelectric generators in remote villages.

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NEA is to identify feasible sites, assuring that the communities can contribute labor and materials in exchange for the turbine and engineering design. A local committee oversees site preparation, installation, operation of the unit, collection of fees, and maintenance. NEA provides detailed engineering designs, and USAID assists with procurement of power plants and funds for construction of necessary civil works. The hydropower installations have provided inaccessible villages with the small increments of power they require, reliably and at a low cost per kilowatt. NEA continues to strive for a completely local hydropower capability, encouraging manufacture of generating units and ancillary equipment. Eventually the Thai private sector should produce units of 500 kW capacity.

12. R.E. Project Descriptors:

Hydroelectric power plants.

13. R.E. Technology Applications:

The 12 proposed hydro (0-1,000 kW) sites will use run-of-river schemes; no water impoundment is anticipated. The standard design calls for water to be diverted from the river into an open or closed headrace through a penstock to the power house, where it actuates the turbine and is then directed back into the normal stream bed. Power generated by the machinery is to be stepped up through the 22 KV transmission line where it would then be stepped down, metered, and connected to the users units. The range of installed capacity at the first six studied sites is 100-440 kW. Available water head varies from 50 meters to 125 meters. The Project Paper contains a sketch of a model site.

The NEA design staff has experience with cross-flow, Pelton, and Francis turbines, but there is no mention in the project literature of which turbines were employed for the sites.

(Sources: Project Paper, PDCAD908; Request for Technical Proposal, PDCAD915; Asia R.E. Evaluation 4/85, PNAAW825)

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings:

A. Renewable Energy Systems Installed in Asia: Current Successes and the Potential for Future Widespread Dissemination. Dr. John H. Ashworth, Associates in Rural Development Inc. (ARD), 72 Hungerford Terrace, Burlington, Vermont 05401, (802) 658-3890, April 1985, 98 pp., PNAAW825.

This report examines renewable energy technologies that have met success in Asia, focusing on experience from Nepal, India, the Philippines, and Thailand. Successful mini and micro hydroelectric systems in Thailand are examined briefly.

Installation of micro (0-100 kW) hydro units was considerably less expensive than extending the national grid to remote villages. The civil works and generating equipment for a micro hydro unit can be installed for about $430 per kilowatt of generating capacity, and the units have proven very reliable. The villagers supply labor and certain materials in exchange for the turbine, and they are responsible for operation of the unit, collection of fees, and maintenance. By comparison, the real cost of extending the national grid is estimated by NEA engineers to be over $15,000 per kilometer, with annual maintenance costs of $500 per kilometer. The micro hydro units also have longer lives and lower recurring costs than do diesel generators.

NEA is striving to develop a completely local micro and mini hydroelectric capability. A machine shop in Chiang Mai already has the capability to build cross-flow turbines up to 50kW capacity and site-fabricated headrace and penstock steel pipe up to 1.5 meters in diameter. Eventually the Thai private sector may be producing units up to 500kW capacity, and export of these units to other parts of Southeast Asia may be possible.

16. Key Persons:

A. AID/Washington:

Dr. Robert Ichord, ANE/TR/EFE, 647-8274

B. AID/Mission:

John Neave, Project Officer
USAID/Thailand, 37 Soi Somprasong 3, Bangkok, Thailand

C. Contractors:

Mr. Lynn Pruitt , Senior Engineer
TEAM-Stanley Consultants-KEC, Stanley Building,
Muscatine, Iowa 52761, (319) 264-6600, TELEX: 468402

D. Host Country:

Mr. Chartdanai Chartolrak, Project Manager
Mr. Prapath Premmani, Secretary-General
National Energy Administration, Rama Road, Bangkok
10500, Thailand

17. Obligations by Fiscal Year (US$000):

Projected expenditures:

Source	FY 82	FY 83	FY 84	FY 85	FY 86	TOTAL*
USAID	470	2,316	3,861	1,514	67	8,230
RTG	213	1,366	2,375	731	15	4,700
TOTAL	683	3,682	6,236	2,245	82	12,930

*May not add up correctly due to rounding.

(Source: Project Paper, p. 26. PDCAD908, and Action Memorandum, 6/26/85, PDCAL980)

18. Host Country Funding of R.E. Components (US$000): 4,700

(Source: Action Memorandum, 6/26/85, PDCAL980)

19. Summary of R.E. Costs (US$000):

Civil works construction	3,672
Technical assistance	1,097
Equipment support	25
Final engineering design	387
Power plant procurement	2,054
Evaluation (grant funds)	100
Contingency	895
TOTAL	8,230

(Source: Activity Data Sheet from Action Memorandum, 6/26/85, PDCAL980)

20. R.E. Component Revisions:

A. An additional $130,000 in grant funds from the Agriculture, Rural Development and Nutrition account was obligated to the project for FY 85. Total LOP funding increased by this amount to $8,230,000. [Note: Project Implementation Report of 6/5/86, PDCAR073, does not reflect this obligation]

(Source: Action Memorandum, 6/26/85, PDCAL980)

21. Follow-On Activities: Second stage contemplated.

22. Comments on R.E. Components: Not specified

23. Date/Data Preparer: July 1986 (mgz)
Revised February 1987 (jrl)

1. Project Number: 4970266.03 2. Geo: INDONESIA

3. Title: SCIENCE AND TECHNOLOGY/PRACTICAL APPLICATIONS FOR DEVELOPMENT

4. Project Life/PACD: 1978-83(extended to 84)/April 12, 1984

5. Status: Terminated

6. LOP Funding (US$000):

   A. Entire Project: 8,000*
   6,500**

   B. R.E. Components: 707.6***

   (Sources: *DIS; **Project Authorization, 9/21/77, PDCAB345; ***Project Implementation Letters No. 11, 10/14/82, and 13, 1/19/83, PDCAB353)

7. Loan or Grant/Appropriation Category (US$000):

   G / SD / 3,000*
   1,500**

   L / SD / 5,000*

   (Source: *DIS; **Amendment No. 2 to Grant Agreement, 6/30/80, PDCAB347)

8. Project Purpose:

   To provide a strong indigenous capacity in selected Government of Indonesia (GOI) scientific and technological institutions to plan and conduct research and development activities in ways that will benefit Indonesia's majority, and offer opportunities for increased productivity, employment, income, and improvements in quality of life.

   (Source: Project Evaluation Summary, 7/24/79, PDAAD912)

9. Renewable Energy (R.E.) Outputs:

   R.E. units tested and demonstrated; Future PUSPIPTEK Energy Research Laboratory employees trained.

10. R.E. Inputs:

   Technical assistance; Training; Commodities.

11. Summary of R.E. Components:

This subproject, Alternative Energy Sources for Rural Development, is one of five subprojects. The Ministry of State for Research and Technology has overall project coordination, whereas specific subproject coordination and administration lies with the Agency for Development and Application of Technology (BPPT). The subproject consists of five subactivities:

- o Biogas from water hyacinths and other aquatic weeds;
- o Ethanol from sago palm (or other carbohydrates);
- o Methanol from agricultural waste (biomass);
- o Wind and small hydropower sources for DC electricity (battery chargers) for small users in remote areas; and
- o Utilization of waste rice straw for village energy.

In addition, the project will provide practical training in connection with the to-be-designed PUSPIPTEK (national research center at Serpong) research laboratory for energy and energy resources, and training inherent in each subactivity.

12. R.E. Project Descriptors:

Biogas; Methanol; Biomass; Agricultural wastes; Wind energy; Ethanol; Hydroelectric power; Water hyacinths; Aquatic weeds; Palm trees; Rice straw.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings:

None of the project evaluations (PDAAD912A1, PDAAG576A1) provide technical details on the R.E. subproject.

16. Key Persons:

A. AID/Washington: Not specified

B. AID/Mission:

William P. Fuller, Director
Desmond O'Riordan, Chief, Engineering and Science Division
William H. Littlewood, Science and Technology Advisor
USAID/Jakarta

C. Contractors:

Olympic Associates Co.
701 Dexter Avenue North, Seattle, WA 98109
(206) 285-4300

D. Host Country:

Dr. Lolo M. Panggabean, Project Director (for Subproject 2)
Agency for Development and Application of Technology (BPPT), Jl. M.H. Thamrin 8, Jakarta

Prof. Dr. Sukadji Ranuwihardjo, Project Coordinator and Assistant Minister of State for Research and Technology, Menara Patra Building, 2nd floor, Jl. M.H. Thamrin 8, Jakarta Pusat

17. Obligations by Fiscal Year (US$000): Not specified

18. Host Country Funding of R.E. Components (US$000): 2,200*

*For entire project; R.E. costs not specified separately.

(Source: Project Implementation Report, 3/31/84, PDCAH400)

19. Summary of R.E. Costs (US$000):

AID LOAN FUNDS:

Water Hyacinth Subactivity	46.00
Ethanol from Sago Subactivity	152.843
Wood Gasification - Methanol Subactivity	0.0
DC Electricity Subactivity	88.616
Contingencies	14.541
TOTAL LOAN FUNDS	302.00

AID GRANT FUNDS:

Water Hyacinth Subactivity	25.653
Ethanol from Sago Subactivity	162.857
Wood Gasification - Methanol Subactivity	11.0
DC Electricity Subactivity	0.0
Contingencies & Future Programming	206.09
TOTAL GRANT FUNDS	405.6

(Sources: Project Implementation Letters No. 11, 10/14/82, and 13, 1/19/83, PDCAB353)

20. R.E. Component Revisions:

A. Subproject was delayed for 16 months until the GOI decided which institutions and topics the subproject should address.

(Source: Project Evaluation Summary, 7/17/80, PDAAG576)

B. PACD extended one year until April 12, 1984.

(Source: Project Implementation Letter No. 11, 10/14/82, PDCAB353)

C. PIL No. 13 reduced the funding earmarked to the subproject in PIL No. 11 by $215,000 in loan funds and $55,000 in grant funds. Remaining amounts earmarked for renewable energy technologies total $302,000 in loan and $405,600 in grant. The $215,000 in loan funds were targeted to be transferred to marine resource development use within the project.

Within subactivity categories, specific reductions were as followed:

LOAN:	
Water Hyacinth Construction	$64,347
Wood Gasification Methanol	113,400
Contingencies	37,253
Subtotal, Loan Reductions	$215,000
GRANT:	
DC Electricity	$15,284
Contingencies	39,716
Subtotal, Grant Reductions	$55,000
TOTAL REDUCTIONS	$270,000

The $113,400 reduction in loan funds for wood gasification and methanol completely eliminated loan funds for this subactivity, and left only $11,000 in grant funds for U.S. non-academic training in this technology.

(Source: Project Implementation Letter No. 13, 1/19/83, PDCAB353)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: July 1986 (jrl)

1. Project Number: 4970268 2. Geo: INDONESIA

3. Title: APPROPRIATE AND LOW-COST TECHNOLOGY

4. Project Life/PACD: 1978-80(extended to 1982)/January 31, 1982

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 500

   B. R.E. Components: 250

   (Source: Grant Agreement, 3/31/78, PDCAB428)

7. Loan or Grant/Appropriation Category (US$000):

   G / SD / 500

   (Source: DIS)

8. Project Purpose:

   To promote rural development and employment generation through low-cost, labor-intensive technology.

9. Renewable Energy (R.E.) Outputs:

   Pyrolytic converter of rice hulls designed and field tested; Market analyses conducted on pyrolytic products (char, fuel oil, gas); Program formulated for development of small industries centered around pyrolytic products; Converters based on other agricultural waste products designed and field tested.

10. R.E. Inputs:

    Technical assistance; Training; Commodities.

11. Summary of R.E. Components:

    Pyrolysis is one of two technologies chosen for development to promote the concept of appropriate technology in Indonesia. A preliminary technical and economic feasibility study in November 1976 by Georgia Tech and the Development Technology Center of the Institute of Technology at Bandung (DTC/ITB) ensured that an adequate supply of wastes was available, that a market existed for the products of

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pyrolytic conversion, and that the means for producing the necessary equipment were at hand, using locally available materials and labor. The project was designed as an applied R&D phase, with dissemination through a separate project to follow it immediately.

Through an evolutionary process, the project designed a low-cost pyrolytic converter, called the Technology Development Unit (TDU), to produce gas, oil, and char from rice husks. Located at the Lembang facility of the Development Technology Center, it was designed primarily for research and development and for crew training. A second reactor, utilizing the best available technology (including lessons learned in the TDU design process), was built at the Sukasari rice mill in Ciranjang in order to determine field operating performance. Two rotary 55-gallon drum charcoal briquetters, one manual and one electric, to briquet the char, and an off-gas burner to burn the gas for the drying of paddy were also developed. Georgia Tech provided technical assistance and training.

12. R.E. Project Descriptors:

Rice husks; Pyrolysis; Agricultural wastes; Biomass.

13. R.E. Technology Applications:

A. Designed, built, and tested the TDU--a nominal one ton/day "batch continuous," vertical, packed-bed, partial oxidation pyrolytic converter using rice husks as fuel. Unit is made from 2-3 mm thick mild steel, and is 2.35 m. tall, with base diameter of 0.84 m. and top diameter of 0.70 m. Initial cost of the reactor in 1979 was $776; associated equipment such as access platform, storage shed, diesel engine, blowers, etc., added an additional $2,054. A state-of-the-art second converter was installed in October 1979 at an operating rice mill at a cost of $4,084, including accessories.

(Source: Pyrolysis of Rice Husks in Indonesia - Interim Report, November 1980, PDAAH714Q, PDAAG860, or PNAAJ566)

B. Redesigned initial unit due to poor performance, making a number of changes: addition of a centrally mounted, water-cooled, process air port; introduction of a rotary "star" grate with a movable top surface; and shortening of the agitator. In preliminary tests with these modifications:

- Raised rice husks throughput up to 112 kg/hr, exceeding the design rate of 100 kg/hr.

- Achieved oil yields of nearly 10%, almost triple previous results, though still 35% below hoped for values.

- Reduced operational and maintenance problems.

- Calculated heating value of the dry gas to be in the range of 170 to 180 Btu/cu. ft., based on composition analysis.

- Tested use of the off-gas to operate a 6 hp Yanmar diesel engine, driving a 3 kw generator. Preliminary results indicated that the engine operates smoothly on the off-gas, with a reduction in more than 60% of diesel fuel consumption (an improvement from a 30% reduction on a simpler system). Ongoing refinements should displace 80%-90% of the diesel fuel.

- Developed two rotary 55-gallon oil drum ("ball mill") briquetters, one electric and one manual, to briquet char from pyrolytic converter. The laboratory electric prototype achieved production rates of 21 kg/hr of briquettes, which is less than half that required to match charcoal production from a pyrolytic converter operating at its design capacity. Slight refinements would allow two such mills to operate per converter.

- Produced satisfactory briquettes:

  -- Using waste cassava pulp in a ratio of 2.5 parts char, one part cooked waste cassava pulp, and 3.5 parts water;

  -- Using pure starch mixed in the ratio of 20 parts char, one part starch, and 20 parts water.

- Measured average energy content for briquettes at 6770 Btu/lb (3762 cal/gm), compared to 5697 Btu/lb (3165 cal/gm) for rice husks with 14% moisture content. Measured specific gravity of 0.32 for briquettes or a density of about 20 lb/cu ft, compared to a density of only about 8 lb/cu ft for rice husks. On a volume basis, briquettes have an "energy density" of about 135,000 Btu/cu ft (1204 cal/cu cm) compared with rice husks with an energy density of only 46,000 Btu/cu ft (411 cal/cu cm).

- Experimented with use of pyrolytic oil as lamp fuel, and found that poor wicking action precluded such use.

- Performed laboratory analysis of the pyrolytic oil, and compared it with kerosene and diesel oil:

PROPERTIES OF VARIOUS LIQUIDS
COMPARED WITH PYROLYTIC OIL

	Kerosene	Diesel Oil	Pyrolysis Oil
Surface tension (dyne/cm)	37.60	42.04	38.55
Dynamic viscosity (centistoke)	3.3 (approx)	4 (approx)	15.3
Kinematic viscosity (centistoke)	2.52	2.96	13.73
Flash point (degrees C)	46.3	64.5	56.5
Pour point (degrees C)	less than 4	less than 4	5.3
Water content (%)	---	---	10-20
Density (26.6 degrees C) (gm/cc)	0.75 (approx)	0.75 (approx)	1.11
pH	7	7	5 (approx)
Distillation Properties (degrees C)			
Initial boiling pt	108	140	98
10% distilled	160	230	98
50% distilled	220	294	236
End point	278	358	252
Heating value(Kcal/gm)	10 (approx)	10 (approx)	6 (approx)

(Source: Pyrolysis of Rice Husks in Indonesia - Interim Report, November 1980, PDAAH714Q, PDAAG860, or PNAAJ566)

14. R.E. Technical Reports and Publications:

A. Pyrolysis Of Rice Husks In Indonesia--Interim Report for the Period Jan. 1, 1978 - Nov. 30, 1980. John W. Tatom, Hadley W. Wellborn, Saswinadi Sasmojo, and Filino Harahap, Institute of Technology, Development Technology Center, Bandung, Indonesia, November 30, 1980, 55 pp., PDAAH714Q, PDAAG860, or PNAAJ566.

Design of the pyrolytic converter has steadily evolved into a truly Indonesian design applicable for rice husks. Two reactors have been constructed and have performed well (see Technology Applications, above). Vigorous efforts have also been made to devise the means and equipment to utilize the products of pyrolysis. These include development of a charcoal briquetting system, an off-gas burner for crop drying, and oil utilization equipment.

Recommendations include: (1) Emphasize char and gas utilization rather than attempting to further upgrade oil production; (2) Explore greater converter mechanization; (3) Continue to upgrade converter throughput; (4) Improve briquette production techniques; (5) Perfect diesel and spark ignition engine operation; and (6) Investigate alternative use for oils.

B. Pyrolytic Conversion of Agricultural and Forestry Wastes to Alternate Energy Sources in Indonesia: A Feasibility Study. Drs. John W. Tatom, Filino Harahap, Tze I. Chiang, and R. Muchidin Apandi, Georgia Institute of Technology, Atlanta, February 1977, 51 pp., PNAAF654.

This feasibility study set the foundation for the project's pyrolysis component. The study presents the findings of an investigation of the availability in Indonesia of the raw materials (feedstock) required for pyrolysis; evaluates the market for pyrolysis-produced products; and includes a preliminary pyrolytic conversion system design complete with approximate economic evaluation of the system.

15. Evaluations/Major Findings:

A. Evaluation Summary--Appropriate and Low-Cost Technology. William H. Littlewood, USAID/Indonesia, 6 pp. June 21, 1979, PDAAD917.

This report is based on a small field evaluation at the ITB/DTC May 29-30, 1979, and the formal mission evaluation. Due to administrative and procedural matters, the project got off to a slow start. However, the Government of Indonesia's focus on basic needs and employment of the poor, as evidenced by the Third Five-Year Development Plan, 1979-1984, gave the project high priority. The team recommended that the 24-month project be extended without further cost to 32-34 months to allow a smooth transition from the applied research phase to the follow-on dissemination project.

16. Key Persons:

A. AID/Washington: Not specified

B. AID/Mission:

Robert C. Simpson, Acting Director
William Litlewood, Science and Technology Advisor
USAID/Jakarta

C. Contractors:

John Tatom
Georgia Institute of Technology, Economic Development Laboratory, Atlanta, GA 30332
(404) 894-3400

D. Host Country:

Dr. Ir. Filino Harahap, Director
Development Technology Center, Institute of Technology Bandung, P.O. Box 276, Bandung, Indonesia

17. Obligations by Fiscal Year (US$000):

FY78	500

(Source: Grant Agreement, 3/31/78, PDCAB428)

18. Host Country Funding of R.E. Components (US$000):

87.5 (175.0 total project contribution by GOI, with R.E. component roughly 50%).

(Source: Grant Agreement, 3/31/78, PDCAB428)

19. Summary of R.E. Costs (US$000):

PROJECTED SUMMARY COSTS
FOR PYROLYTIC CONVERSION COMPONENT

Technical assistance	100
Commodities	50
Local labor for prototypes	45
Travel	45
Report and evaluation costs; contingency	10
TOTAL	250

(Source: Project Paper, 3/78, PDAAD916 or PDCAB426)

20. R.E. Component Revisions:

A. The PACD was extended several times. Implementation Letter (IL) No. 6 extended it from 4/1/80 to 2/1/81; IL No. 8 extended it to 4/1/81; IL No. 10 extended it to 7/1/81; it was finally extended to 1/31/82 by IL No. 12 to provide a smooth transition between this research project and the planned follow-on project.

(Source: Implementation Letter No. 12, 8/18/81, PDCAB434)

21. Follow-On Activities:

A. A follow-on grant project, 4970307, a two-year, $1 million level (approx. $500,000 R.E. component), is planned for dissemination of the "optimized" converter designs, including associated hardware such as redesigned stoves, lamps, charcoal briquette devices, pyrolytic gas engines, etc., which can utilize the pyrolytic gas, oil, and char products of the converters.

(Sources: Incoming telegram, 6/81, PDCAB431; Project Evaluation Summary, p. 2, 6/21/79, PDAAD917)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: July 1986 (jrl)
Revised February 1987 (jrl)

1. Project Number: 4970300 2. Geo: INDONESIA

3. Title: ENERGY MANPOWER AND TRAINING

4. Project Life/PACD: 1981-84/September 30, 1984

5. Status: Terminated

6. LOP Funding (US$000):

   A. Entire Project: 1,000

   B. R.E. Components: Not specified

   (Source: DIS)

7. Loan or Grant/Appropriation Category (US$000):

   G / EH / 1,000

   (Source: DIS)

8. Project Purpose:

   To develop personnel with the necessary level of expertise in the energy field to staff effectively the institutions required for energy research, planning, policy making, and program implementation and to develop a program responsible for continuing professional training.

9. Renewable Energy (R.E.) Outputs:

   Qualified staff for energy center(s); A graduate-level interdisciplinary program with energy specializations at the Technical University of Bandung (trained staff, curriculum, course syllabi, instructional and laboratory equipment in place, and reference material).

10. R.E. Inputs:

    Technical assistance; Training; Travel; Commodities and services.

11. Summary of R.E. Components:

    This Project is designed to develop a graduate program in the field of energy technology at the Technical University of Bandung (ITB). The study programs are interdisciplinary, and will include specializations in solar and geothermal energy.

ITB staff attended workshops abroad and received training at a U.S. institution.

12. R.E. Project Descriptors:

Solar energy; Geothermal energy.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

Mr. Robert Ichord, Jr.
AID Bureau for Asia, Room 702, SA-18 Washington, D.C. 20523

B. AID/Mission:

Desmond O'Riordan, Project Officer and Chief, Division of Engineering and Science
USAID Mission, American Embassy, Jl. Medan Merdeka Selatan 5, Jakarta.

C. Contractors:

Merton R. Barry, Director
International Engineering Programs, University of Wisconsin at Madison, 1402 University Avenue, Madison, Wisconsin 53706
(608) 263-2191

D. Host Country:

S. Pramoetadi, Director of Academic Affairs
Prof. Dr. Dody Tisnaamidjaja, Directorate General of Higher Education
Ministry of Education and Culture, Jalan Pintu I, Senayan, Jakarta

17. Obligations by Fiscal Year (US$000):

Projected Disbursements for Entire Project
(Fiscal year not stated)

	AID	GOI
YR 1	330	133
YR 2	503	181
YR 3	167	96
TOTAL	1,000	410

(Source: Project Paper, 8/80, PDCAB762)

18. Host Country Funding of R.E. Components (US$000): 410*

*For entire project; R.E. costs not specified separately.

(Source: Project Implementation Report, 9/30/86, PDCAJ675)

19. Summary of R.E. Costs (US$000):

Projected Cost Summary for Entire Project

Technical assistance	298
Training	513
Commodities and services	100
Other direct costs	33
Contingencies	56
TOTAL	1,000

(Source: Project Paper, 8/80, PDCAB762)

20. R.E. Component Revisions:

A. PACD extended by six months until September 30, 1984, to allow long-term training candidates the benefit of an extra semester and summer session. Lengthy delays in the first phase of project implementation postponed participant selection and departure for this training.

(Source: Implementation Letter No. 3, 1/12/83, PDCAB768, and Project Implementation Report, 3/31/83, PDCAE987)

21. Follow-On Activities: Not specified

22. Comments on R.E. Components: Not specified

23. Date/Data Preparer: July 1986 (jrl)

1. Project Number: 4970318 2. Geo: INDONESIA

3. Title: ENERGY PLANNING FOR DEVELOPMENT II

4. Project Life/PACD: 1982-85/September 30, 1985

5. Status: Terminated

6. LOP Funding (US$000):

   A. Entire Project: 650

   B. R.E. Components: Not specified

   (Source: State Department telegram, 4/86, PDCAQ023)

7. Loan or Grant/Appropriation Category (US$000):

   L / SD / 650

   (Sources: DIS; State Department telegram, 4/86, PDCAQ023)

8. Project Purpose

   To increase the information base and capability of the Directorate General of Electric Power and New Energy in national energy planning so that it can serve as an effective secretariat to the Interministerial Technical Committee on Energy and the Coordinating Body on Energy at the ministerial level.

9. Renewable Energy (R.E.) Outputs:

   DJL officials trained in energy modeling and analytical techniques; Macro energy/economic model capable of assisting in regional energy analysis of usage of firewood and other alternative energy sources; Urban household energy use survey; National survey on the production, demand, and uses of rural electrification.

10. R.E. Inputs:

    Technical assistance; Computer hardware and software; Training.

11. Summary of R.E. Components:

    This project, a follow-on to project 4980249, aimed to upgrade the capability of the Indonesian Ministry of Mines

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and Energy's Directorate General of Electric Power and New Energy (DJL) to serve as an effective, ministry-level secretariat to the Interministerial Technical Committee on Energy (PTE) and the Coordinating Body on Energy (BAKOREN). The project had four major components:

- Design, development, and installation of a microcomputer-based Energy Information and Analysis System (EIASI) at DJL which provides a state-of-the-art capability in energy information storage and retrieval and in energy systems analysis; this included development of an energy balance model using RESGEN software, adapted to Indonesian conditions. Moreover, a Regional Demand Model for eight regions and a country-wide Energy Demand Projection Model were designed.

- A pilot survey of energy consumption patterns (including wood and charcoal consumption) of 1,636 households in eight urban regions: Jakarta, Bogor, Ujung Pandang, Bandung, Medan, Jogjakarta, Surabaya, and Semarang. The study found that wood use accounted for 4.2% of total energy consumption, and charcoal use, 3.1%.

- A study on the productive use of rural electricity, including an analytic selection of areas to be electrified. This follows the general trend of substituting commercial energy for non-commercial energy, and the Government of Indonesia's plan to stimulate rural social and economic development while reducing petroleum consumption through increased electricity usage, which will in turn be produced more and more by coal, hydro, and geothermal.

- Technology and knowledge transfer, accomplished not only through the development and installation of the analytic tools and data described in component 1, but also through formal and non-formal training.

12. R.E. Project Descriptors:

Wood; Charcoal; Biomass; Firewood.

13. R.E. Technology Applications:

Little reliable data is available on growth and yield figures for tree species growing in Indonesia, whether in natural forests or in plantations. The figures below represent the best performers among many species tested from the point of view of both growth and energy content.

GROWTH & ENERGY CONTENT OF
SELECTED FAST-GROWING SPECIES IN INDONESIA

Species	STOCKING DENSITY (m)	ROTATION (Yrs)	MAI* (cu m/Ha/Yr)	WOOD DENSITY (W/V)**	ENERGY PROD. (GJ/Ha/Yr)
Causuarina junghuhniana	2x3	10	25.0	1.04	452.5
Eucalyptus justigata	2x2	8	24.5	.76	325.8
Calliandra calothyrsus	1x1	5	32.0	.70	384.0
Eucalyptus maculata	2x2	8	28.0	1.05	512.0
Eucalyptus maedenii	2x2	8	27.5	.70	388.3
Leucaena leucocephala	1x2	5	21.0	.82	309.0

* Mean annual increment
** Wood density (specific gravity) = weight/volume. It is an indicator of heating value at constant moisture content:

Over .90, superior
.75 - .90, very good
.60 - .75, good
Below .60, moderate to poor

(Source: Energy Planning For Development (Phase II) - Appendix 7: Energy From Biomass in Indonesia. Directorate General of Electric Power and New Energy, Ministry of Mines and Energy, Republic of Indonesia and Energy/Development International, Setauket, NY, USA, September 1985, p. 9, PNAAU423)

14. R.E. Technical Reports and Publications:

A. Energy Planning For Development (Phase II). Directorate General of Electric Power and New Energy/Ministry of Mines and Energy/Republic of Indonesia, and Energy/Development International, Setauket, NY, USA, September 1985, 973 pp., PNAAU423.

This report describes the project briefly, then gives details on the EIASI computer system, the urban household

energy survey, and the study on productive uses of rural electricity. Recommendations are made for follow-on activities to maintain and use the EIASI system, and to further strengthen DJL's capability for effective energy policy analysis. Appendix 5 - "Survey of Energy Use in Urban Households" and, especially, Appendix 7, "Energy from Biomass in Indonesia" are most relevant to R.E. The latter is a preliminary analysis of the technical and economic feasibility of increasing the consumption of biomass energy in Indonesia to substitute for petroleum. It is based on the goal of substituting 10% of the kerosene used for cooking in the household sector and 10% of the diesel consumed by the State Electricity Company (PLN) for electricity production with biomass energy. Reliable data on growth and yield of different species under varying site productivity conditions and management alternatives are not readily available for Indonesia; therefore, the authors assessed the annual production of wood per hectare needed for such an investment to break even.

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

Mr. G. Imhoff
Office of Technical Resources, Bureau for Asia, USAID,
Washington, DC 20523

B. AID/Mission:

Desmond O'Riordan, Project Officer and Chief
Gary R. Redman
Division of Engineering and Science, USAID Mission,
American Embassy, Jl. Medan Merdeka Selatan 5, Jakarta

C. Contractors:

Dr. Philip Palmedo, Project Manager
Energy/Development International (E/DI)
100 North Country Road, Setauket, NY
(516) 751-5400

D. Host Country:

Prof. Dr. Arismunandar, Director General
Luluk Sumiarso, Head of System and Policy Analysis
Mr. Charis Chusno, BS.Min.E., Secretary
Directorate General of Electric Power & New Energy (DJL),
Jl. Rasuna Said Block X-2, Kav. 7-8, Kuningan, Jakarta

17. Obligations by Fiscal Year (US$000):

Projected Disbursement Schedule for Entire Project
(By Calendar Year)

	AID	GOI
1983	215	95
1984	380	86
1985	75	54
Subtotal	670	235
Contingencies and inflation	80	15
TOTAL	750	250

(Source: Project Paper, 9/82, PDCAB907)

18. Host Country Funding of R.E. Components (US$000): 250*

*For entire project; R.E. costs not specified separately.

(Source: Project Implementation Report, 9/30/85, PDCAN010)

19. Summary of R.E. Costs:

A. Projected Cost Summary for Entire Project

	AID	GOI
1. Modeling and analysis		
Technical assistance	200	0
Computer hardware	120	0
Office support	0	35
Service contract	0	35
Staff	0	60
Evaluation	15	0
2. Energy policy studies		
Urban household energy use study:		
Technical assistance	85	0
Survey supervisors and interviewers	0	35
Office support	0	5

National survey: productive demand and uses of electricity:		
Technical assistance	250	0
Survey supervisors and interviewers	0	60
Office support	0	5
	---	---
Subtotal	670	235
Inflation and contingencies	80	15
	___	___
TOTAL	750	250

(Source: Project Paper, 9/82, PDCAB907)

B. The costs of the household survey, which encompassed the major renewable activities of the project, amounted to approximately $140,000.

(Source: Phone conversation of 10/29/86 with Dr. Philip Palmedo, E/DI)

20. R.E. Component Revisions:

A. Loan funding was reduced from $750,000 to $650,000.

(Source: State Department telegram, 4/86, PDCAQ023)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: July 1986 (jrl)
Revised February 1987 (jrl)

1. Project Number: 4970333 2. Geo: INDONESIA

3. Title: PUSPIPTEK ENERGY LABORATORY

4. Project Life/PACD: 1982-89/September 30, 1989

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 12,250

   B. R.E. Components: Not specified

   (Source: Project Implementation Report, 9/30/85, PDCAN043)

7. Loan or Grant/Appropriation Category (US$000):

   L / SD / 11,750
   G / SD / 500

   (Source: DIS)

8. Project Purpose:

   To assist the Government of Indonesia (GOI) in (1) establishing a viable, professional energy research and development center, the PUSPIPTEK Energy Research Laboratory (PERL), which will have three objectives: to conduct applied research and technology development in the field of energy; to provide support to Indonesian energy-related industries; and to undertake technical and economic feasibility analyses on potential energy programs, projects, and products; and (2) establishing a cooperative program with an appropriate U.S. institution for conducting applicable research and technology adaptation in the following activities: biotechnology; renewable marine resources; science and technology management and policy; and other areas that might be identified and mutually agreed in writing.

   (Source: Amendment No. 4 to Loan Agreement, 5/8/85, p. 3, PDCAK556)

9. Renewable Energy (R.E.) Outputs:

   Trained staff; Management structure; R.E. product development; Information and reference center; Field tests; Studies and technology assessments; Cooperative research with Indonesian universities.

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10. R.E. Inputs:

Technical assistance; Training; Commodities; Management and evaluation.

11. Summary of R.E. Components:

Project aims to establish the Energy Research Laboratory (PERL) at the GOI National Center for Research, Science, and Technology (PUSPIPTEK) as a national energy research and development laboratory. The GOI Agency for Development and Application of Technology (BPPT), under the supervision of the State Minister for Research and Technology, will implement the project with the help of a general contractor and a long-term advisor.

Extensive technical assistance will be provided during early project years. In addition, long-term training of PERL employees at the PhD and MS levels in the U.S. or third country will be provided, as will non-academic on-the-job training, seminars, and exchange visits.

PERL will undertake research projects through cooperative grants to Indonesian universities. Its primary activity, however, will be to develop new energy technologies needed for Indonesian industrial development. Emphasis will be on biomass and solar energy systems (photovoltaics and solar thermal); limited investigations will be made in other areas, especially corrosion of materials and heat transfer. Joint ventures between U.S. manufacturers and the Indonesian private sector for ultimate Indonesian production of energy systems will be encouraged. New systems will be field tested. PERL is currently installing equipment for small-scale fabrication of solar cells. PERL will contain a Photovoltaic Test Facility and a Solar Thermal Testing Laboratory.

PERL will also conduct social, economic, and technical analyses to determine national energy technology strategies and programs and to assess the effectiveness of specific projects and programs. To this end, the project will fund short-term consultancies, provide PERL with a small computer, and establish and equip a technical library.

As of March 31, 1986, the contractor, Battelle Memorial Institute (BMI), had completed the Master Plan and was preparing the engineering design for equipment for the Solar Energy Laboratory. Four BPPT staff had attended

workshops in the U.S. and training at the BMI facilities on Gasifier and Solar Energy. The project, however, was experiencing major implementation problems, to which the mission staff were attending.

(Source for latest data: Project Implementation Report, 3/31/86, PDCAQ153)

12. R. E. Project Descriptors:

Biomass; Solar energy; Photovoltaic energy.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

Mr. Alan Jacobs, Director ST/ET, 508 SA-18,
(202) 235-8902

B. AID/Mission:

Desmond O'Riordan, Project Officer and Chief
Gary R. Redman, USAID Representative
Division of Engineering and Science, USAID Mission,
American Embassy, Jl. Medan Merdeka Selatan 5, Jakarta

C. Contractors:

Battelle Memorial Institute
505 King Ave., Columbus, Ohio 43201
(614) 424-6424

D. Host Country:

Ir. Wardiman Djojonegoro, Deputy Director
Dr. L. Panggabean, Senior Scientist
Prof. Dr. Ir. Harsono Wiryosumarto
Prof. Dr. Sediono
M.P. Tjondronegoro
BPP Teknologi (BPPT), BPPT Bldg. 14 Floor, Jl. M.H. Thamrin No. 8, Jakarta

Ir. H.D. Pusponegoro, Director
PUSPIPTEK Energy Research Laboratory.

17. Obligations by Fiscal Year (US$000):

Projected Financial Plan for Entire Project*

FY	LOAN	GRANT	TOTAL
82	2,700	500	3,200
83	4,000	0	4,000
84	4,550	0	4,550
	---	---	---
TOTAL	11,250	500	11,750

*Does not reflect $500,000.00 loan increase.

(Source: Project Paper, 8/82, PDCAC009)

18. Host Country Funding of R.E. Components (US$000):

4,000*

*For entire project; R.E. costs not specified separately.

(Source: Project Implementation Report, 3/31/85, PDCAK563)

19. Summary of R.E. Costs (US$000):

R.E. components not costed separately; the following costs represent entire project:

	GRANT	LOAN
Technical assistance	500	5,275
Long-term training		1,765
Technology and systems procurement		2,015
Commodities procurement		2,195
U.S. National Academy of Sciences program		500
	---	---
TOTAL	500	11,750

(Source: PIL No. 17, p. 2, PDCAK561, and PIR, 9/30/85, PDCAN043)

20. R.E. Component Revisions:

A. USAID loan increased by $500,000 and project purpose modified, expanding activities into non-energy areas to include a cooperative program with the U.S. National

Academy of Sciences dealing with applied research and technology. This follows the expanded mandate of the Ministry of State for Science and Technology to conduct applied research in all fields of science and technology.

(Sources: Action Memorandum, 2/14/85, PDCAK557, and Amendment No. 4 to Loan Agreement, 5/8/85, PDCAK556)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: July 1986 (jrl)
Revised February 1987 (jrl)

1. Project Number: 4970340 2. Geo: INDONESIA

3. Title: DEVELOPMENT STUDIES

4. Project Life/PACD: 1983-87(extended to 91)/June 30, 1991

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 12,000*

   B. R.E. Components: 200

   *Telegram of 8/86 indicates USAID/Jakarta intends to obligate an additional $103,000 in grant funds.

   (Sources: Action Memorandum for the Assistant Administrator, 5/15/86, PDCAQ166; PIL No. 30, 12/16/85, PDCAN051; and State Department telegram, 8/86, PDCAQ164)

7. Loan or Grant/Appropriation Category (US$000):

   G / SD / 12,000*

   *Telegram of 8/86 indicates USAID/Jakarta intends to obligate an additional $103,000 in grant funds.

   (Source: Action Memorandum for the Assistant Administrator, 5/15/86, PDCAQ166; and State Department telegram, 8/86, PDCAQ164)

8. Project Purpose:

   To strengthen Indonesian policy formulation by improving analysis of development issues and, consequently, decisionmaking and implementation by Indonesian institutions; To enhance the acceptability of analysis as an instrument of policymaking through the involvement of Indonesians in studies; To encourage greater cooperation between private and public research institutions.

9. Renewable Energy (R.E.) Outputs:

   Six working gasifiers; Fuelwood plantations to feed gasifiers.

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10. R.E. Inputs:

Technical assistance; Training; Commodities.

11. Summary of R.E. Components:

Subproject 13, "Studies and Development of Gasification in Rural Development," is designed to investigate uses of gasification in post-harvest processing. It consists of the setting up of six 100 kva gasifiers; technical monitoring of their performance; experimentation, training, and extension to target groups at demonstration centers; and the establishment of fuelwood plantations to feed the gasifiers.

12. R.E. Project Descriptors:

Gasification; Firewood.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings:

A. Development Studies Project (DSP) First Year Evaluation. Manasse Malo, Jakarta, May 1985, 40 pp. plus 5 p. PES, PDCAQ171.

This report reviews the status of the entire project and evaluates it in terms of effectiveness in disseminating information, flexibility in proposal development and selection, speed of conducting research, and quality of research undertaken. Little specifics are provided on renewables.

16. Key Persons:

A. AID/Washington:

Steve Singer
Asia/ISPA

B. AID/Mission:

William P. Fuller, Director
Michael Morfit, Project Coordinator
USAID, American Embassy, Jakarta.

C. Contractors: Not specified

D. Host Country:

Directorate General of Cooperative Development
Ministry of Cooperatives
National Planning Agency (BAPPENAS)

17. Obligations by Fiscal Year (US$000):

Projection of Cost Commitments for Entire Project*

FY 83	1,760
FY 84 & 85	2,240
TOTAL	4,000

*Does not reflect LOP funding increase to $12 million.

(Source: Project Paper, 6/83, PDCAF082)

18. Host Country Funding of R.E. Components (US$000): 265

(Source: PIL No. 30, 12/16/85, PDCAN051)

19. Summary of R.E. Costs (US$000):

CATEGORY	USAID	GOI	TOTAL
1. Site Study	10	-	10
2. Diesel engines & gensets, six 100 kva units	-	180	180
3. Civil works	-	30	30
4. Transportation cost of diesel engine/gasification to 6 sites	-	30	30
5. Equipment & supplies (wires, etc.)	-	20	20
6. Production of gasification equipment for demonstration centers, six 100 kva units	130	-	130
7. Experimentation, training, and extension to target groups at demonstration centers	20	5	25
8. Workshops and seminars	10	-	10
9. Technical monitoring of gasification performance, and local management system	10	-	10
10. Firewood plantations (lamtoro and other fast growing trees)	10	-	10
11. Contingency	10	-	10
TOTAL	200	265	465

(Source: Project Implementation Letter, No. 30, 12/16/85, PDCAN051)

20. R.E. Component Revisions:

A. Subproject No. 13, "Studies and Development of Gasification in Rural Development," originally funded at $165,000, received an additional $35,000.

(Source: Project Implementation Letter, No. 30, 12/16/85, PDCAN051)

B. Total project LOP grant funding was increased by $1 million to $4 million.

(Source: Action Memorandum for the Assistant Administrator, 1/24/85, PDCAK569)

C. PACD extended one year to June 30, 1988.

(Source: Project Implementation Report, 9/30/85, PDCAN054)

D. LOP grant funds were increased by $8 million to $12 million, and the PACD was extended to June 30, 1991.

(Source: Action Memorandum for the Assistant Administrator, 5/15/86, PDCAQ166)

E. USAID/Jakarta stated that an implementation letter had been finalized to reobligate to the project $103,000 in grant funds that were being deobligated from project 4970314.

(Source for UPDATE: State Department telegram, 8/86, PDCAQ164):

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: July 1986 (jrl)
Revised February 1987 (jrl)

1. Project Number: 4980265 2. Geo: ASIA REGIONAL

3. Title: EXTENSION OF SMALL SCALE AGRICULTURAL EQUIPMENT (IRRI)

4. Project Life/PACD: 1980-85 (extended to 86)/September 30, 1986

   (Source: Evaluation Report, 6/82, p.1, PDCAF858; and Annual Progress Report: 1985, 9/1/85, PDAAT181)

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 4,350

   B. R.E. Components: Not specified

   (Source: Evaluation of BPI (MAF-IRRI) Small Farm Machinery Industrial Extension Program, 10/84, PNAAR343)

7. Loan or Grant/Appropriation Category (US$000):

   G / FN / 4,350

   (Source: DIS)

8. Project Purpose:

   To increase the number of fabricators, level of production, number of local designs or adaptations, and value added per machine.

9. Renewable Energy (R.E.) Outputs:

   Design, testing, demonstration, and local manufacture (through training and technical assistance to local manufacturers) of a variety of small-scale agricultural equipment, including improved buffalo plow, rice husk-fueled food dryers, and pedal threshers and winnowers.

10. R.E. Inputs:

    Prototypes; Technical assistance; Training; Commodities.

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11. Summary of R.E. Components:

This project continues support to the International Rice Research Institute (IRRI) extension efforts begun in 1975 under Technical Assistance Bureau (now S&T) funding. Previous operations in Thailand and Indonesia will be continued, and new outreach programs started in India and the Philippines.

AID funding will enable IRRI to promote local manufacture of small scale IRRI-designed agricultural implements through provision of training, blueprints, and technical assistance to local fabricators. The project will also enable IRRI to develop and test further implements for the above four target countries. Demand for the products will be increased through demonstrations and extension, and institutionalization of the process within the respective countries will be stressed. Although most of the focus is on hand and small conventional-fueled equipment, the project includes design/adaptation, testing, and promotion of buffalo-drawn plows, pedal-powered threshers and winnowers, foot-operated treadle water pumps, food dryers fueled by agricultural wastes and/or solar energy, rice husk carbonizers, simple charcoal briquetters, and charcoal briquette-fueled stoves, and testing of a steam engine utilizing rice straw as fuel.

12. R.E. Project Descriptors:

Animal traction; Plows; Buffaloes; Biomass; Agricultural wastes; Furnaces; Water heaters; Crop driers; Stoves; Charcoal; Water pumps; Chipping machines; Solar collectors; Solar energy; Threshing machines; Rice husks; Rice; Cassava; Sweet potatoes; Steam engines; Carbonizers.

13. R.E. Technology Applications:

A. Redesigned a popular buffalo plow manufactured in Khon Kaen. Initial tests indicated that a moldboard with a larger radius of curvature required less specific draft; later tests revealed that further reduction could be obtained with the plow point and moldboard assembly rotated 20 to 25 degrees clockwise about a horizontal axis; suction angle of plow points were reduced to 18 degrees, from traditional plow's 22 degree angle.

(Source: Buffalo Drawn Implements, 8/81, PNAAR527 or PDAAM275)

B. Two initial improved designs of the buffalo plow had 38 cm radius of curvature of the moldboard and 18 degree suction angle. One had a 20 degree attitude tilt angle and 244 sq cm projected area; the other had a 25 degree attitude tilt angle and 241.9 sq cm projected area. For

the former, total draft in paddy was 146.4 kg and specific draft was 0.60 kg per sq cm; for the latter, total draft was 120.95 kg and specific draft was 0.50 kg per sq cm. Total draft of the Khon Kaen plow (described above) was 129.04-140.33 kg with only 161.3 sq cm projected area; specific draft was 0.80-0.87 kg per sq cm. From these results, it was calculated that an improved plow similar to the ones tested but with projected area identical to that of the Khon Kaen plow

would have a total draft of 80.65-96.78 kg, a reduction in draft of 31-37.5%.

(Source: Conclusion of Buffalo Plow Draft Comparison, 11/24/80, PDAAL944)

C. A larger power tiller moldboard with 45.7 cm radius of curvature was developed to further improve the performance of buffalo plows. Field test comparisons between the Khon Kaen plow (described above) and this plow were conducted using a mechanical power source with uniform velocity, depth controlled at 12.7 cm with gage wheels in upland and with skids in paddy, and ground speed and other parameters controlled. The test plow achieved approximately a 33% reduction in draft for both upland and paddy conditions compared to the manufactured plow.

Two improved designs were developed:

-- A plow with a wider point and moldboard with 50% more projected area and top width than the control plow (with 161.3 sq. cm projected area) at 12.7 cm plow depth. The radius of curvature is 45.7 cm, attitude angle is 20 degrees, and the suction angle is 18 degrees. This plow requires approximately the same total draft (in limited testing) as the control plow, but will reduce the plowing time by about one third.

-- A plow with projected area and top width at 12.7 cm plow depth comparable to the manufacturer's plow. Total draft is reduced to two thirds. It may be used with small animals, for deeper plowing, or for upland conditions.

(Source: Buffalo Drawn Implements, 8/81, PNAAR527)

D. Department of Extension at Pitsanuloke built a production plow frame with two above-mentioned plow bottoms, and tested it in the field for five hours on three successive

days, using the same buffalo. Plow depth was adjustable, measuring 12.0-13.0 cm in each test. Area plowed was measured each day, with the following results:

Local plow	=	1,980 square meters
Recommended narrow	=	2,480 square meters
Recommended wide	=	3,290 square meters

(Source: Buffalo Drawn Implements, 8/81, PNAAR527)

E. Three manufacturers in Thailand have started production of the improved buffalo plows. A Khon Kaen plow firm produced 55 units in 1982. A Nakhon Sawan firm built 15 between 1/1/83 and 2/28/83: 10 narrow upland units and 5 wider paddy plows.

(Source: Thai-IRRI Cooperative Machinery Project, Semi-Annual Report, 2/28/83, PDAAM719)

F. Designed two center-tube furnaces utilizing agricultural wastes as fuel. One furnace is constructed from metal drums, the other from soil bricks. They were tested successfully for water heating and grain drying. Characteristics of the two designs are:

DIMENSIONS	DRUM FURNACE	SOILBRICK FURNACE
Over-all, diameter x length (cm)	58 dia x 122	150 dia x 130
Burning chamber	43 dia x 140	90 dia x 100
Burning surface(sq cm)	660	980
Ash chamber (cm)	58 dia x 46	130 dia x 30
Feeding hopper(cu m)	0.20	-
Chimney (cm)	15 dia x 265	25 dia x 180

FUEL CONSUMPTION (kg/hr)

Rice husk	5 - 60
Coconut husk	10 - 80
Coconut shell	10 - 80
Sawdust	5 - 60
Burning efficiency (%)	95
Water heating capacity (l/hr)	250 (20-30 degrees C.)
Equivalent grain drying capacity (ton/day)	2 - 8

In three actual trials in drying paddy in a warehouse dryer, average heating efficiency was calculated at 79%.

(Source: Design and Development of a Furnace for Efficient Burning of Agricultural Wastes, 5/83, PDAAM719)

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G. Designed, built, and tested an inexpensive 8-ton warehouse-type dryer measuring 10m x 5m x 3m made from walls of soil-rice straw reinfornced with 1.2 cm steel bars. Fish, rice, and other crops may be dried. The dryer includes the following:

-- The above described center-tube soil brick furnace (made from paddy soil and rice husk ash at 4% by weight) capable of generating heat for a 10-ton dryer. Ash recovered is almost negligible for coconut husks and sawdust and about 16% by weight for rice husks. Heating for the dryer is indirect.

-- Passive air movement assisted by 1) two vortex wind machines with innerside vanes curved outward creating a greater low-pressure suction zone, and 2) design of the furnace chimney positioned directly beneath the wind machine.

-- 54 square meter "solar collector" roof made from corrugated G.I. sheets at 14 degree tilt angle with mean daily rate of solar energy absorption of 753.96 W per square meter (8AM-4PM, solar time).

-- Adjustable temperature and airflow by means of chimney dampers, air inlet doors and windows, adjustable airflow guide, and regulation of the fuel feed rate.

Certain design considerations are site specific and may require adaptations to other sites.

Economic analysis revealed that the dryer has a positive Benefit Cost Ratio equal to 1.8; the investment can be recouped in 2.04 years or after drying 2040 tons of paddy.

(Source: Design and Performance of a Multi-Purpose Dryer Using Non-Conventional Energy Sources, 4/83, PDAAM719)

H. Designed and built two prototype "winged" dryers, modified warehouse dryers with extended corner walls (the "wings") which direct the wind into the warehouse and increase the suction of the vortex wind machine. One unit has a direct-fired stove, as well as a heat duct under the floor for indirect pre-drying.

(Source: Dryer Development and Biomass Utilization Research: 1986 Internal Program Review, undated, PDAAT181)

I. Designed and built a prototype tent dryer, a warehouse-type multi-product dryer with a fixed frame covered with removable black canvas. Drying is done by solar energy, with supplemental artificial heating if desired. Drying air is exhausted by a vortex wind machine.

(Source: Dryer Development and Biomass Utilization Research: 1986 Internal Program Review, undated, PDAAT181)

J. Designed and built a prototype one-ton capacity warehouse dryer with 3m x 3m x 2m dimensions designed to dry a variety of crops for an individual farmer. Conducted drying tests with paddy, cassava, and sweet potato chips, as well as peanuts pre-dried on heat exchanger surface. Major modifications to the heating system and the air exhaust stack will be undertaken.

(Source: Dryer Development and Biomass Utilization Research: 1986 Internal Program Review, undated, PDAAT181)

K. Developed a heated floor rice dryer that consists of a drying floor heated by hot water, which is heated by a furnace fueled by rice husks or straw. The dryer was tested at the PPC farms in Mindanao, Philippines. This activity provided much useful data but was terminated because the system proved uneconomical.

(Sources: Annual Progress Report, 9/1/82, PDAAM275; Semi-Annual Progress Report, 3/1/83, PDAAM719; Annual Progress Report, 9/1/83, PDAAN883)

L. Designed two types of small-capacity rotary pre-dryers (for cloudy and rainy periods). One direct-fired dryer is made from oil drums and equipped with a hand-operated fan for faster drying. Possible fuels are agricultural wastes such as coconut husks, rice husks, corn cobs, etc. The second unit, also direct-fired, consists of a perforated cylinder (in which the drying material is placed) heated to 70 degrees centigrade and rotated. The fuel is charcoal, and drying takes place through conduction. Each dryer capacity varies from 10 to 25 kg per batch and reduces the moisture content from 28% to 20% in 10-60 minutes. The loading capacity, heat requirement, and drying rate of paddy, corn, and peanuts were tested in the pre-dryer.

(Source: Dryer Development and Biomass Utilization Research: 1986 Internal Program Review, undated, PDAAT181)

M. Tested a full-size prototype rotary dryer, which utilizes rice husks as fuel, in collaboration with a rice mill in Bicol, Philippines.

(Source: MA-IRRI Industrial Extension Program for Small Farm Equipment, Annual Report for October 1, 1984-September 30, 1985, p. 3, PDAAT181)

N. Started work at Thai-IRRI on a buffalo-powered water pump.

(Source: Thai-IRRI Cooperative Machinery Project, Semi-Annual Report, 2/28/83, PDAAM719)

O. Developed and promoted manufacture of pedal threshers and pedal winnowers, and field tested the threshers.

(Sources: Annual Report of IRRI-Indonesia Industrial Extension Project: September 1982 - August 1983, PDAAN883; Annual Report of IRRI-DITPROD Industrial Extension Project in Indonesia for the Year October 1983 - September 1984, PDAAR177)

P. Designed and tested the MA-IRRI "Tapak-Tapak" ("step-step") pump, a foot-operated "treadle pump" based on a design developed in Bangladesh by the Rangpur Dinajpur Rehabilitation Service. This is a suction pump with two cylinders, each having a foot valve and a plunger rod with round molded rubber cup. The pump costs about $20 for all materials and labor, is suitable for stationary or portable applications for open-pit wells, tube wells, canals, lakes, and rivers, requires no priming for depths as great as 5 meters, and has a maximum lift of 7 meters. (For considerable volumes of water to be pumped, such as for irrigation purposes, 5 meters is about maximum viable lift because of the force required.) Approximate capacities are: 3 liters/second (48 gal/min) for 2-meter lift, and 2 liters/second (32 gal/min) for 4-meter lift. The pump was introduced in late 1983, and manufacturers in the Philippines reported producing 213 pumps in 1984.

(Sources: MA-IRRI Industrial Extension Program for Small Farm Equipment, Annual Report (September 1983 - September 1984), Annex D, PDAAR177 - includes drawing & photo; MAF-IRRI Industrial Extension Program for Small Farm Equipment Annual Report for October 1984-September 1985, Table 1, p. 5, PDAAT181; Human-Powered Pump for Low-Lift Irrigation, 6/85, PDAAT181)

Q. Developed the BPI cassava chipping machine, which can be

pedal-powered or powered by a small engine, designed for cutting cassava tubers or other rootcrops into chips to improve drying and storage. Pedal unit has bicycle chain and sprocket and has a 300 kg/hr capacity. Unit weighs 70 kg, and is 76cm x 76cm x 91cm. Demonstrated to local manufacturers.

(Sources: MA-IRRI Industrial Extension Program for Small Farm Equipment, Semi-Annual Report for the Period 10/1/83 - 2/29/84, pp. 2-3 and Annex A, p. 2, PDAAP456; MA-IRRI Industrial Extension Program for Small Farm Equipment, Annual Report (September 1983-September 1984), Annex D - includes 2 photos, PDAAR177)

R. Made arrangements with two inventors for the testing of a rice straw-fired steam engine as a portable power unit.

(Source: Annual Progress Report: 1984, 9/1/84, p. 9, PDAAR177)

S. Reviewed literature on development of an improved carabao (water buffalo) harness.

(Source: MA-IRRI Industrial Extension Program for Small Farm Equipment, Annual Report-September 1983 to September 1984, PDAAR177)

T. Designed and constructed two rice husk carbonizers. These are cylindrical structures made of soil bricks with a feeding hopper; a husk spreader is suspended from the feed hopper to retard the fall of rice husk allowing it to burn initially during its downward movement. Chars are collected at the bottom and placed immediately in water to stop further combustion; they can be briquetted later. Volatile gases from one carbonizer were directed to a center-tube furnace to produce hot flue gases for food drying.

(Source: Dryer Development and Biomass Utilization Research: 1986 Internal Program Review, undated, PDAAT181)

U. Initiated the following briquette work:

-- Constructed and tested two hand-operated compactor briquetters;

-- Established a charcoal-soil binder ratio for charcoal briquetting (soil is paddy soil of at least 50% clay content);

-- Tested briquette compressive strength and temperature generation efficiency; and

-- Designed and built stoves for charcoal briquettes.

(Source: Dryer Development and Biomass Utilization Research: 1986 Internal Program Review, undated, PDAAT181)

14. R.E. Technical Reports and Publications:

A. Conclusion of Buffalo Plow Draft Comparison. Chanchai Rojanasaroj, Revised November 24, 1980, 5 pp., PDAAL944.

Draft reduction statistics of two early versions of improved plows are compared with a commercial Thai plow. Drawings are included. See 13.B, above, for further details.

B. Buffalo Drawn Implements. Chanchai Rojanasaroj, Raymond C. Fischer, and Chak Chakkaphak, Bangkok, August 1981, 16 pp., PNAAR527 or PDAAM275.

This paper was presented at the FFTC/ASPAC Meeting on Buffalo Production at Kasetsart University in Bangkok during August 11-17, 1981. It reviews the use of buffalo draft animals in Thailand: extent, development of new equipment, manufacture of equipment, and dissemination of improved implements. Details are provided on two improved buffalo plows developed through the Thai-IRRI Cooperative Farm Machinery Project, and results from limited testing are included. See 13.A, 13.B, and 13.D, above, for details.

C. Farm Machinery for Upland Rice. R.C. Fischer, THAI-IRRI, Bangkok, October 1981, 19 pp., PDAAL816.

This report was presented at the FAO Regional Training course "Improved Cultural Practices for Upland Rice" held in Chiong Mai from October 5-21, 1981. It discusses rice-related work done by the THAI-IRRI program, including a review of the progress on developing improved buffalo plows.

D. Design and Development of a Furnace for Efficient Burning of Agricultural Wastes. Dr. Clarence W. Bockhop, Dr. Yong Woon Jeon, and Leonides S. Halos, AED/IRRI, Manila, Philippines, May 1983, 20 pp., PDAAM719.

This paper was presented at the 1983 Grains Post-Harvest Workshop held May 3-6, 1983, in Sindanglaya, West Java, Indonesia. Critical criteria for designing an efficient furnace that burns a number of fuels are described. Drawings, design specifications, and performance data for two efficient, inexpensive, center-tube furnaces, one

made from metal drums, the other from soil bricks, are presented. Rice husks, sawdust, and coconut husks were used as fuel in the investigation. See 13.F, above, for further details.

E. Design and Performance of a Multi-Purpose Dryer Using Non-Conventional Energy Sources. Leonides S. Halos, Yong Woon Jeon, and Clarence W. Bockhop, AED/IRRI, Manila, Philippines, April 1983, 25 pp., PDAAM719 or PDAAN883.

Design of an 8-ton warehouse dryer that uses the above center-tube furnace (see 14.D) is described. The report includes investigations into low-cost materials to build and waterproof the dryer; design of a vertical tray drying system and of a passive vortex wind machine to move air; test results from drying paddy, corn, copra, and fish; and a cost analysis. A drawing and photos of the dryer and components are provided. See 13.G, above, for further details.

F. Preliminary Tests of a Low-Cost Paddy Dryer Utilizing Rice Hull or Straw. B.D. Shukla, I. Manalili, R.E. Stickney, and C.W. Bockhop, 2/12/83, 36 pp., PDAAM719.

The report presents preliminary results of design work on a heated floor dryer incorporating a metal floor heated by circulating hot water, which is heated by a rice straw-fueled or husk-fueled furnace. The dryer is designed to complement traditional sun-drying of paddy when cloudy and rainy weather prevails during harvest by lowering the moisture content to 18%, at which point it can be safely stored for several days if needed and then dried in the traditional manner to a final 14% moisture content. Drawings and photos of an experimental dryer as well as charts dealing with characteristics of the dried paddy are provided.

G. Heated Floor Dryer and Study on Heat Treatment Processes for Reducing Deterioration of Moist Paddy. AED/IRRI, Manila, Philippines, December 1983, 21 pp., PDAAN883.

This report describes a heated floor dryer incorporating a metal floor heated by circulating hot water, which is heated by a rice straw-fueled or husk-fueled furnace. In addition, the report presents results of preliminary tests carried out to explore the feasibility of using a brief heat treatment to reduce fungus and grain activity in paddy.

H. Report on Survey of Farmer's Attitude and Acceptance of Improved Plow (DOA-IRRI) at Wat Sing District, Chai Nat Province. Mr. Kasom Skultab and Mr. Veera Piriyapan, January 4, 1984, 8 pp., PDAAR177.

This report presents the results of a survey undertaken by the Farm Mechanization Promotion Center in Chainat Province in cooperation with the Department of Agricultural Extension in Bangkhen, Bangkok. The objectives were twofold: to determine the feasibility and acceptance of the improved project-designed buffalo (small model) plow, and to devise a strategy for its promotion. As only two improved plows were available, only limited field trials were done, and only eight farmers returned questionnaires.

I. Human-Powered Pump for Low-Lift Irrigation. American Society of Agricultural Engineers, Paper No. 85-5054. R.E. Stickney, V. Piamonte, Q. de Sagun, and I. Ventura, St. Joseph, MI, June 1985, 17 pp., PDAAT181.

This report describes a foot-operated, double-cylinder, suction-type, irrigation "treadle pump" adapted by the MAF-IRRI Philippine team from a design developed in Bangladesh by the Rangpur Dinajpur Rehabilitation Service. Pump characteristics and initial extension efforts are detailed. Drawings and photos are included. See 13.P, above, for further details.

J. A Socio-Economic Mechanization Study in Northeast of Thailand. Chak Chakkaphak, Billy J. Cochran, and Bart Duff, IRRI-THAI Small Farm Mechanization Industrial Extension Project, Bangkok, September 1985, 98 pp., PDAAT181.

This report presents the findings of separate surveys conducted on 331 farm households in the Northeast region of Thailand between September and November 1984. A total of 16 questionnaires were designed and used to measure patterns of production, resource use, labor and machinery use, and inventory change.

K. Dryer Development and Biomass Utilization Research: 1986 Internal Program Review. Dr. C.W. Bockhop et al., Agricultural Engineering Department-IRRI, Los Banos, Laguna, Philippines, undated, 39 pp., PDAAT181. (Also included is a four-page article, undated and with no author specified, entitled "Dryer Development and Biomass

Utilization Research," which provides slightly different details.)

This report describes in general terms the accomplishments and future plans of the research team at AED-IRRI concerning development of food dryers, chipping/slicing devices, a rice husk carbonizer and center-tube furnace, hand-operated briquetters, and

fired-clay and drum stoves that burn briquettes. See 13.H, 13.I, 13.J, 13.L, and 13.T, above, for further details.

L. Numerous progress reports are available from the DIHF Geobureau files.

15. Evaluations/Major Findings:

A. The Impact of Farm Machinery on Thai Agriculture: An Evaluation of the IRRI Industrial Extension Project. Vasantha Narendran, Dow Mongkolsmai, Rapeepun Jaisaard, Bangkok, December 6, 1979, 90 pp., PDCAM687.

This report assesses the consequences of mechanical technology in Thailand and then appraises the IRRI extension program within this context. It reviews results from (1) the AID-IRRI two-week farm level "Consequences of Farm Mechanization" survey, (2) a farm-level survey of mechanization conducted in the central plains and the north, and (3) a survey of farm machinery manufacturers in Thailand. Six case studies of rice farms are also available.

Although it was not possible to find a definite pattern between mechanization and certain key variables, some observations were made, including the following: in many rain-fed areas, farmers indicated the need for a reliable water supply before converting from draft animals to mechanization; in certain rain-fed areas of the central plains the soil type is unsuitable for animal traction, and the farms are completely mechanized; in the north, farm sizes are small, field labor is generally available, and farmers prefer to retain their draft animals rather than hire or own machinery, whereas in the central plains farms are larger, field labor is scarce, and farm mechanization equates with minimal production costs. IRRI designs manufactured in Thailand are all small-scale power equipment; IRRI threshers are popular. The evaluation team observed that employment in the manufacturing enterprises of IRRI designs has declined 13% since the beginning of the year due to the adverse effects of the Thai economy. The team recommended that IRRI introduce machinery that has not yet appeared on the market. It suggested that IRRI might pay more attention to the design of animal traction equipment such as disc harrows, seed drillers, and animal-powered water lifting devices. IRRI should work more closely with the fabricators (in addition to concentrating on product development), work more closely with the Industrial Service Institute of the Ministry of Industry, and get more actively involved with information dissemination to the farmers.

B. Evaluation Report on Project 4980265, Extension of Small Scale Agricultural Equipment (IRRI). Gerrit Argento, USAID Asia Bureau/Technical Resources Office, June 1982, 20 pp., PDCAF858.

The evaluation reported that the project is going well in Indonesia, poorly in Thailand, getting off to a good start in the Philippines, and, after three years of discussion, will soon begin in India.

For the project as a whole, IRRI's management has been weak with respect to strategy, work planning, field staff support, data collection and use, multidisciplinary approach, and integration of research and extension. Consequently, in spite of IRRI's excellent reputation, the desirable project purpose, and practical results-oriented approach of IRRI, many opportunities have been missed.

Regarding Thailand, the evaluator concluded that the project had produced some definite valuable implements, but should be terminated nonetheless if it cannot be improved substantially. The evaluator noted the "non-use" of IRRI expertise in social, agricultural, policy, and institutional analysis, even though such activities were recommended in the 1979 evaluation, the Project Paper, and the agreement and were funded in the project budget. Weaknesses in IRRI's outreach program were not being met by improved managerial performance.

In Indonesia, equipment extension activities and development of small fabricators were making excellent progress. It was recommended that the project concentrate on developing fabricators in West Sumatra and avoid overextension into other areas.

For India, recommendations deal with planning and implementation, and, for the Philippines, with support to the outreach officer and with project reporting.

C. Trip Report: Thailand. C. W. Bockhop, February 1983, 13 pp., PDAAM719.

The purpose of the trip was to evaluate the Industrial Extension program in Thailand. The author visited 19 organizations and 37 individuals. All reported that the project is needed, valuable, and should be continued. Manufacturers cited the IRRI-designs they produce and the usefulness of the Thai-IRRI training they had received; others cited the number of units they had purchased or ordered from local fabricators assisted by Thai-IRRI. The evaluator recommended that (1) the Thai-IRRI project

continue; (2) a replacement for Ray Fischer, the Project Co-Leader who was retiring, be recruited immediately; and (3) a new work plan be developed once the new Co-Leader is in place.

D. Evaluation of IRRI-DITPROD Small Agricultural Equipment Extension Project, Executive Summary. Sam H. Johnson III et al, 1985, 4 pp., PDAAT181.

This report is based on a one-month (January 15 - February 15, 1985) study of the Indonesia project activities. The evaluation team found that the project far exceeded its goals in W. Sumatra but was less successful in S. Sulawesi and S. Kalimantan, although, nonetheless, meeting its goals to work with local manufacturers in those areas. The team noted that the project was left orphan for two years by AID/Washington, and normal activities such as development of work plans, annual evaluations, and project reviews were not carried out. The surprising success of the project in spite of this fact was attributed more to the persistence of Mr. Reddy, the Co-Leader, than to the planning and management or either AID/Washington or IRRI. In view of the need for the Government of Indonesia (GOI) to establish priorities for agricultural mechanization, the team recommended that the project undertake a study on the micro and macro aspects of agricultural mechanization prior to development of any additional mechanization projects.

E. Evaluation of BPI (MAF-IRRI) Small Farm Machinery Industrial Extension Program. Richard E. Rhoda et al., October 1984, 27 pp., PDAAR343.

This report is based on a four-day evaluation by a five-member team. The evaluators observed that the benefits of the MAF-IRRI Program most definitely outweighed the costs and felt that the Program was generally well balanced, with funds allocated properly among the various functions of extension, training, equipment development/ testing, and communication/coordination with other organizations. The team made 14 recommendations, including that AID Asia Bureau grant a no-cost, two-year extension to enable the program to improve its institutional capability and maintain its recently acquired momentum during the current Government of the Philippines (GOP) budget crisis; that USAID/Philippines in collaboration with its GOP counterparts investigate the possibility of assisting the program through one of its larger projects; that the GOP policymakers give increased attention to the farm mechanization requirements of their shift toward accelerated agricultural production and focus on five priority crops;

and that BPI should strengthen linkages with local technology resource institutes and other government and non-government agencies involved in industry extension activities.

F. Promoting the Manufacture and Use of Small-Scale Agricultural Machinery in Indonesia. AID Evaluation Special Study No. 26. USAID, Washington, D.C., June 1985, 109 pp., PNAAL052.

This report is aimed at assessing the effectiveness of the IRRI-DITPROD program in Indonesia in promoting the manufacture and use of small-scale agricultural machinery in selected rice growing areas. It is based on a four-week on-site visit. The authors concluded that while it is premature to assess the program's cost-effectiveness, IRRI-DITPROD has demonstrated a successful public sector approach to transferring technology to the private sector. Nonetheless, much of the Indonesian private sector remains geared to importation of agricultural machinery rather than domestic production.

16. Key Persons:

A. AID/Washington: Not specified

B. AID/Mission: Not specified

C. Contractors:

Mr. V. R. Reddy, IRRI Project Leader
IRRI-DITPROD(Directorate of Food Crop Production)
Industrial Extension Project, P.O. Box 18/KBYPM, Pasar Minggu, Jakarta Selatan, Indonesia, Phone: 782557

Dr. Robert E. Stickney, Project Co-Leader
Benito C. Gonzalo, BPI Project Co-Leader
International Rice Research Institute, c/o Bureau of Plant Industry, Ministry of Agriculture and Food, San Andres Street, Malate, Metro Manila, Philippines

Ray C. Fischer, Associate Agricultural Engineer and Project Co-Leader (retired in February 1983)
Dr. Billy J. Cochran, Project Co-Leader (replaced Fischer)
Chak Chakkaphak, Head of Research and Testing Section and Project Co-Leader
Thai-IRRI Agricultural Machinery Program, Agricultural Engineering Division (AED), Department of Agriculture, Ministry of Agriculture and Cooperatives, Thailand

Mr. Prabhakar Datt, Project Engineer
Mr. Fred Nichols. Project Advisor
CIAE-IRRI Industrial Extension Project on Small Farm Machinery, Tamil Nadu Agricultural University, Lawley Road, Coimbatore-641003, India

D. Host Country:

Dr. C. W. Bockhop, Head of Department, and Project Co-Leader
Agricultural Engineering Division, Thailand

17. Obligations by Fiscal Year (US$000): Not specified

18. Host Country Funding of R.E. Components (US$000): Not specified

19. Summary of R.E. Costs (US$000):

	APPROVED BUDGET*	TOTAL EXPENDITURES AND COMMITMENTS
Salaries & Wages	1,540.39	1,321.130
Overhead	224.34	193.349
Fringe Benefits & Allowances	1,158.50	634.903
Travel & Transportation	569.86	409.473
Equipment, Materials & Supplies	364.00	435.546
Training	170.91	103.210
Studies	132.00	15.987
Workshop/Evaluation	190.00	74.946
TOTAL	4,350.00	3,188.544

*For entire project, R.E. costs not specified separately

(Source: Annual Progress Report: 1985, 9/1/85, PDAAT181)

20. R.E. Component Revisions:

A. PACD extended one year to September 30, 1986, for the Philippine and India components to enable the local USAID missions to establish budgets for continuation of the projects; the Indonesia and Thailand components ended on September 30, 1985, the orignal PACD.

(Source: Annual Progress Report: 1985, 9/1/85, p. 1, PDAAT181)

21. Follow-On Activities:

A. Appropriate Technology International (ATI) provided seed capital and training programs to PPPM, a non-governmental

organization in Indonesia, to launch extension of the IRRI-DITPROD pedal threshers and pedal winnowers.

(Source: IRRI-DITPROD Quarterly Report, 9/24/84, p. 4, PDAAR177)

B. Each country's IRRI project office was concerned with institutionalizing the capability of local agricultural implement design, manufacture, and extension. Consequently, they worked in close association with local research organizations, other related projects within their countries, governmental institutions, and universities toward the achievement of this goal before the PACD. In Indonesia and Thailand, the Industrial Extension activity is now a part of the national program. Extensions to PACD were granted to the Philippine and India components since they required more time to become integral parts of their respective national programs.

(Source: Annual Progress Report: 1985, 9/1/85, PDAAT181)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: October 1986 (jrl)

1. Project Number: 5150138 2. Geo: COSTA RICA

3. Title: SCIENCE AND TECHNOLOGY

4. Project Life/PACD: 1979-84 (extended to 85)/July 19, 1985

5. Status: Terminated

6. LOP Funding (US$000):

   A. Entire Project: 4,500

   B. R.E. Components: Not specified

   (Source: DIS)

7. Loan or Grant/Appropriation Category (US$000):

   L / SD / 2,500
   L / EH / 2,000

   (Source: DIS)

8. Project Purpose:

   To strengthen Costa Rica's capacity to plan, conduct, and apply to its productive processes scientific and technological research that takes into account the needs of Costa Rica's poorest groups and the rational use of its natural resources.

9. Renewable Energy (R.E.) Outputs:

   Thirteen technology assessments; Research and development projects; Technology guides and manuals; Wind surveys and solar radiation surveys.

10. R.E. Inputs:

    Operating expenses; Technical assistance.

11. Summary of R.E. Components:

    The Science and Technology project provided funds to strengthen the capacity of the Government of Costa Rica (GOCR) to plan, conduct, and apply scientific and technological research to its productive processes. The project was administered by the Costa Rican National Council

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for Scientific and Technological Research (CONICIT). Three activities were conducted:

- Research and Development Assessment, Planning, and Promotion,
- Research Community Support, and
- Technology Extension.

Research and development activities included a comprehensive assessment of the Costa Rican industrial sector and assessments of subsectors in which technological change had the most potential for increasing labor demand and productivity. Energy and forestry were two of those subsectors. CONICIT formulated a research program to identify potential research subprojects. Originally, 58 research subprojects were planned, several of which involved renewable energy:

- Use of geothermal energy to produce electricity;
- Wind and solar radiation as rural energy sources;
- Industrial and agricultural applications for solar panels, solar collectors, windmills, and biomass digesters;
- Improved charcoal production; and
- Hydropower to produce electricity.

The wind and solar radiation inventory at various isolated sites throughout the country was outlined and ready to begin even before the completion of the industrial sector assessment. The inventory data were intended for use in the design of future rural energy projects.

Extension activities were conducted by the Technology Institute of Costa Rica (ITCR), which received support to prepare and publish technical information pamphlets. Its technology extension unit provided small producers and farmers with access to new technologies.

12. R.E. Project Descriptors:

Solar energy; Biomass; Wind energy; Hydropower; Geothermal energy; Charcoal; Electric power generation.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington: Not specified

B. AID/Mission: Not specified

C. Contractors: Not specified

D. Host Country:

Jaime Raigosa Echeverri, Coordinator
Science and Technology Project, CONICIT

17. Obligations by Fiscal Year (US$000):

DISBURSEMENT SCHEDULE BY CALENDAR YEAR (CY)

	CY80	CY81	CY82	CY83	CY84	TOTAL
R&D Assessment, Planning, and Promotion	354	415	487	447	198	1,901
Research Community Support	206	476	456	130	0	1,268
Technology Extension-ITCR	130	125	125	125	75	580
All Components	690	1016	1068	702	273	3,749
Contingency & Inflation						751
					TOTAL	4,500

(Source: Project Paper, 5/29/79, Table III.B.3, pp. 62-63, PDKAA201)

18. Host Country Funding of R.E. Components (US$000): 4,500*

*For entire project, R.E. costs not specified separately.

(Source: Project Paper, 5/29/79, pp. 62-63, PDKAA201)

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19. Summary of R.E. Costs (US$000):

Budget For Entire Project

	USAID*	GOCR**	TOTAL
1) Research & Development Assessment Planning and Promotion (RDAPP)			
Assessments	212.525		
Research Project	1,454.416		
Information & Evaluation	42.0		
Administration	352.0		
RDAPP Total	2,060.941	2,376	4,436.941
2) Research Community Support	1,843.059	553	2,396.059
3) Technology Extension (TE-ITCR)			
Equipment & Vehicles	90.0		
Short-Term Technical Assistance	71.0		
Training	419.0		
TE-ITCR Total	580.0	722	1,302.0
4) Contingencies	16.0	849	865.0
	---	---	---
TOTAL	4,500.0	4,500	9,000.0

(Sources: *Implementation Letter No. 33, 3/29/85, PDKAA208; **Loan Agreement, 7/30/79, Annex I pp. 13-14, PDKAA203)

20. R.E. Component Revisions:

A. PACD extended from July 19, 1984, to July 19, 1985.

(Source: Implementation Letter No. 34, 7/18/85, PDKAA208)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: August 1986 (mgz)

1. Project Number: 5150145 2. Geo: COSTA RICA

3. Title: NATURAL RESOURCES CONSERVATION

4. Project Life/PACD: 1979-85/September 13, 1985

5. Status: Terminated

6. LOP Funding (US$000):

   A. Entire Project: 9,800

   B. R.E. Components: Not specified

   (Source: Implementation Letter No. 39, 2/27/85, PDKAA328)

7. Loan or Grant/Appropriation Category (US$000):

   L / FN / 8,000
   L / SD / 1,800

   (Source: DIS)

8. Project Purpose:

   To strengthen the institutional mechanisms through which the Government of Costa Rica (GOCR) manages the country's renewable natural resources.

9. Renewable Energy (R.E.) Outputs:

   Research on firewood species, forest plantations, agroforestry; Forest production activity to link private sector to forestry management; Reforestation.

10. R.E. Inputs:

    Personnel; Nursery operations costs; GOCR reforestation subsidies; Technical assistance.

11. Summary of R.E. Components:

    The Natural Resources Conservation Project was designed primarily to reverse the accelerating rate of deforestation in Costa Rica by strengthening the institutional mechanisms through which the GOCR manages renewable natural resources. The GOCR wants to fully utilize the natural resources without further deterioration of the resource base. The Ministry of Agriculture (MAG) has strongly supported the Directorate

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General of Forestry (DGF), which has direct nationwide responsibilities for natural resource utilization and conservation. To implement the policies and activities of the project, CORENA, the natural resources control agency, was created within DGF, with the Deputy Director of DGF serving as Director of CORENA. In December 1983 the United Nations Food and Agriculture Organization (FAO) signed an agreement with MAG to provide technical assistance for the forestry and watershed management activities.

The project has five components, two of which contain renewable energy aspects. A research component will examine, among other things, growth and yield of species in forest plantations; wood technology; economics of agroforestry; and management of improved forest plantations and nurseries. An agreement with the Universidad Nacional calls for the development of a key for the identification of species of firewood in Sarapiqui canton.

Another component, Experimental Projects, includes a forest production activity. DGF wishes to persuade the private industrial forestry sector to participate more fully in the management of forests through enterprises that use resources rationally. For a forest enterprise to have economic prospects, industrialization will be necessary. One such industrial enterprise, promoted by CORENA, involves the construction of a power plant for the town of Horquetas in the canton of Sarapiqui. The power plant will use unmarketable trees of undesired species, cull trees, and sawmill residues. Without the power plant to provide a market, those materials would have been left in the forest because they were uneconomical to harvest.

The project explicitly mentions management of forest, soil, and water resources. Fuelwood for an expanding rural population, the greatest pressure on the forests, is included implicitly.

12. R.E. Project Descriptors:

Firewood; Electric power generation.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications:

Forty references (many in Spanish) are mentioned at end of Special Evaluation Report, 11/83, PDKAA335.

15. Evaluations/Major Findings:

A. Project Evaluation Summary. O. Lustig, R. Rosario, and B. Schouten, USAID/CR, San Jose, Costa Rica, May 1984, 5 pp., PDKAA335.

This is a standard PES with a Special Evaluation Report (SER) attached. Most of the findings are contained in the SER (see below).

B. Evaluation of the Natural Resource Conservation Project, Loan No. 515-T-032, Costa Rica. Special Evaluation Report. Servicios Tecnicos del Caribe, San Juan, Puerto Rico, November 1983, 90 pp., PDKAA335 or XDAAP382A.

This report presents the results of the first in-depth evaluation, conducted in October 1983. Although the project was approved by USAID in the fall of 1979, it was not ratified by the Costa Rican legislature until March 1981. This evaluation, therefore, covers the first two and a half years of the project.

Major findings:

- Project got off to a slow start but was under competent, dynamic leadership by time of the evaluation.
- Most land in the reforestation scheme will be reforested with Cordia alliadora, a local species known as laurel, which has shown great potential on a small scale.
- Planting small patches of trees between pastures or crops is not commercially viable; farmers need credit and incentives to initiate real reforestation programs.
- More observation plots need to be established for gathering data on native and exotic species' adaptability to the area, their pest and disease resistance, and their growth rates.
- Project wishes to involve the private industrial forestry sector in the management of forests.

The evaluation team recommended that the project continue at least until the PACD of September 1985.

16. Key Persons:

A. AID/Washington:

Owen Lusting, LAC/CEN, Project Officer
Room 5258 NS Washington, D.C., 647-4795

B. AID/Mission:

Thomas C. Ivers, Agricultural Development Officer
Rafael Rosario, Assistant Agricultural Development Officer

C. Contractors:

Cristian Coronas, Project Advisor
(Personal Services Contract)

D. Host Country:

Raul Solorzano, Project Director
CORENA

17. Obligations by Fiscal Year (US$000):

Scheduled disbursements, by calendar year:

CY80	CY81	CY82	CY83	CY84	TOTAL*
2,504	1,911	1,744	988	864	8,011

*Contingencies and inflation funds of 1,789 bring the total to 9,800

(Source: Project Paper, 6/6/79, Table III.B.3, PDKAA318)

18. Host Country Funding of R.E. Components (US$000):

Entire Project: 11,200
Reforestation: 1,104

(Source: Project Paper, 6/6/79, Table III.B.3, PDKAA318)

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19. Summary of R.E. Costs (US$000):

A. By category, expected expenditures:*

	USAID	GOCR
Operating Costs	502.5	6,631.4
Contracted Studies	346.9	0.0
Government Subsidies, Reforestation	0.0	1,103.6
Credit Fund/Improved Cattle Management	1,674.0	0.0
Vehicles, Equipment, and Supplies	2,020.4	73.0
Construction	1,044.4	0.0
Land Purchase	0.0	1,205.0
Technical Assistance	1,157.0	0.0
Training and Seminars	1,266.0	396.0
Contingencies and Inflation	1,788.8	1,791.0
TOTAL	9,800.0	11,200.0

*For entire project; R.E. costs not specified separately.

(Source: Project Paper, 6/6/79, Table III.B.1, PDKAA318)

B. By component, revised budget, in US Dollars:*

Policy Analysis, Research and Project Coordination	994,298
Experimental Projects	3,217,803
Management Plans	260,022
Environmental Conservation and Education	387,318
Training and Technical Assistance	2,165,150
Contingencies and Inflation	175,409
SUBTOTAL	7,200,000**
Not Programmed	2,600,000
TOTAL	9,800,000

*For entire project; R.E. costs not specified separately.

**Subtotal represents the projected cost of executing requested project activities up until PACD, 9/13/85).

(Source: Implementation Letter No. 39, 2/27/85, PDKAA328)

20. R.E. Component Revisions:

A. Following a recommendation in the SER of 11/83, a Project Advisor was added to the project.

(Source: Special Evaluation Report, 11/83, p. 90, PDKAA335)

21. Follow-On Activities:

A. Long-term training to develop natural resources management and planning skills.

(Source: Special Evaluation Report, 11/83, p. 82, PDKAA335

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: August 1986 (mgz)

1. Project Number: 5150175 2. Geo: COSTA RICA

3. Title: ENERGY POLICY DEVELOPMENT

4. Project Life/PACD: 1981-84(extended to 85)/December 31, 1985

5. Status: Terminated

6. LOP Funding (US$000):

   A. Entire Project: 1,000

   B. R.E. Components: Not specified

   (Source: Second Amendatory Grant Agreement, 3/29/83, PDKAA233)

7. Loan or Grant/Appropriation Category (US$000):

   G / SD / 1,000

   (Source: Second Amendatory Grant Agreement, 3/29/83, PDKAA233)

8. Project Purpose:

   To strengthen the Government of Costa Rica's capacity for energy sector planning.

9. Renewable Energy (R.E.) Outputs:

   Energy Advisory Committee established; Planning data gaps analyzed; National Energy Sector Plan generated; Energy supply options analyzed; Five prefeasibility studies prepared; Energy-related personnel trained.

10. R.E. Inputs:

    Technical Assistance; Training; Commodities; Funds for studies and analyses; Personnel development support; Other costs.

11. Summary of R.E. Components:

    The Energy Policy Development Project was designed to strengthen the capacity of the Government of Costa Rica (GOCR) to perform energy sector planning. The project was administered by the Direccion Sectorial de Energia (DSE) within the Ministry of Industry, Energy, and Mines (MIEM).

The project had four components: Energy Sector Management Activities, Energy Research and Studies, Energy Planning Information, and Training and Exchange Programs.

In Energy Sector Management Activities, DSE began production of a National Energy Sector Plan for 1986-2006 and took on an increasing amount of energy-related activities funded by donors other than USAID.

In Energy Research and Studies, a pre-investment analysis of woody-biomass fuel use in industry (undertaken by Meta Systems) was completed, as was a national survey of residential energy utilization. The project furnished in-country coordination of all sectors for the S&T/EY-funded Horquetas Bio-electrification Project and committed $100,000 in grant funds for equipment purchases. That project includes a gasifier fueled by wood chips to generate 190 KW of electricity for the village of Horquetas.

In Energy Planning and Information, a documentation center and an information program were established.

In Training and Exchange Programs, no exchanges had occurred by June 1984. Some short-term training had taken place, including participation in the fifth session of training in Alternative Energy Technology in Gainesville, Florida; in a wind energy seminar in Texas; in a National Charcoal Program in Washington, D.C.; in a course on geothermal energy in Denver; and in the Annual Conference and Workshop on Alternative Energy and Cogeneration in the Caribbean Basin held in Miami, Florida.

12. R.E. Project Descriptors:

    Energy planning; Energy research; Information centers; Gasification; Wood chips; Energy conservation; Electric power generation; Gasohol; Biomass; Alcohols; Energy policy.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings:

    A. An Interim Evaluation of the Costa Rica Energy Policy Development Project. James Westfield, Energy/ Development International, Washington, D.C., June 1984, 63 pp., PDAAU786.

    There were three major findings. First, the work performed to date was well done, but much remained to be

accomplished. Of particular importance are the planned industrial energy conservation audit project and the alcohol-gasohol study.

Second, insufficient attention was being given to public information programs, particularly with respect to energy conservation and efficient use options.

Third, DSE should concentrate more on its own future needs, including planning for funding sources.

B. Project Evaluation Summary. Ann Farrar, Heriberto Rodriguez, H. Diez de Medina, K. Kelly, and R. Archi, USAID/Costa Rica, San Jose, November 19, 1984, 7 pp., PDKAA248 or PDAAQ016.

This evaluation covers the period from September 1981, the beginning of the project, until June 1984, the original PACD. It outlines the major findings of the in-depth project evaluation carried out by Energy Development International during June 1984 (see above). As of March 1984, the 50 percent of the project that had been completed was well done. However, as of June 1984, at least three major study projects had not been initiated, the National Energy Sector Plan for 1986-2006 remained to be completed (due February 1985), and further training activities needed to be organized.

There was no indication that the grant had resulted in either efficiency or policy implementation. DSE had established a role for itself in the energy policy decision-making process, although it had yet to influence any major energy sector decision.

C. Final Evaluation of the Costa Rica Energy Policy Development Project. James D. Westfield, Energy/ Development International, Washington, D.C., December 1985, 124 pp., PDKAH155.

Major findings: (1) The GOCR's capacity for energy planning was strengthened, although many inappropriate and overly ambitious verifiable objectives were not reached; (2) A wholistic description and view of the energy sector was created; (3) Energy planning professionals were trained in adequate numbers; (4) A good working relationship was established between DSE and other institutions; (5) Adequate data on supply and demand options were generated for energy sector planning, but a deficiency exists in important energy sector issues; (6) Short-term technical assistance provided by U.S. contractors was considerably less than adequate, with serious delays in delivering contractual outputs; (7) Due to many management, political, and technical

factors, DSE was unable to complete a National Energy Plan; (8) DSE has evolved into a recognized information and development and planning group, especially in the areas of energy demand and renewable energy sources, but has not yet made a major impact on energy policy; (9) In its final days. the project lacked senior management, demonstrating the need to ensure technical and management assistance throughout a project, especially an institution building project.

Fourteen general recommendations are made concerning the completion of unfinished grant-funded activities, further achievement of project goals, new funding and support for follow-on efforts, and general USAID actions.

16. Key Persons:

A. AID/Washington:

Jim Hester, LAC/DR
Room 2239 NS, Washington, D.C., 647-8279

B. AID/Mission:

Heriberto Rodriquez, General Engineer
USAID/Costa Rica

C. Contractors:

United Nations Development Programme (UNDP)
One U.N. Plaza, Room DC 2032, New York, NY 10017
(UNDP supplied an advisor to the project)

Meta Systems, 10 Holworthy Street, Cambridge, MA 02138
(617) 868-8660

D. Host Country:

Dr. Jorge Blanco Roldan, Director (and Project Director)
Direccion Sectorial de Energia, Ministry of Industry, Energy and Mines, San Jose, Costa Rica

Jorge Eduardo Monge Aguero, Director
Executive Secretariat of Energy Sectorial Planning

Dr. Alvaro Umana, AID Project Advisor

17. Obligations by Fiscal Year (US$000):

Disbursement Schedule:

	USAID	GOCR	TOTAL
FY81	65	45	110
FY82	600	215	815
FY83	200	55	255
Subtotal	865	315	1,180
Contingencies	135	35	170
TOTAL	1,000	350	1,350

(Source: Project Paper, 9/28/81, p. 37, PDKAA231)

18. Host Country Funding of R.E. Components (US$000): 350*

*For entire project; R.E. costs not specified separately.

(Source: Project Paper, 9/28/81, PDKAA231)

19. Summary of R.E. Costs (US$000):

A. By Component, Estimated Project Budget*:

	USAID	GOCR
Energy Sector Management	115.6	200
Energy Research and Study	676.0	35
Energy Planning Information	85.0	50
Training and Exchange Programs	78.4	30
Project Evaluation	20.0	0
Contingencies & Inflation	25.0	35
TOTAL	1,000.0	350

*For entire project, R.E. costs not specified separately.

(Sources: Implementation Letter No. 14, 1/16/84, PDKAA237; Project Paper, 9/28/81, p. 37, PDKAA231)

B. Revised estimate of the USAID portion, as of November 1, 1985*:

Energy Sector Management	119.3
Energy Research and Studies	691.2
Energy Planning Information	48.9
Training and Exchange Program	111.9
Project Evaluation	17.7
Contingencies & Inflation	0

TOTAL	988.9**

*For entire project, R.E. costs not specified separately;
**Total may not add up correctly due to rounding.

(Source: Final Evaluation, Table I-1, p. 2, 12/85, PDKAH155)

20. R.E. Component Revisions:

A. PACD extended from June 30, 1984, until June 30, 1985.

(Source: Implementation Letter No. 14, 1/16/84, PDKAA237)

B. PACD extended from June 30, 1985, until December 31, 1985, mainly to allow completion of the Horquetas bioelectrification gasification project, publication of study results, and delayed delivery of goods by the contractors.

(Source: Final Evaluation, 12/85, PDKAH155.

C. The project was to be administered by the Ministry of Energy, but, during a change of GOCR administration in 1982, that ministry was dissolved. In May 1982 the administration of the project was transferred to the Direccion Sectorial de Energia (DSE) within the newly created Ministry of Industry, Energy and Mines (MIEM).

(Source: PES, 11/84, PDKAA248)

D. To balance available funds and spending priorities, the project budget was realigned in late 1983. Money was taken from the Project Advisor, Contingency and Inflation, and Energy Planning Information elements and added to Energy Research and Studies.

(Source: PES, 11/84, Section 16, PDKAA248)

E. By the end of 1984 both project advisors had left. The UN advisor was not replaced. It was decided that the

USAID advisor, who had completed his two-year term, would be replaced by an administrative assistant, rather than a technical and management advisor.

(Source: Final Evaluation, 12/85, PDKAH155)

F. It was decided near the end of the project that additional subprojects, including a planned alcohol-gasohol study, would not be funded.

(Source: Final Evaluation, 12/85, PDKAH155)

G. The Horquetas gasification project, managed by the USAID Central Bureau Energy Office and partially ($100,000) funded by this project, experienced long delays in delivery of equipment by U.S. and Dutch subcontractors. Completion is planned for some undetermined date after the PACD. A further complication arose when the Instituto Costarricense de Electricidad (ICE) extended the electric grid to the village where the gasification demonstration project was to take place. Consideration was being given to changing the focus from complete electrification of the village to grid interconnection of the gasifier and gasifier technology demonstration.

(Source: Final Evaluation, 12/85, PDKAH155)

21. Follow-On Activities:

A. DSE, through funding from AID and other donors, is creating activities and projects that will lead to energy use changes. A major follow-on to Meta System's biomass conversion study is a cement company biomass fuel substitution project. The French government is also funding a biomass conversion project in the cement industry; it is not clear from the literature if these two cement projects are one and the same. DSE is working with other funding sources to study renewable energy resources potential.

(Sources: Interim Evaluation, 6/84, PDAAU786; Final Evaluation, 12/85, pp. 27 and 29, PDKAH155)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: August 1986 (mgz)
Revised January 1987 (jrl)

1. Project Number: 5170126.01 2. Geo: DOMINICAN REPUBLIC

3. Title: NATURAL RESOURCES MANAGEMENT

4. Project Life/PACD: 1981-86/July 31, 1986

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 11,000*
   11,200**

   B. R.E. Components: Not specified

   (Source: *Project Authorization, 8/21/81, PDKAE207; **DIS)

7. Loan or Grant/Appropriation Category (US$000):

   L / FN / 10,500*

   G / FN / 500*
   700**

   (Source: *Project Authorization, 8/21/81, PDKAE207; **DIS)

8. Project Purpose:

   To strengthen the capability of the Government of the Dominican Republic (GODR) to promote the effective management of the country's natural resources, and to establish a soil and water conservation model that can be used to help stop the degradation of the nation's natural resources.

9. Renewable Energy (R.E.) Outputs:

   National forestry plan; 20-year natural resource strategy plan; Establishment of tree nurseries; Land reforestation; Agroforestry and forest management planning capacity; Charcoal marketing study.

10. R.E. Inputs:

   Technical assistance; Commodities; Training; Credit for fuelwood production.

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11. Summary of R.E. Components:

The Natural Resource Management (NARMA) project, also known as "El Proyecto Manejo de Recursos Naturales" (MARENA), was developed to help the Government of the Dominican Republic to effectively manage its natural resources, especially in response to a perceived imminent environmental crisis caused by hillside farmers. Poor land use and farming practices on steep slopes as well as destruction of highland forest by encroaching agriculture and by forest cutting for charcoal and firewood production appeared to be leading to flooding, siltation damage to hydro-electric facilities, lower agricultural productivity, etc. To combat this situation, the project had two major components: Institutional Strengthening; and Soil and Water Conservation.

The Directorate General for Forestry (DGF), the National Water Resources Institute (INDHRI), and the Subsecretariat for Natural Resources (SURENA) were the principal GODR institutional actors, with SURENA the implementing agency. Michigan State University and Ohio State University provided technical assistance for the Institutional Strengthening component, and the USDA-Soil Conservation Service/Puerto Rico provided technical assistance for field work. The University of Kentucky furnished technical assistance to the Soil and Water Conservation component.

The project contained 16 elements, including the development of an agroforestry and forest management planning capacity; the undertaking of marketing channel studies for a number of products to be affected by the project, such as charcoal; and provision of credit from the Agricultural Bank of the Dominican Republic through the Soil Conservation Credit Fund for the production of fuelwood and lumber.

Some training did take place in conservation forestry. However, the program shifted from Dominican training toward reliance on technical assistance for major planning and programming inputs, thereby constraining the development of an in-country forestry planning and management capability. This shift also had the effect of preventing better relations from developing between SURENA and the DGF.

12. R.E. Project Descriptors:

Firewood; Charcoal; Biomass; Grasses; Energy farming; Vegetable oils as fuel.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings:

A. First Evaluation Report of the Dominican Republic Natural Resources Management Project - NARMA. Ronald Tinnermeier, Gene Miller, Thyrele Robertson, and Robert Werge, Santo Domingo, July 1984, 54 pp., PDAAR258 or PDKAE228

The evaluation team's overall impression was that the NARMA project is a much needed effort and that very satisfactory progress is being made toward reaching the proposed outputs and purposes. Inadequate counterpart funding was the major perceived problem. Nine recommendations are presented; none mention R.E. technologies.

B. Natural Resource Management (NARMA) Project - Dominican Republic Evaluation. George Armstrong et al., RONCO Consulting Corporation, 1629 K Street, NW, Suite 401, Washington, DC 20006, April 1986, 286 pp., PDAAT442 or PDKAE227

The evaluation team found that one of the two major assumptions on which NARMA was built, that soil erosion was occurring at a catastrophic rate and was caused principally by hillside farmers, was incorrect. Their calculations indicated that erosion rates were not as high as had been predicted, and that natural erosion and infrastructure such as roads accounted for most of the erosion.

The evaluation concurred with the second assumption, that the GODR's natural resources were deteriorating rapidly on a widespread basis, and that a nationwide program was needed to help slow or halt this deterioration. It found that the institutional strengthening to government served a very useful purpose. However, a number of issues arising out of managerial inadequacies and pressures for growth constrained NARMA's progress. Six recommendations dealing with the institutionalization of NARMA within the government and with cost reductions/improved resource allocations address these concerns.

The evaluation states that fibrous grasses, in addition to serving as effective means for erosion control and water runoff, can also be a highly productive energy crop; this land-use practice should be considered as a viable alternative to present land uses. The evaluation further notes that fallow and abandoned lands that cannot be used for intensive, high-return crops might be used to develop energy farms. These could produce charcoal, firewood, chipped wood, or grass for use in electric power production. Or, the farms could grow oil crops such as perennial cotton and castor beans for direct

combustion of the seeds or vegetable oil production for fuel.

16. Key Persons:

A. AID/Washington:

Marion H. Ford, ARDO
Jane K. Mohan, LAC/DR/RR

B. AID/Mission:

Delbert McCluskey, Project Officer

C. Contractors:

Dr. Gary S. Kemph, USAID/DR Project Manager

Michigan State University
East Lansing, Michigan 48824

Ohio State University
Columbus, Ohio 43210

University of Kentucky

D. Host Country:

Jorge Garibaldi Pezzotti, Director, NARMA Project
Subsecretary of State for Natural Resources
Secretariat of State for Agriculture
Centro de los Heroes, Santo Domingo, Dominican Republic

Maximo Aquino, Project Coordinator
Subsecretaria del Estado para los Recursos Naturales
(SURENA)

17. Obligations by Fiscal Year (US$000):

ESTIMATED SCHEDULE OF DISBURSEMENTS FOR ENTIRE PROJECT

(FY not specified)

	YR 1	YR 2	YR 3	YR 4	YR 5	TOTAL
AID	1,900	1,630	2,600	2,575	2,300	11,005
GODR	1,475	1,380	2,450	2,400	2,490	10,195
TOTAL	3,375	3,010	5,050	4,975	4,790	21,200

(Source: Grant Agreement, 8/31/81, Annex 1, p.2, PDKAE206)

18. Host Country Funding of R.E. Components (US$000): 10,200*

*For entire project; R.E. costs not specified separately.

(Source: Grant Agreement, 8/31/81, p.3, PDKAE206)

19. Summary of R.E. Costs (US$000):

ESTIMATED COMPONENTS COST*

	AID LOAN	AID GRANT	TOTAL AID	GODR	TOTAL
Institutional strengthening	2,314	500	2,814	2,733	5,547
Soil and water conservation	5,401	0	5,401	4,721	10,122
Contingency	525	0	525	482	1,007
Inflation	2,278	0	2,278	2,200	4,478
TOTAL	10,518	500	11,018	10,136	21,154
TOTAL (Rounded)	10,500	500	11,000	10,200	21,200

*For entire project; R.E. costs not specified separately.

(Source: Grant Agreement, 8/31/81, Annex 1, p.3, PDKAE206)

20. R.E. Component Revisions:

A. As a result of contract negotiations in 1982, the planned 24-month technical advisor input was dropped. The role of the advisor was to help develop guidelines for future forestry planning and action. In addition, the proposed training through short courses of 200 DGF field agents in conservation forestry was trimmed.

(Source: Evaluation, Ronco Consulting Corp., 4/86, pp. 17 and 40, PDAAT442 or PDKAE227)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: September 1986 (jrl)

1. Project Number: 5170143 2. Geo: DOMINICAN REPUBLIC

3. Title: ENERGY POLICY DEVELOPMENT

4. Project Life/PACD: 1980-81(extended to 84)/September 29, 1984

5. Status: Terminated

6. LOP Funding (US$000):

   A. Entire Project: 764*
   770**

   B. R.E. Components: Not specified

   (Source: *Grant Agreement, 9/29/80, PDKAE277; **DIS)

7. Loan or Grant/Appropriation Category (US$000):

   G / SD / 764*
   770**

   (Source: *Grant Agreement, 9/29/80, PDKAE277; **DIS)

8. Project Purpose:

   To establish a system for providing continuous, updated information necessary for developing energy policy, and to upgrade the management and technical skills of the National Energy Commission (NEC) and other agencies involved in the implementation of energy programs.

9. Renewable Energy (R.E.) Outputs:

   Energy information systems; Information outreach study; Training needs study and plan; Six technical mini-courses.

10. R.E. Inputs:

    Consultants; Computer hardware; Training; Technical assistance.

11. Summary of R.E. Components:

    The Energy Policy Development Project was created to establish an energy information system and to improve the management of the National Energy Policy Commission, which would manage the system. The project had two components, both of which addressed renewable energy issues.

The main activity of the project was the creation of the Energy Information System (EIS) for the regular acquisition, processing, and dissemination of energy-related information. The EIS addressed three areas. To assist GODR officials with energy policy and investment decisions, the Policy Analysis component gathered and organized reliable data concerning energy use, supply, and demand. These data were to be used to update a USAID-funded baseline energy assessment and to generate National Energy Plans. A second EIS component, Technical Information Transfer, sought to access energy information from sources outside the Dominican Republic, such as the U.S. Department of Energy and the Solar Energy Research Institute. The computerized system contained information on energy prices, supply and demand trends, conservation measures, new energy technologies, etc. Information Outreach, the third EIS component, disseminated information to energy decisionmakers in the public and private sectors.

The second major activity was Technical Assistance and Training, also with three components. The Energy Training Needs Study and Plan component identified the gaps in the technical and managerial skills of government and private energy professionals, and financed development of a training plan for meeting those needs. Even before that component was completed, the second component, Mini-Course Program, was underway. The Energy Commission and the University of Madre y Maestra (UCMM) presented technical courses to university graduate students, government staff, and employees in private technical firms. Proposed topics for mini-courses included climate, energy conservation, and architectural design; design of domestic and commercial systems for solar water heating; practical applications of windmills; commercial and industrial energy audits; and solar air conditioning. The third component, Long and Short Term Training, financed the training of Dominicans to meet the immediate needs identified by the Training Needs Study and Plan. Possible fields of study included gasohol production, biogas fermentation, photovoltaics, and industrial conservation techniques. Some study in the United States was financed.

12. R.E. Project Descriptors:

Energy planning; Solar heating; Windmills; Solar energy; Air conditioning; Gasohol; Biogas; Photovoltaic energy; Water heaters; Information centers; Energy conservation; Energy policy.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington: Not specified

B. AID/Mission: Not specified

C. Contractors: Not specified

D. Host Country:

Jose Ramon Acosta, Executive Secretary
National Energy Policy Commission, Plaza Compostela - 5to. Piso, Ave. John F. Kennedy, Santo Domingo, R.D.

17. Obligations by Fiscal Year (US$000):

Original Disbursement Schedule

Component	FY81	FY82	TOTAL
Energy Information System	305	175	480
Technical Assistance and Training	154	80	234
Project Evaluation	0	20	20
Contingency	15	15	30
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TOTAL	474	290	764

(Source: Project Paper, 9/80, p. 68, PDKAE276)

18. Host Country Funding of R.E. Components (US$000): 260*

*For entire project; R.E. costs not specified separately.

(Source: Grant Agreement, 9/29/80, p. 21, PDKAE277)

19. Summary of R.E. Costs (US$000):

By Component, Estimated Expenditure*

	USAID	GODR
A. Energy Information System (EIS)		
1. Policy Analysis	380	170
2. Technical Information	50	0
3. Information Outreach	50	25

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B. Technical Assistance and Training (TAT)		
1. Energy Training Needs Study	40	5
2. Mini-Course Program	120	10
3. Long and Short Term T.A. and Training	74	30
	---	---
Subtotal	714	240
C. Project Evaluation	20	10
D. Contingency	30	10
	---	---
TOTAL	764	260

*For entire project; R.E. costs not specified separately.

(Source: Grant Agreement, 9/29/80, p. 21, PDKAE277; Implementation Letter No. 13, 6/15/82, PDKAE283)

20. R.E. Component Revisions:

A. PACD extended from September 29, 1983, until September 29, 1984 to allow acquisition of additional hardware and software for existing computer system and to allow for computer repair training.

(Source: Implementation Letter No. 18, 9/29/83, PDKAE283)

B. PACD extended from September 29, 1982, until September 29, 1983 to complete the establishment of the Energy Information System.

(Source: Implementation Letter No. 15, 7/28/82, PDKAE283)

21. Follow-On Activities:

Training started under this project was to be continued under other (unspecified) USAID-sponsored projects.

(Source: Grant Agreement, 9/29/80, PDKAE277)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: September 1986 (mgz)

1. Project Number: 5170144 2. Geo: DOMINICAN REPUBLIC

3. Title: ENERGY CONSERVATION AND RESOURCE DEVELOPMENT

4. Project Life/PACD: 1982-87/April 22, 1987

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 17,532

   B. R.E. Components: 6,306

   (Sources: Implementation Letter No. 16, 3/25/86, PDKAE294; Advice of Program Change, 4/25/85, PDKAE289)

7. Loan or Grant/Appropriation Category (US$000):

   L / FN / 5,268
   G / FN / 3,114
   L / SD / 6,550
   G / SD / 2,600

   (Source: Advice of Program Change, 4/25/85, PDKAE289)

8. Project Purpose:

   To develop the institutional capability necessary for achieving energy conservation and non-petroleum resource utilization on a wide scale.

9. Renewable Energy (R.E.) Outputs:

   National energy plan developed; Industrial conservation program initiated; Mini-hydro institutional capacity improved; Wood fuel research program completed.

10. R.E. Inputs:

    Technical assistance; Training; Materials/equipment; Credit; Local costs; Project administration; Inflation/contingency.

11. Summary of R.E. Components:

    The objectives of this project were to develop a national energy investment planning capability, initiate a continuing program of industrial conservation, develop the institutional

capacity to harness small-scale hydro and wood fuels as energy sources, and provide management assistance to the Dominican Electricity Corporation.

The National Energy Policy Commission (COENER) was responsible for overall project coordination. COENER also implemented the national energy planning and the industrial energy conservation components; the Central Bank managed a credit fund under the latter component. International Development and Energy Associates, Inc. provided technical assistance for energy planning. Fluor Corp. furnished technical assistance to the industrial energy conservation component. The Dominican Electricity Corporation (CDE), the Dominican National Water Resources Institute (INDHRI), and COENER shared implementation responsibility for the mini-hydro component; Hazra Engineering Co. furnished technical assistance. Superior Agrarian Institute (ISA) carried out the wood fuels component; Purdue University provided technical assistance.

Project design weaknesses, inexperience of COENER in conducting procurements properly, weak AID monitoring, and slow disbursement of counterpart funds plagued the project, causing implementation delays. Nonetheless, original goals for evaluating potential mini-hydro sites and for undertaking spacing and yield tests for different tree species were exceeded. Because of cost underestimations for the mini-hydro plants, only one of the three to four planned plants will be built. A nursery to produce 200,000 tree seedlings annually was established. As of September 30, 1985, four small charcoal kilns were built.

12. R.E. Project Descriptors:

Hydroelectric power plants; Kilns; Charcoal; Firewood; Energy farming.

13. R.E. Technology Applications:

A. Fifty-five sites were investigated as possible hydro power sites; 25 were selected for reconnaissance studies, and 17 of these for subsequent investigation. Financial, economic, technical, social, and environmental assessments were conducted for 11 of the 17 sites, and the sites were ranked for further studies. Three evaluations--Rio Banilejo, Rio Guayabal, and Rio Yuboa--were completed. The Banilejo project was rejected, as investigations revealed that it was not feasible. The Guayabal project was postponed, in spite of it having a good rate of return, because of its 2,500 kW capacity, exceeding the range for mini-hydro. The Yuboa project was selected for development because of its 470 kW output, good rate of return, and acceptable cost estimate

range. Two other feasibility studies (Manuel Bueno and La Casualidad) are in process.

(Source: PES, 11/85, PDAAT421 or PDKAE301)

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings:

A. Project Evaluation Summary. William Smith (USAID), and Ramon Flores and Bolivar Rosario (COENER), Santo Domingo, Dominican Republic, April 1986, 7pp., PDKAE301 or PDAAT419.

This PES, which is a replication of the Intermediate Evaluation prepared by DSI, summarizes the Energy Planning Component. The evaluators are optimistic that project goals will be met. Recommendations are made, however, to reorient the Planning Component slightly to focus more on the immediate energy needs of an economy in distress, although long-term energy planning will still be the main objective. Progress on energy planning is examined. Recommendations are made for changes in the computer center (installed under the Energy Policy Development Project, 5170143).

B. Intermediate Evaluation: Energy Planning Component, Energy Conservation and Resource Development Project. Development Sciences Inc. (DSI), 39 Pleasant Street, Box 444, Sagamore, MA, 02561, (617) 888-0101, October 15, 1985, 10pp., PDKAE301.

This evaluation is the source of the April 1986 PES outlined above. Beyond the information presented in the PES, the evaluation suggests that problem-solving workshops should be conducted to transfer planning skills to COENER staff. Workshops might focus, for example, on local lignite development and hotel energy conservation as near- and medium-term opportunities to meet oil import reduction goals.

C. Audit of Selected Delayed Projects: USAID/Dominican Republic. Audit Report No. 1-521-86-10. AID Office of the Regional Inspector General, Tegucigalpa, Honduras, March 18, 1986, 76 pp., PDAAS969.

This audit covered nine USAID/Dominican Republic projects in various stages of implementation, including the Energy Conservation and Resource Development project. The conservation project experienced delays due to the following reasons:

- Inexperience of COENER in conducting procurements in accordance with AID requirements;
- Project design weaknesses;
- Slow disbursement of counterpart funds;
- Weak host country contracting capability;
- Delays in meeting conditions precedent; and
- Weak AID monitoring.

Recommendations are given to rectify such problems.

D. Project Evaluation Summary - Mid-Term Evaluation Report. Dr. Mason Carter and J. L. Collom, Purdue University, March 1985, 20 pp., PDAAT420 or PDKAE301.

This is an internal, mid-term review of the wood fuels component. The evaluators concluded that progress on the component was satisfactory and there was significant potential for additional Purdue cooperation. Communication and transportation problems in some of the remote sites were indicated.

Specifically, it was found that basic studies were off to a good start, considering that only limited resources were available for them. A number of existing plantations had been measured and productivity of fuelwood was projected for several regions and species. Some initial analysis of the fuelwood and charcoal market had occurred, and studies on the returns to investments in fuelwood plantations had been initiated.

Species trials were found to have exceeded project expectations. Spacing trials were begun, but required additional work. Trials in the isolated region of Azua awaited a suitable site and cooperator.

Native forest management was found to be insufficiently addressed in the initial project description. The project did, however, develop valuable research in this area. It was recommended that such research be continued, covering additional types and shapes of plots.

The charcoal research was still in its initial stages. It was recommended that plans for kiln comparisons be revised to involve fewer kilns and larger quantities of fuel at the Mao site and to make explicit use of the mixed species commonly found in the native forest.

Moreover, it was recommended that evaluation criteria be defined for charcoal quality by a simple consumer preference test supplemented by laboratory analysis.

E. Evaluation Report - Mini-Hydro Development Program. Frederick March and Jack Fritz, Louis Berger International, Washington, D.C., July 5, 1984, 27 pp. + 3-page PES (written 11/85), PDAAT421 or PDKAE301.

The production of a "Reconnaissance Report" was the major visible product observed by the evaluation team. The document was described as excellent, capable of serving as a guide to site selection for further mini-hydro development.

Several problems were identified: a poor relationship between the contractor resident and COENER; lack of institutional standing of the mini-hydro staff of COENER, CDE, and INDHRI, and less than ideal support to the project from the latter two organizations; lack of logistical support; and shortcomings in USAID back-stopping.

Five recommendations were made to help alleviate these problems.

F. Final Evaluation Report for Component 2: Industrial Energy Conservation Program. Hagler, Bailly & Company, March 1985, 86 pp., PDAAR108.

The evaluation team found that the conservation activities were seriously handicapped by management, implementation, and resource problems, compounded by a severe economic crisis limiting counterpart funding and project personnel. Five major recommendations, plus several dozen other recommendations, are provided for improving this component.

16. Key Persons:

A. AID/Washington:

Jim Hester, LAC/DR
Marea Hatziolas, LAC/DR
Room 2239 NS, Washington, D.C., 647-8279

B. AID/Mission:

Larry Armstrong, Project Development Officer
William Smith, Energy Officer
Leo Perez Minaya, Energy Project Advisor
USAID/Dominican Republic,

C. Contractors:

Dr. Romir Chatterjee
International Development and Energy Associates, Inc. (IDEA), 1025 Connecticut Ave NW, Suite 705, Washington, D.C. 20036
(202) 955-5744

Harza Engineering Co., 150 South Wacker Drive, Chicago, IL 60606
(312) 855-7000

Dr. Mason Carter, Head, Department of Forestry and Natural Resources
J. L. Collom, Associate Director of International Programs
Dr. Douglas Knudson, Purdue Team Leader in Dominican Republic
Jose Mauro de Almeida (on-site long-term staff member)
Purdue University, AGAD Building, West Lafayette, IN 47907
(317) 494-3590

D. Host Country:

Ramon Flores, Project Coordinator
Jose Ramon Acosta, Executive Secretary
Bolivar Rosario, Section Chief, Energy Planning Component
National Energy Policy Commission (COENER),
Edificio Plaza Compostela - 5to. Piso, Avenida John F. Kennedy, Santo Domingo, D.N.

17. Obligations by Fiscal Year (US$000):

Projected Cost Disbursements for Entire Project by Year

(FY not specified)

YR 1	2,383
YR 2	2,217
YR 3	3,549
YR 4	3,935
YR 5	2,848
TOTAL	14,932*

*Does not include $1 million for project administration and evaluation, nor increase in LOP grant funds.

(Source: Project Paper, pp. 173-181, 12/4/81, PDKAE284)

18. Host Country Funding of R.E. Components (US$000): 1,338

(Source: Implementation Letter No. 16, 3/25/86, PDKAE294)

19. Summary of R.E. Costs (US$000):

A. LOP revised Budget, by Project Component:

	USAID	GODR	TOTAL
National Energy Planning.....	756	50	806
Industrial Conservation Program....	8,838	4,852	13,690
Mini-Hydro Development Program.....	4,166	868	5,034
Wood Fuel Development Program.....	2,140	470	2,610
CDE Technical Assistance Program...	700	50	750
Project Admin/Evaluation.....	782	0	782
Contingency and Inflation.....	150	0	150
TOTAL	17,532	6,290	23,822

(Source: Implementation Letter No. 16, 3/25/86, PDKAE294)

B. Original Budget, by Category:

	USAID	GODR	TOTAL
Technical Assistance.....	3,114	0	3,114
Materials/Equipment.....	4,685	475	5,160
Financial Programs.....	5,000	4,000	9,000
Local Personnel.....	220	1,815	2,035
Project Admin/Evaluation.....	1,000	0	1,000
Inflation & Contingency.....	1,913	0	1,913
TOTAL	15,932	6,290	22,222

(Source: Project Paper, 12/4/81, P. 19, PDKAE284)

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20. R.E. Component Revisions:

A. LOP grant funds increased from $4,114,000 to 5,714,000.

(Source: Amendment Number Four to the Grant Agreement, 3/12/86, PDKAE286)

B. Funds were reprogrammed among the various project components several times, by Implementation Letters No. 4, 9, and 16. In IL No. 16, $90,000 originally targeted for the CDE Technical Assistance component was reprogrammed to the Wood Fuel ($80,000), National Energy Planning ($5,000), and Industrial Conservation Program ($5,000) components.

(Sources: Implementation Letters No. 16 of 3/25/86, and No. 9 of 6/20/85, PDKAE294)

C. The Electricity Conversion element of the Wood Fuel component was eliminated and replaced by an Energy Farm element. On the basis of the research carried out by ISA and coordinated by COENER, an investment credit fund was established within the Fund for Investment in Economic Development (FIDE) to finance energy farm investments in the private sector. Credit program beneficiaries were to receive a guarantee to the right to commercially harvest trees. $225,000 was to be provided to finance training and feasibility studies leading to energy farm investments.

(Source: Implementation Letter No. 16, 3/25/86, PDKAE294)

D. The mini-hydro plant unit of COENER was transferred physically and institutionally to the CDE.

(Sources: Implementation Letter No. 8, 6/7/85, PDKAE294; PES, 11/85, PDAAT421 or PDKAE301)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: September 1986 (mgz/jrl)

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1. Project Number: 5170173 2. Geo: DOMINICAN REPUBLIC

3. Title: FORESTRY MANAGEMENT

4. Project Life/PACD: 1984-89/November 30, 1989

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 8,000*
   7,950**

   B. R.E. Components: Not specified

   (Source: *Project Authorization, 8/13/84, PDKAE408; **DIS)

7. Loan or Grant/Appropriation Category (US$000):

   G / FN / 2,000*
   1,950**

   L / FN / 6,000*

   (Source: *PDS of Project Paper, 8/13/84, PDAAP866; **DIS)

8. Project Purpose:

   To promote sound public sector forest management; To promote private sector involvement in forestry production; To strengthen the institutional capacity of the Directorate General for Forestry (DGF) to fulfill its mandate for the forestry sector.

9. Renewable Energy (R.E.) Outputs:

   DGF strengthened with a new managerial organization and structure; Forestry technicians trained; Research unit established; Extension unit established; Farmers trained; Land reforested; Forest management plans completed; Private Sector Forestry Credit funds disbursed for private forestry development and investment; Analysis of marketing, finances, technologies, and policy performed; Inventories for two public forests completed.

10. R.E. Inputs:

   Technical assistance; Commodities; Training; Operating costs; Infrastructure.

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11. Summary of R.E. Components:

The project will assist the implementing agency, the Directorate General for Forestry (DGF), to develop and strengthen its institutional capacity to manage forest resources and undertake action programs promoting private sector investment in forestry production. The management of forest resources, based upon the principle of multiple use and sustained yield, will be improved in both the public and the private sectors. The project has three major categories: (1) provision of technical assistance to assist in the reorganization of the DGF, training of forestry personnel, and expansion of DGF facilities; (2) policy and market analyses, financial and technical feasibility studies of forestry enterprises, and establishment of a credit fund for private sector forestry development (with firewood and charcoal production a concern of both the studies and the credit fund); and (3) priority field activities by DGF.

Coordination and oversight will be exercised by the Comision Nacional Tecnica Forestal (CNTF). Credit will be channelled through the Banco Agricola.

The project will focus on the Sierra de Bahoruco in Barahona Province and Sabana de San Juan in Azua, and adjacent lands.

12. R.E. Project Descriptors: Firewood; Charcoal.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

Wendy Stickel, now with AFR/PD/SAP, 2884 NS, 647-9200

B. AID/Mission:

Betty Facey, USAID/DR engineer

C. Contractors: Not specified

D. Host Country:

Ramon Rodriguez, Project Manager
Braulio Alcantara Hernandez, General de Brigada, E.N., Director General Forestal
Direccion General Forestal, Centro de los Heroes, Santo Domingo, Dominican Republic

17. Obligations by Fiscal Year (US$000):

Estimated Budget By Year (FY not specified)*

	AID LOAN	AID GRANT	AID TOTAL
YR1	1,277	384	1,661
YR2	1,280	576	1,856
YR3	995	366	1,361
YR4	593	204	797
YR5	552	162	714
TOTAL	4,697	1,692	6,389

*Represents income to DGF only, not total LOP funding.

(Source: Project paper, 8/84, p. 73, PDKAE407)

18. Host Country Funding of R.E. Components (US$000): 11,400*

*For entire project, R.E. costs not specified separately.

(Source: Project Paper, 8/13/84, PDKAE407)

19. Summary of R.E. Costs (US$000):

A. PROJECTED INPUTS BY ACTIVITY*

	AID	GODR	TOTAL
Technical Activities - Public Forest Management	3,020	3,436	6,456
Private Sector Forestry Development	881	5,346	6,227
Strengthening of DGF	2,124	1,773	3,897
Evaluation	72	0	72
Procurement & Transportation	795	0	795
Contingency & Inflation	1,108	845	1,953
TOTAL	8,000	11,400	19,400

*For entire project; R.E. costs not specified separately.

(Source: Paper Paper, 8/13/84, p. 85, PDKAE407)

B. PROJECTED SUMMARY COST ESTIMATE BY COMPONENT*

	AID LOAN	AID GRANT	TOTAL AID	GODR	TOTAL
Technical Assistance	0	1,728	1,728	0	1,728
Vehicles/Parts	626	0	626	0	626
Heavy Equipment/Parts	768	0	768	0	768
Equipment/Materials	909	0	909	846	1,755
Training	870	0	870	770	1,640
Infrastructure	285	0	285	450	735
Technical Services	150	0	150	514	664
Operating Costs	689	0	689	897	1,586
Personnel	0	0	0	2,078	2,078
Credit	0	0	0	5,000	5,000
Evaluation	0	72	72	0	72
Procurement/Transport	795	0	795	0	795
Contingency/Inflation	908	200	1,108	845	1,953
TOTAL	6,000	2,000	8,000	11,400	19,400

*For entire project; R.E. costs not specified separately.

(Source: Project Paper, 8/13/84, p.87, PDKAE407)

20. R.E. Component Revisions: Not specified

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: October 1986 (jrl)

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1. Project Number: 5180029 2. Geo: ECUADOR

3. Title: ALTERNATIVE ENERGY SOURCES PROJECT

4. Project Life/PACD: 1981-85(extended to 87)/March 1987

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 4,000

   B. R.E. Components: 4,000*

   *A very small component dealt with energy conservation.

   (Source: DIS)

7. Loan or Grant/Appropriation Category (US$000):

   G / SD / 1,000
   L / SD / 3,000

   (Sources: DIS)

8. Project Purpose:

   To increase the capability of the National Energy Institute to impact on energy policy and to promote non-conventional energy appropriate to Ecuador.

9. Renewable Energy (R.E.) Outputs:

   Solar water heaters constructed and installed; Limited R.E. (solar, wind, biomass, small hydropower, and geothermal) resource data gathered; A Master Energy Plan prepared; Rural energy demand and use data compiled; Progress made toward development of a national technological capability in small turbine and electronic load control design and construction to promote microhydro; R.E. seminars conducted; Biogas digesters built; Solar dryers constructed/tested/operated; Fuel-efficient cookstoves designed; Participation in NASA-AID PV refrigeration and lighting projects for health clinics; PV water pump demonstrated.

10. R.E. Inputs:

    Technical assistance; Commodities; Training.

11. Summary of R.E. Components:

The project consists of four components: (1) Energy studies and research, to assist the National Energy Institute (INE) in completing the National Development Plan, to enhance INE's institutional capabilities, and to promote private and public sector analyses and investigations of energy issues important to the Government of Ecuador; (2) Energy technology transfer and information network, to facilitate exchange of information on non-conventional energy sources among private and public institutions within Ecuador and between Ecuador and other countries; (3) R.E. demonstrations and dissemination, initially concerned with micro-hydro, solar hot water heaters, biogas, and fuel-efficient stoves; and (4) promotion of energy conservation measures.

The National Energy Institute collaborated with numerous institutions in the building, testing, and operating of R.E. devices. Five portable fuel efficient woodstoves were developed, and INE worked through the Central University to test the new designs. INE collaborated with Peace Corps volunteers in the construction of seven Indian-design biogas digesters. INE also participated in a NASA-AID project to test PV refrigeration and lighting systems in two rural health clinics. In addition, INE designed a number of solar dryers for such products as coffee, grain, lumber, and fish, working with various local organizations to build, test, and operate them.

12. R.E. Project Descriptors:

Information centers; Stoves; Wood; Biogas digesters; Photovoltaic energy; Refrigeration; Lighting; Solar energy; Crop driers; Coffee; Grain; Fish; Lumber; Turbines; Hydroelectric power; Firewood; Plantations; Water heaters; Energy conservation; Geothermal energy; Data collection; Energy planning; Electronic load control; Cookstoves; Water pumps.

13. R.E. Technology Applications:

A. Turbine and Transistorized Load Control Mechanism

INE designed a Michel-Banki (cross-flow) turbine and a transistorized load control mechanism, which were installed with assistance from the regional electrical utility (EMELNORTE) in the sierran community of Apuela as part of a refurbishing of a 50 kW hydro plant. INE is expanding its turbine testing and development program to include (1) more cross-flow and Pelton designs and (2)

production plans for national fabrication. Working through private firms, INE has developed an improved electronic regulator using triacs circuitry, which is ready for acceptance testing, and a third generation regulator prototype using microprocessors; a fourth generation is under development. Again, working through a private company, an oil pressure regulator for the improved Pelton turbine will be designed and built.

(Source: Mid-Term Evaluation, 9/84, pp. 46-47, PDAAR919 or PDKAD827)

B. Plantations

INE collaborated with the Fundacion Ecuatoriana de Desarrollo (FED) in planting about 18,000 trees in two communities near Riobamba.

(Source: Mid-Term Evaluation, 9/84, p. 49, PDAAR919 or PDKAD827)

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings:

A. Mid-Term Evaluation of USAID Project No. 5180029: Alternative Energy Sources. Gary Garriott and Ruth Hombach, Volunteers In Technical Assistance (VITA), Arlington, Virginia, September 1984, 153 pp., PDAAR919 or PDKAD827.

In terms of institution building, the evaluators viewed the Alternative Energy Sources Project (AESP) a qualified success. Although support also came from non-AESP sources, INE has developed considerable technical and planning expertise, and is responsible for an emerging awareness of conservation, planning, and non-conventional energy development at a national level. The evaluators thus recommended that AESP be extended to December 1986. They based their decision more on the belief that INE now had the capability to successfully implement the remaining project elements, rather than the achievements of the past, which were less than satisfactory in a number of areas. They urged that more emphasis be placed on developing an information center and information transfer capability.

Implementation was very slow from 1981-1983 for a number of reasons: an institutional structure that emphasized non-conventional energy development over national energy planning; relative inexperience of INE staff with R.E.

development; a national economic crisis; lack of an adequate administrative structure; a cautious attitude of INE to avoid wasteful spending of project funds; a political dispute in 1983; and lack of an operating plan until late 1983.

In October 1983 INE hired a new Executive Director. Orientation changed, with INE ceasing direct research projects and taking on the role of (1) project identifier and contract manager, with a limited project support role, and (2) agent of technology dissemination and transfer. INE was reorganized and a two-year operating plan developed. The evaluators viewed these changes in a very positive light.

16. Key Persons:

A. AID/Washington: Not specified

B. AID/Mission:

Mr. Carl Duisberg, Regional Development Officer
Mr. Leopoldo Garza, General Development Officer
United States AID Mission to Ecuador, Edificio Computec,
Av. Colombia 1573 y Queseras del Medio, Quito, Ecuador

C. Contractors:

Dr. Hugh Pearson, AESP Coordinator

D. Host Country:

Eduardo Moran, Director, Direccion de Desarrollo Energetico
Fernando Gonzalez, Chief, Division of Technical Diffusion
Franklin Carrasco, Chief, Division of Non Conventional Energy
Michel Lopoukhine, Geothermal Group
Victor Castellancs, Noemi Flores, and Letron Gilles, Solar Group
Fernando Barriga, Julio Hidalgo, Alfonso Mejia, and Jan Tauber, Small Hydro Group
Miguel Acuna, Amilcar Salazar, and Eduardo Yanez, Biomass Group
The National Energy Institute
Ciudad, Ecuador

17. Obligations by Fiscal Year (US$000):

ESTIMATED DISBURSEMENT SCHEDULE BY CALENDAR YEAR*

	Grant	Loan	TOTAL
CY81	100	120	220
CY82	250	610	860
CY83	180	520	700
CY84	120	370	490
CY85	0	130	130
Subtotal	650	1,750	2,400
Inflation/Contingency	150	150	300
TOTAL	800	1,900	2,700

*Does not reflect increase in total project LOP.

(Source: Project Paper, Table No. 12, p. 64, PDAAL572 or PDKAD806)

18. Host Country Funding of R.E. Components (US$000): 1,500

(Source: Project Loan and Grant Agreement, 9/29/81, PDKAD810)

19. Summary of R.E. Costs (US$000):

PROJECTED SUMMARY BUDGET*

	USAID GRANT	USAID LOAN	USAID TOTAL	GOE	PROJECT TOTAL
I. ENERGY PLANNING & ANALYSIS					
A. Assessments & studies	100	20	120	200	320
B. Measuring instruments	0	80	80	0	80
C. R&D Fund	0	150	150	150	300
Subtotal	100	250	350	350	700

II. TECHNOLOGY TRANSFER & INFORMATION NETWORK					
A. Technology transfer	200	120	320	90	410
B. Information center	-	80	80	80	160
C. Resident advisor	200	-	200	30	230
Subtotal	400	200	600	200	800
III. NCE DEMONSTRATIONS & DISSEMINATION					
A. Mini-hydro	-	500	500	300	800
B. Cookstoves & woodlots	-	90	90	110	200
C. Solar hot water	-	110	110	90	200
D. Others	-	500	500	100	600
Subtotal	-	1,200	1,200	600	1,800
IV. ENERGY CONSERVATION					
A. Conservation campaign	100	-	100	50	150
B. Conservation service	50	100	150	50	200
Subtotal	150	100	250	100	350
V. CONTINGENCIES & INFLATION					
	150	150	300	250	550
TOTAL	800	1,900	2,700	1,500	4,200

*Does not reflect increase in LOP funding.

(Source: Project Paper, Table No. 2, p. 16, PDAAL572 or PDKAD806)

20. R.E. Component Revisions:

A. INE was charged initially with the responsibility of conducting a national inventory of renewable energy resources. Due to a scarcity of instrumentation and the general inaccessibility of much of the country, data gathering for certain resources (e.g., solar, wind, and biomass) came to be viewed as an outcome of demonstration activities, rather than as a result of a national inventory.

(Source: Mid-Term Evaluation, 9/84, pp. 41-42, PDAAR919 or PDKAD827)

B. Original plans called for construction and installation of 360 solar hot water heaters in GOE housing projects. This was reduced in number, but the scope broadened so that a properly planned demonstration, taking into consideration such factors as credit, training, and maintenance, would promote widespread replication.

(Source: Mid-Term Evaluation, 9/84, p. 40, PDAAR919 or PDKAD827)

C. The original concept of developing an institutional capability within INE/INECEL (the state electricity company) to design, construct, operate, and maintain small hydro plants through construction of a 200 kW plant was proven unworkable. Emphasis changed to development of a national capability in small turbine and electronic load control design and construction, which could then be used by INECEL.

(Source: Mid-Term Evaluation, 9/84, pp. 45-46, PDAAR919 or PDKAD827)

D. Through late 1983, the project emphasized R.E. development activities at the expense of energy planning. In late 1983, a new Executive Director took over at INE and placed considerably more emphasis on the latter. This change mirrored a reorientation of INE's function from an implementation body to that of a coordinating body, contracting work out to other organizations/firms.

(Source: Mid-Term Evaluation, 9/84, PDAAR919 or PDKAD827)

E. The PACD was extended several times: to June 30, 1986; to August 31, 1986, for geothermal activities and the final evaluation activity; and to March 1987.

(Sources: Implementation Letter No. 17, 7/1/86, PDKAH805; AID Project Accounting Information System: Selected Reports from the PAIS Data Files, 12/31/86)

F. Original total LOP funding was for $2.7 million ($800,000 in grant funds and $1,900,000 in loan funds). In 1985, $250,000 in loan funds were deobligated leaving $1,650,000 in loans. Total LOP was subsequently increased to $4 million ($1 million grant and $3 million loan).

(Sources: Project Authorization, 6/11/81, PDKAD807; State Department telegram, 5/86, PDKAD812; AID Project Accounting Information System: Selected Reports from the PAIS Data Files, 12/31/86)

21. Follow-On Activities:

A. A State Department telegram stated that S&T/EY understood the Mission's desire to continue support of INE after the conclusion of the AES project, and offered the services of a team for two weeks to help define and design a program for Mission consideration. Microhydro and solar collector/hot water heaters were mentioned as R.E. technologies warranting continued support because of local private sector manufacturing and commercialization participation.

(Source: State Department telegram, 8/86, PDKAH804)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: April 1987 (jrl)

---------- AID RENEWABLE ENERGY DATA BASE ----------

1. Project Number: 5200245 2. Geo: GUATEMALA

3. Title: RURAL ENTERPRISES DEVELOPMENT

4. Project Life/PACD: 1979-84(extended to 86)/December 31, 1986

5. Status: Terminated

6. LOP Funding (US$000):

   A. Entire Project: 6,200

   B. R.E. Components: Not specified

   (Sources: Incoming Telegram, 1/84, PDKAA888; Amendment No. 2 to Loan Agreement, 9/11/86, PDKAH347)

7. Loan or Grant/Appropriation Category (US$000):

   G / FN / 850
   L / FN / 5,350

   (Sources: Incoming Telegram, 1/84, PDKAA888; Amendment No. 2 to Loan Agreement, 9/11/86, PDKAH347)

8. Project Purpose:

   To develop and expand artisan and small rural enterprises by improving the access of such firms to credit, appropriate technology, and related technical assistance.

9. Renewable Energy (R.E.) Outputs:

   Sub-loans to enterprises; Credit to small and medium sized firms through Bank of Guatemala; Credit line for artisans and small entrepreneurs; Training in financial administration and production for entrepreneurs; Regional courses in business development areas; Credit agents trained; Appropriate technology prototypes developed, tested, and disseminated; Artisan marketing system developed.

10. R.E. Inputs:

   Credit; Technical assistance.

11. Summary of R.E. Components:

The project was designed to assist expansion of small rural industries and artisan enterprises by making credit and technical assistance available. Small loans were to be made available by the National Finance Corporation (CORFINA). The National Skills Training and Productivity Institute (INTECAP) was to organize credit education and promotion and provide individual technical assistance to entrepreneurs. The National Economic Planning Council (SENEPLAN) was to conduct policy studies, hold appropriate technology seminars, and develop and disseminate 12 appropriate technology prototypes/models.

The project has encountered implementation problems. The institutions, and their inexperienced staffs, were not prepared to carry out their tasks, and political unrest in the targeted area of the western highlands complicated implementation. By mid-1983, three years after the project had begun, little progress had been made. CORFINA had made few loans, and the delinquency rate was high (12% vs. 2% planned). Appropriate technology prototypes were to include, among other things, improved stoves and solar heaters. Three prototypes had been developed; however, the project literature does not specify which ones.

A project redesign, based on recommendations from a July 1983 evaluation, resulted in a Project Paper Amendment. Medium sized firms were added to the loan portfolio to bring down administration costs. SENEPLAN, which was not an implementing agency by nature, turned over development and dissemination of appropriate technologies to INTECAP. The number of technologies to be developed was dropped from 12 to 10. Credit, technical assistance, and technologies were to be aimed at growth industries and away from shops in the "informal sector." A special credit fund for artisans and small entrepreneurs was established within CORFINA. The project geographical area was expanded beyond the western highlands.

(Sources: Project Paper Amendment, 1/84, PDKAA880; DIS)

12. R.E. Project Descriptors:

Solar heating; Stoves.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings:

A. Consultant's Final Report, Reprogramming of the Rural Enterprises Development Project. George Morelos, GAMCO Inc., July 1983. (Not reviewed; mentioned in Project Paper Amendment, p. 5, PDKAA880)

B. Project Implementation Evaluation, September 1982. (Not reviewed; mentioned in Project Paper Amendment, p. 4, PDKAA880)

16. Key Persons:

A. AID/Washington: Not specified

B. AID/Mission:

Dr. Gilberto Mendez, Project Officer
Lawrence Odle, Energy Officer

C. Contractors: Not specified

D. Host Country:

Roberto Sandoval, Project Coordinator
Leonel Hernandez Cardona, Secretary General, INTECAP
Juan Gerardo Ponciano Gomez, General Manager, CORFINA

17. Obligations by Fiscal Year (US$000):

Projection of Expenditures by Year for Entire Project

	LOAN	GRANT	TOTAL*
YR 1	710	234	944
YR 2	1,240	294	1,534
YR 3	1,735	264	1,999
YR 4	1,660	256	1,916
YR 5	1,655	122	1,777
TOTAL	7,000	1,170	8,170

*Does not reflect adjustments made to LOP funding. See Revisions, below, for details.

(Source: Project Paper, 6/24/78, PDKAA880)

18. Host Country Funding of R.E. Components (US$000): Q3,110,000*

*Local currency, for entire project; R.E. costs not specified separately.

(Source: Amendment No. 2 to Loan Agreement, 9/11/86, PDKAH347)

19. Summary of R.E. Costs (US$000):

By Category, Revised Projections (1/84) for Grant:
Revised Projections (9/86) for Loan:

	GRANT*	LOAN**	TOTAL
Credit Fund	0	5,051.1	5,051.1
Technical Assistance			
To Enterprises	313.5	130.6	444.1
To Implementing Institutions	118.6	0	118.6
Handcrafts Market	127.2	125.0	252.2
Appropriate Technology	290.7	43.3	334.0
TOTAL	850.0	5,350.0	6,200.0

(Note: Figures reflect deobligation of $320,000 in grant funds.

(Source: *Incoming Telegram, 1/84, PDKAA888; **Amendment No. 2 to Loan Agreement, 9/11/86, PDKAH347)

20. R.E. Component Revisions:

A. PACD extended from September 10, 1984, until September 10, 1985.

(Source: Project Grant Agreement, Amendment No. 5, 3/84, PDKAA884)

B. Original funding approved was $8,170,000 ($7 million loan and $1,170,000 grant). The Project Paper Supplement indicated total LOP funding of $7,170,000 ($6 million loan and $1,170,000 grant).

(Sources: Project Paper, 6/24/78, PDKAA880; Project Paper Supplement, 1/20/84, PDKAA880)

C. The project was redesigned in late 1983 and a Project Paper Supplement approved on January 1, 1984. The supplement extended credit to medium-sized businesses. To ensure that small businesses still had access to loan funds, $584,000 was reduced from the Central Bank credit

fund and shifted to CORFINA's credit fund for small business use.

(Source: Incoming Telegram, 1/84, PDKAA888)

D. Due to continuing resolution restrictions on new grant funds to Guatemala in FY84, $320,000 in grant funds were removed from the budget. Those funds will be included if restriction is lifted for FY85.

(Source: Incoming telegram, 1/84, PDKAA888)

E. PACD extended from September 10, 1985, until June 30, 1986

(Source: Implementation Letter No. 47, 1/17/86, PDKAA893)

F. Number of appropriate technology prototypes to be developed, tested and disseminated dropped from 12 to 10.

(Source: Project Paper Amendment, 1/84, p. 12, PDKAA880)

G. PACD extended from June 30, 1986, until December 31, 1986, for financial considerations. Over $2 million remained in the pipeline as of June 30, 1986.

(Source: Telephone conversation with AID/W/LAC, 8/21/86)

H. $650,000 in loan funds designated for credit activity were deobligated, leaving $5,350,000 in total project loan funds.

(Source: Amendment No. 2 to Loan Agreement, 9/11/86, PDKAH347)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: August 1986 (mgz)
Revised January 1987 (jrl)

1. Project Number: 5200274 2. Geo: GUATEMALA

3. Title: HIGHLANDS AGRICULTURAL DEVELOPMENT

4. Project Life/PACD: 1983-90/September 30, 1990

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 15,600

   (Source: Loan Agreement No. 3, 9/27/86, PDKAH365; Grant Agreement Amendment No. 1, 1/9/85, PDKAB060; Grant Agreement Amendment No. 2, 9/27/86, PDKAK364)

   B. R.E. Components: 500

   (Sources: Project Paper, 6/83, PDKAB056; Project Paper Amendment, PDKAB057)

7. Loan or Grant/Appropriation Category (US$000):

   G / ARDN / 2,100
   L / ARDN / 13,500

   (Sources: Grant Agreement Amendment No. 1, 1/9/85, PDKAB060; Grant Agreement Amendment No. 2, 9/27/86, PDKAK364; Loan Agreement No. 3, 9/27/86, PDKAH365)

8. Project Purpose:

   To improve the productive resource base of the rural poor in the Highlands.

9. Renewable Energy (R.E.) Outputs:

   Trained community reforestation committees; 200 hectares of improved reforested areas, providing fuelwood.

10. R.E. Inputs:

    Technical assistance; Commodities; Training; Labor payments; Credit; Studies, evaluations, audits.

11. Summary of R.E. Components:

    The Highlands Agricultural Project was designed to improve the productive resource base of the rural poor in the highly

populated Western Highlands, and thereby increase agricultural productivity. The project has three components: (1) Soil conservation, small-scale irrigation, and other agricultural activities, which will be administered by the Direccion General de Servicios Agricolas (DIGESA); (2) The Direccion General de Caminos, through its Rural Roads Department (DCR), will improve rural access roads; and (3) The Instituto Nacional Forestal (INAFOR) will implement a forestry component.

INAFOR will establish at least 14 communal forests, in separate communities, comprising a total of 200 hectares. Fast-growing fuelwood species (aliso, fresno, cherry, and eucalyptus) will be planted. All unskilled labor will be provided on a volunteer basis from the beneficiary communities. The goal is to help assure a long-term profitable supply of fuelwood for about 800 farmers. Long and short term training will be provided to INAFOR personnel.

12 R.E. Project Descriptors: Firewood.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

Jim Hester
LAC/DR, Room 2239 NS, Washington, D.C., 647-8279

B. AID/Mission:

G.E. Like, Office of Rural Development
H.E. Wing, Office of Rural Development
USAID/Guatemala, American Embassy
Guatemala City, Guatemala

C. Contractors: Not specified

D. Host Country:

Nector Heraldo Fajardo, General Manager
National Forestry Institute (INAFOR)

17. Obligations by Fiscal Year (US$000):

A. Projected expenditures for original LOP total of $9 million:

	FY84	FY85	FY86	FY87	FY88	TOTAL
LOAN	3,232	1,186	1,138	1,212	732	7,500
GRANT	710	310	310	110	60	1,500
TOTAL	3,942	1,496	1,448	1,322	792	9,000

(Source: Project Paper, Annex F(2), p. 1, 6/83, PDKAB056)

B. Annual projection of expenditure for reforestation component (FY not specified):

YR 1	YR 2	YR 3	YR 4	YR 5	TOTAL
157	168	113	62	0	500

(Note: When project funding increased, no new funding was obligated to reforestation.)

(Source: Project Paper, 6/83, pp. 40-41, sum of lines 2 and D1, PDKAB056)

18. Host Country Funding of R.E. Components (US$000): 158

(Source: Project Paper, 6/83, p. 23, PDKAB056)

19. Summary of R.E. Costs (US$000):

A. By Category, Entire Project (not reflecting increases in loan and grant):

	LOAN	GRANT
Technical Assistance	345	1,150
Commodities	3,427	0
Training	41	0
Labor Payments	2,473	0
Credit	1,000	0
Studies, Evaluations, Audits	214	350
Road Reconditioning	3,000	0
TOTAL	10,500	1,500

(Source: Activity Data Sheet attached to Advice of Program Change, 6/83, PDKAB063)

B. For Reforestation:

	USAID	GOG
Labor Intensive Wages	210	23
Commodities	29	1
Rotating Fund	50	0
In Country Training	11	0
Technical Assistance	200	0
GOG Personnel Costs	0	71
Land (Municipalities)	0	63
TOTAL	500	158

(Source: Project Paper, 6/83, pp. 22-23, PDKAB056)

20. R.E. Component Revisions:

A. LOP funding increased from $9 million to $12 million.

(Source: Advice of Program Change, 6/83, PDKAB063)

B. Area to be reforested increased from 125 to 200 hectares, with costs amounting to $200,000 in AID loan funds and $145,477 in GOG counterpart funds. Long and short term training will also be provided to INAFOR personnel, with $285,000 AID grant funds and $61,220 in GOG counterpart funds budgeted for this activity.

(Source: Amendment No. 2 to Project Grant Agreement, 9/27/86, PDKAH364)

C. PACD extended to September 30, 1990.

(Source: Amendment No. 2 to Project Grant Agreement, 9/27/86, PDKAH364)

D. Loan increased to $13.5 million in order to increase funds for Soil Conservation, Small-Scale Irrigation Systems, Reforestation, and Labor Intensive Road Maintenance Project activities.

(Source: Loan Agreement No. 3, 9/27/86, PDKAH365)

E. Grant increased by $600,000.

(Source: Grant Agreement Amendment 2, 9/27/86, PDKAK364)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: August 1986 (mgz);
Revised March 1987 (jrl)

1. Project Number: 5220071 2. Geo: HONDURAS

3. Title: FEASIBILITY STUDY LOAN

4. Project Life/PACD: 1966-75/PACD not specified

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 440*
   1,000**

   B. R.E. Components: Not specified

   (Source: *DIS; **Capital Assistance Paper, 4/11/69, PDAAF451)

7. Loan or Grant/Appropriation Category (US$000):

   L / AL / 440

   (Source: DIS)

8. Project Purpose:

   Expansion and improvement of the capacity of the Government of Honduras (GOH) for rural development and administrative planning.

9. Renewable Energy (R.E.) Outputs:

   Economic programs designed and implemented; Prefeasibility studies prepared, including study on use of windmills in ground water development; Natural resources surveys.

10. R.E. Inputs:

    Technical assistance.

11. Summary of R.E. Components:

    This loan was extended to the Government of Honduras to carry out feasibility studies of high priority in the economic and social development of Honduras. The Superior Council for Economic Planning (CONSUPLAN) was the GOH agency responsible for the project.

The feasibility studies concentrated on four areas: roads, irrigation, ground water development, and industrial studies. Within the ground water component, the use of windmills, which are sited on wells and ponds, was studied. The windmills were to be integrated into the irrigation effort. Each study was to contain all elements of a project design paper so that funding could be easily requested for further development.

An amendment to the original project expanded the areas of study to include, among other topics, natural resource surveys and forest products studies.

12. R.E. Project Descriptors:

    Windmills.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

    A. AID/Washington: Not specified

    B. AID/Mission:

       Van Dyne McCutheon and Paul W. Fritz, Loan Officers
       William S. Gardner, Jr., Engineer
       USAID/Honduras

    C. Contractors: Not specified

    D. Host Country: Not specified

17. Obligations by Fiscal Year (US$000): Not specified

18. Host Country Funding of R.E. Components (US$000): Not specified

19. Summary of R.E. Costs (US$000):

Distribution among proposed feasibility study areas for entire project:

Transportation	80
Agriculture	
Irrigation	130
Natural Resources Surveys	100
Industry	
Forest Products	100
Foundries & Metal Working	50
Tourism	100
Others	
Rural Development	300
Private Sector	140
TOTAL:	1,000

(Source: Capital Assistance Paper, 4/11/69, pp. 1-6, PDAAF459)

20. R.E. Component Revisions:

A. Areas of study expanded when loan was doubled in 1969. Studies in natural resource surveys, forest products, foundries and metal working, and tourism were added.

(Source: Capital Assistance Paper, 4/11/69, PDAAF451)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: September 1986 (mgz)

1. Project Number: 5220157 2. Geo: HONDURAS

3. Title: RURAL TECHNOLOGIES

4. Project Life/PACD: 1979-82 (extended to 88)/September 25, 1988

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 9,000

   B. R.E. Components: Not specified

   (Source: Project Paper Amendment, 7/84, PDKAB459)

7. Loan or Grant/Appropriation Category (US$000):

   G / ARDN / 9,000

   (Source: DIS)

8. Project Purpose:

   To increase small farm utilization of labor and land through use of improved light farm implements and structures; To increase small-scale rural industrial productivity and employment through introduction of improved productivity and management systems for existing small enterprises and through the establishment of new pilot enterprises; To increase utilization by rural poor of low-cost appropriate technologies or products designed to improve the quality of life.

9. Renewable Energy (R.E.) Outputs:

   Development, adaptation, and dissemination of technologies appropriate for small farmers, rural enterprises, and homes (including waterwheels, hydraulic rams, solar dryers, wood stoves, and animal-powered pumps); Delivery system for management and technology advisory services for small enterprises; Long-term educational capacity of post-secondary institutions in appropriate technology development/ industrial training; Evaluation/planning capacity established in industrial development center.

10. R.E. Inputs:

Personnel; Technical assistance; Training; Commodities; Other costs.

11. Summary of R.E. Components:

This project is designed to develop and disseminate new technologies to enhance utilization of land and labor in agriculture, increase industrial productivity, and improve the quality of life among the rural poor. The implementing agency is the Center for Industrial Development (CDI), a semi-autonomous Government of Honduras (GOH) agency. The Rural Technologies Project (PTR - Programa de Tecnologias Rurales) was created within CDI to administer the project through six zonal offices and several PVOs.

New technologies to meet the needs of small farmers, small rural enterprises, and the rural poor were to be developed, field tested, and disseminated on a wide scale. Agriculture and industry were to be the priorities, but most distributed technologies were for the rural poor. Waterwheels for improved irrigation, animal-drawn plows and dump carts, hydraulic rams, solar dryers, and wood stoves were widely distributed.

The Small Farmer Technology Project (5220123) was absorbed by this project.

12. R.E. Project Descriptors:

Waterwheels; Animal traction; Stoves; Hydraulic rams; Water pumps; Crop driers; Solar energy; Irrigation; Food preparation.

13. R.E. Technology Applications:

A. By the end of 1984, 13,331 reproductions of the prototype technologies had been disseminated; 90% of these were for the home, such as wood stoves and hand corn shellers. Only 1,296 of them were for agriculture, and only 194 for industry. The following chart shows some of the R.E. technologies disseminated and the number of families that benefited:

R.E. Technology	Families Benefiting As of 1/84	Total Planned (LOP)
Waterwheels	219	300
Hydraulic rams	23	200
Gravity irrigation	326	1,000
Hand or animal powered pumps	14	200
Silos and solar driers	1,686	4,000
Fuel-saving wood stoves	1,394	2,000

(Sources: Audit Report, 9/85, PDAAR807; PES, 5/81, Table 1, PDKAB459)

B. A sample survey of technologies performed by Winrock International in early 1986 revealed that the "noria" (waterwheel) was the most common irrigation technology used. It was capable of lifting about 30 gpm of water 10-15 feet from a swift mountain stream to irrigate one manzana (1.7 acres) or more. The noria cost from L1,200* to L1,800 (US$375-US$562) per acre. An equivalent small gasoline pump would cost about L1,200 to purchase and would require about 1,000 hours of operation per manzana. The norias were economical under conditions of a swift stream, low banks, and suitable adjacent land, and were superior to small pumps and larger gravity projects in steep, narrow valleys; they were also somewhat cumbersome and difficult to remove from the stream, and several had been destroyed by high water during sudden storms. At least two farmers reported that they were able to pay for their wheels with just two crops.

*Official exchange rate was Lempiras L2 = US $1; no explanation given for discrepancy.

(Source: Impact Evaluation, 3/8/86, pp. 4-24 to 4-27, PDKAH426 or PDKAH427)

C. The Winrock survey also reported that of 144 respondents, 141 were still using new Lorena stoves; only 3 had discontinued use of it. Nearly 91% of the respondents had used a typical "fogon" type of stove prior to adoption of the Lorena; the remainder had used either an open fire or an electric cooking device. The survey data revealed that average wood consumption had decreased from 140 sticks/week with the open fire to 58 sticks/week with the Lorena. Annual savings were estimated at L292.76. Approximately 3,214 Lorena stoves had been disseminated for the period 1980-1984, and 348 in 1985. It was projected that 1,000 additional Lorena stoves would be

disseminated in the period 1986-1988. Statistics on stove use and cost benefits are provided in the source.

(Source: Impact Evaluation, 3/8/86, PDKAH426 OR PDKAH427)

14. R.E. Technical Reports and Publications:

A. Diagnostics of Honduran Agricultural Mechanization. Swiss Cooperation Development Center (COSUDE). This report was mentioned in the Project Evaluation Summary, 8/83, p. 3, PDAAN988, but no copy was obtained.

An exhaustive technical assessment of the state of machine and animal traction in Honduras.

15. Evaluations/Major Findings:

A. Project Evaluation Summary for the Period September 1979-December 1980. R.F. Gomez, V. de Beausset, M. Scott, P. Deinken, D. Bernius, L. Ruelas, and J. Hanks, USAID/GOH, May 1981, 42 pp., PDAAJ773.

Organizational problems were just being overcome and technology dissemination was underway. Reports (in Spanish) of various GOH agencies are attached as appendices.

Major findings:

- Management of the project was awkward with six GOH agencies involved; agencies should participate more in project design.

- GOH institution building is difficult and time-consuming; more work should be done by private, non-governmental agencies.

- New technologies development and dissemination levels were unrealistically high, but emphasis is now placed on implements or technologies with highest impact.

- An integrated system of farm implements and technologies should be distributed to ensure major increases in small farmer production capabilities.

- There is a need to link technology development efforts to the private enterprise sector, accelerating the flow of technological improvements to the rural poor.

B. Evaluacion del Programa de Tecnologias Rurales (in Spanish). Rosa Maria de Lanza, Dora de Suarez, Oscar Montes, et al., Tegucigalpa, February 1981, XDAAJ773-B.

During the first year of the project, nine prototype farm implements were fabricated, of which the waterwheel was considered the most important for Honduran rural development. Criteria were developed for selecting committees to demonstrate multiple-use stoves. A study on a wood dryer was begun. A proposal was made for testing prototype grain dryers and hydraulic rams; a grain dryer was successfully tested, but a lower cost design with higher capacity was being investigated. The Instituto de Formaciol'n Profesional (INFOP) provided various courses, including one on waterwheel construction. Recommendations included the need to locate institutions to undertake technology testing.

C. Project Evaluation Summary for the Period September 1979-July 1983. R. Culbertson, E. Jones, P. Fraser, V. de Beausset, R. Baum, O. Hernandez, and J. Herrero, Development Associates Inc. with USAID/Honduras and PTR staff, August 1983, 17 pp., PDAAN988.

The project was well under way, but facing problems.

Major findings:

- Providing new implements free to some farmers for demonstration purposes has proven counterproductive; other farmers awaited the next give-away.

- With credit available only to farmers with moderately large tracts of land (five manzanas or more), the vast majority of small independent farmers are left out of the program.

- The decision to delay introduction of the Experimental Credit Activity until the third year of the project was deemed unbeneficial; instead, technical assistance should be linked with credit.

- Small enterprises have benefited as new farm implements have been purchased through or constructed by these firms; some credit has been made available to these small enterprises.

- The possibility of using PVOs as primary implementing agencies should be discarded. PVOs have made a valuable contribution to project implementation by targeting opportunities and easing administrative load; a PVO, however, is not as good as the primary implementing agency, because too few people would be reached; the central PTR must handle implementation.

- Institution building should not concentrate solely on top management, which changes with national politics; middle-level managers should receive more training.

D. Audit Report for the Period September 1979-March 1985: Review of USAID/Honduras' Rural Technologies Project. C.N. Gothard Jr., USAID Regional Inspector General for Audit/Tegucigalpa, September 27, 1985, 29 pp., PDAAR807.

This is a program-results audit to determine if the project has obtained the objectives specified in the project agreement.

Major findings:

- Relatively few implements in the priority areas of agriculture and industry were disseminated; many of those disseminated were not working.

- Excessive dollar funds were advanced, increasing borrowing costs substantially; creation of a local currency revolving fund to handle disbursement needs is recommended.

- Internal control is weak in some implementing agencies; the agencies should follow the recommendations specified in evaluations.

E. Impact Evaluation of the Honduras Rural Technologies Project. James B. Fitch et al., Winrock International, March 8, 1986, 181 pp., PDKAH426 or PDKAH427.

USAID/Honduras had this special evaluation conducted following the critical Regional Inspector General's audit (PDAAR807, see above), with which the Mission did not agree.

The evaluation team found that by February 1986 more than 8,500 technologies had been distributed, with Lorena stoves accounting for almost half of these. Based on a sample field survey of 291 participants, it was estimated that 81% of all technologies were used regularly, and 7% used sometimes; in more than 90% of the cases the Lorena stove was always being used. It was estimated that the project would achieve a benefit-cost ratio of 1.22 (2.18 assuming modest diffusion to non-participants) over a 20-year period. The overall average benefit per technology was calculated at L263 (US$132) per year during the first seven years of the project. In other words, assuming an average of 1.7 technologies per family, the average annual income per family per year would increase by L447 (US$224).

Only $27,000 of the $4 million allocated for loans had been lent due to delays in arranging with a private bank to administer the loans, and the evaluators stressed the importance of supporting the credit program.

The project demonstrated that marginal rural poor could be reached through a project operating outside of established institutional channels. Initially, there was too much emphasis on too many technologies, but this problem was being addressed through the implementation of the Farming Systems Methodology. Institutionally, it was recommended that PTR give serious consideration to restructuring itself into a private voluntary organization oriented toward seeking future funding.

Sixteen recommendations are provided. The final one concerns renewables: PTR should intensify its efforts to identify a suitable animal drawn plow to be incorporated into soil conservation and improved farming practices.

16. Key Persons:

A. AID/Washington:

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LAC/DR, Room 2239 NS, 647-8279

B. AID/Mission:

Val de Beausset, Project Advisor
Blair Cooper, Project Officer

C. Contractors:

Carlos Crisostomo
Servicios Tecnicos del Caribe

D. Host Country:

Juan Ramon Ponce, Project Manager

17. Obligations by Fiscal Year (US$000):

FY80	FY81	FY82	FY83	FY84	TOTAL
1,485	1,824	2,068	1,834	1,719	8,930

(Source: Project Paper, p. 63, PDKAB458)

18. Host Country Funding of R.E. Components (US$000): 2,250

(Source: Audit Report, 9/85, p. 1, PDAAR807)

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19. Summary of R.E. Costs (US$000):

A. Estimated expenditures, by component:*

Personnel.....	2,770
Technical Assistance....	1,350
Commodities.....	350
Training.....	410
Small Enterprise Fund...	3,500
Other Costs.....	550
TOTAL	8,930

*For entire project; R.E. costs not specified separately.

(Source: Action Memorandum, 8/79, with Project Paper, PDKAB458)

B. Estimated expenditures, by activity:*

Development Adaptation and Info.	1,240
CDI Program Services Division	2,958
Small Farmer and Small Businessmen Training	100
Small Enterprise Development Fund	1,152
Appropriate Technology Development, Adaptation, and Dissemination Fund	1,703
Human Resources Development	0
Small Industry Advisory Office	30
CDI Studies Division	892
MOE policy analysis Unit	49
Administration and Coordination	876
TOTAL	9,000

*For entire project; R.E. costs not specified separately.

(Source: Project Amendatory Agreement No. 8, 3/15/86, PDKAH424)

20. R.E. Component Revisions:

A. PACD extended from September 25, 1982, to June 25, 1983.

(Source: Action Memorandum, 10/81, PDKAB464)

B. PACD extended from June 25, 1983, to March 31, 1984.

(Source: Action Memorandum, undated, PDKAB464)

C. PACD extended to September 25, 1988.

(Source: Project Paper Amendment, 7/84, PDKAB459)

D. LOP funding increased to $9,000,000.

(Source: Project Paper Amendment, 7/84, PDKAB459)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: August 1986 (mgz)
Revised March 1987 (jrl)

---------- AID RENEWABLE ENERGY DATA BASE ----------

1. Project Number: 5220166 2. Geo: HONDURAS

3. Title: RURAL WATER AND SANITATION

4. Project Life/PACD: 1980-84 (extended to 87)/December 31, 1987

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 20,700

   B. R.E. Components: 380

   (Sources: Project Agreement Amendment, 7/85, p. 1, PDKAB515; Evaluation, 5/86, Exhibit 8, p. 26, PDAAU780)

7. Loan or Grant/Appropriation Category (US$000):

   G / HE / 1,200
   L / HE / 19,500
   L / PH / 3,800*

   (Source: DIS; *No mention in project literature of this loan as noted in DIS)

8. Project Purpose:

   To expand access to, and use of, safe water systems and human waste disposal systems in rural Honduras.

9. Renewable Energy (R.E.) Outputs:

   Windmills/piped-water systems installed; Photovoltaic water pumps/piped-water systems installed.

10. R.E. Inputs:

    Construction materials; Equipment; Technical assistance; Training; Budget support.

11. Summary of R.E. Components:

    The Rural Water Supply and Sanitation Project (PRASAR) was designed to improve the health status and practices of rural people in five northwestern departments of Honduras through full community participation in all aspects of water supply and sanitation installations. The project is carried out by

a committee made up of one USAID project coordinator and three project directors--one responsible for water supply and sewage system inputs from the National Water Supply and Wastewater Disposal Service (P/SANAA), one for inputs of privies, wells, and windmills from the Ministry of Health (P/MOH), and one for the health education and training inputs (P/OHE).

The project originally called for 25 windmills to be installed on water supply systems, primarily for investigative purposes. On July 30, 1983, the project was amended, essentially doubling funding and targets. Fifty windmills were anticipated. This was reduced, in 1986, to only 7 windmills which had already been installed.

In January 1983, an OPG was granted to the Pan American Development Foundation (PADF) and Volunteers In Technical Assistance (VITA) for an integrated rural development project on Bay Islands. Water work was carried out by VITA on the island of Roatan. Originally, VITA was to install 15 windmill systems using Baker windmills obtained by the USAID Mission before initiation of the project. A Baker windpumper was installed in Milton Bight, Brick Bay, Juticalpa, and two in Los Fuertes and in Spanish Town. Significant problems were encountered due to design faults and rusting of the windmills before project initiation. USAID concurred with VITA in June 1985 that the Baker windmills were unreliable and agreed to try other options. Consequently, fourteen water supply systems were built; five pumped water with windmills, five others used solar pumps, and the other four used diesel or electric power. Additional development work and maintenance of existing systems were taken over by the local authority, Asociacion Pro-Desarrollo de las Islas de la Bahia (APRODIB).

12. R.E. Project Descriptors:

Wind energy; Photovoltaic energy; Solar energy; Water pumps; Windmills.

13. R.E. Technology Applications:

A. On the island of Roatan, windmills and solar pumps were installed to pump water from wells into piped rural water supply systems:

- o A 12-foot, 16-blade Baker windmill (through SANAA/PRASAR) with Model 50AP Heller-Aller force pumps was installed in Brick Bay, in Juticalpa, and in Milton Bight. Two were installed in Los Fuertes and in Spanish Town. The 2 in Spanish Town were

replaced by electric submersible pumps, when it was discovered that the grid was not too far from the site. One in Los Fuertes was not operational.

Significant problems were encountered with the Baker windpumpers. The windmills, purchased prior to the project's start-up, had rusted considerably before receipt by the project, resulting in weakened key parts. Moreover, the Baker windmills were poorly designed, with a brake assembly that broke easily, and with a tailspring assembly that prevented the windmill from furling out of the wind easily at high wind speeds.

- A 14-foot Dempster windpumper with 40-foot tower was installed in Gravel Bay and in Jonesville. The one in Jonesville was replaced by a solar pump (see below) after the well went bad and a new well was drilled at a site with poor wind resources.

- Photovoltaic (PV) pumps were installed at five sites. The systems at Pollytilly Bight and Sandy Bay were identical, consisting of 27 ARCO Solar M51 modules wired three in series and nine in parallel in a fixed array, and a Jacuzzi Solar Flow Pump/Motor set (S425-17/1000 WDH with SJ-1 motor). The Pollytilly Bight system was designed to pump 3,000 gallons of water per day from a depth of 140 feet under worst-case insolation conditions of 4.6 kilowatt-hours per day; water is pumped into a 10,000 gallon storage tank. The only difference between the two systems is that the Sandy Bay pump had more residents to serve, so it was supplemented by an electric pump powered by a diesel generator located at a small local hotel. The PV pumping system at Corazol contained 28 ARCO Solar M75 (47 Wp) modules wired in a fixed array, coupled to a Jacuzzi SJ-2 motor/C14 pump. At Diamond Rock the initial pump was a Jacuzzi with SJ-2 motor. This was replaced in 12/86, after the motor failed twice, with a Grundfos SP2-18 with 3 HP AC motor and inverter, which was much more reliable. The PV system consisted of 28 ARCO Solar M75 modules connected to 4 Zomeworks passive trackers. At Jonesville the system consisted of a Jacuzzi SJ-2 motor/D10 pump set connected to 24 ARCO Solar M75 modules in a fixed array.

  At the end of 1986 all of the Jacuzzi pumps were experiencing difficulties with the DC motors. The Jacuzzi SJ-1 first generation motors had been operating in Sandy Bay since December 1983 and in Pollytilly Bight since January 1984. They appeared to be outlasting the second generation motors, which

were installed in April and May of 1986. VITA provided partial funding from its own resources for the Diamond Rock Grundfos replacement pump, which was more expensive than the Jacuzzi. USAID said that no further funds would be available to remedy the pump motor problems at the other PV pumping sites.

(Sources: Evaluation, May 1986, PDAAU780; Final Report, 7/86, PDAAJ781; ARCO Solar News, Summer 1984, Vol. 4 No. 2, p. 10; VITA home office files; conversations of 3/2/87 with Robert Noth, VITA Program Officer for Latin America and the Caribbean, and Tim Ball of Solar Engineering Services, P.O. Box 7122, Olympia, WA 98507; conversation of 3/3/87 with Ed Kennell, Clean Energy Products, 3534 Bagley N., Seattle, WA 98103)

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings:

A. Project Evaluation Summary. W. Turner, A.G. de Rothkaegel, C. Pineo, H. Van, W. Smith, WASH and Creative Associates, Washington, D.C., January 1983, 13 pp., PDKAB529 or PDAAP216.

At the time of this mid-term project evaluation, only 2 of the 25 originally planned windmills had been installed. The evaluators recommend increasing the number of windmills to be installed from 25 to 50.

B. Diagnostics and Recommendations for Rural Water and Sanitation Systems in Honduras. C. Pineo and H. Van, WASH, 1611 N. Kent St., Arlington, VA., January 1983, 55 pp., PNAAM066.

At the time of this comprehensive project evaluation, no windmills had been installed. However, it is planned that VITA will install 5 on the mainland as a reasearh project. An additional 20 windmills are programmed for installation on the Bay Islands, which have a more favorable wind regime.

C. Evaluation of the Bay Islands Integrated Rural Development Project. (OPG 522-0233). L.S. Berliner and J.A. Haratani, WASH, 1611 N. Kent St. Arlington, Virginia, May 1986, 75 pp., PDAAU780.

Describes the efforts made by PADF, VITA, and the local authority, APRODIB, in water supply, sanitation, health, small business, and institutional development on the Bay Islands. Most work has been conducted on the island of Roatan. Fourteen water supplies have been established by VITA; five pump water with windmills, five others use

solar pumps. Design of the systems is briefly described. Major findings were: 1) it was twice as hard to undertake a project in the Bay Islands than on the mainland due to lack of strong government involvement; 2) a successful island project should be as self-contained and self-sustaining as possible, with outside links receiving special attention; 3) a development project should not be limited to using equipment which has not been properly tested for the specific environment; 4) development projects should not be limited to one technology; and 5) the islanders will have to become more aware of the central government and its workings to gain more support from it.

The evaluators made three recommendations concerning the water supply component: 1) APRODIB obtain the services of a consultant engineer to train a Honduran engineer to be staffed on a permanent basis; 2) efforts be made to hire additional, proven field construction supervisors; and 3) APRODIB place the water and sanitation function under the general guidance of the Executive Director as a dependent but separate cost center.

D. Bay Islands Integrated Rural Development Project: Final Report on Water and Sanitation Activites. J.M. Downey, VITA, Arlington, Virginia, July 1986, 11 pp. plus appendix, PDAAU781.

Describes activities in the 14 communities that received water supply systems. An appendix contains comments and corrections to the May 1986 evaluation.

16. Key Persons:

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D. Host Country:

Nelson Alberto Flores, Director
PRASAR/SANAA

Emilio Silvestri, Executive Director
APRODIB

17. Obligations by Fiscal Year (US$000):

	FY80-83	FY84	FY85	FY86	FY87	TOTAL
LOAN	5,500	3,800	3,800	3,800	2,600	19,500
GRANT	490	130	200	200	180	1,200
TOTAL	5,990	3,930	4,000	4,000	2,780	20,700

(Sources: Implementation Letter No. 89, 1/84, PDKAB521; Advice of Program Change, 4/85, PDKAB518)

18. Host Country Funding of R.E. Components (US$000): 10,462*

*For entire project, R.E. costs not specified separately.

(Source: Project Amendatory Agreement No. 4, 8/22/86, p. 2, PDKAH429)

19. Summary of R.E. Costs (US$000):

By Category:*

	GRANT	LOAN
Construction and Design.....	0	16,679
Maintenance and Operation.....	0	1,500
Technical Assistance.....	680	345
Training and Education.....	520	476
Contingency.....	0	500
TOTAL	1,200	19,500

*For entire project, R.E. costs not specified separately.

(Source: Project Amendatory Agreement No. 4, Article C, p. 1, 8/22/86, PDKAH429)

20. R.E. Component Revisions:

A. PACD extended from March 31, 1984, to December 31, 1987.

(Source: Implementation Letter No. 79, 8/83, PDKAB521)

B. Grant funding increased by $200,000 to $1,200,000.

(Source: Project Agreement Amendment, 7/83, PDKAB515)

C. The original target of 50 windmills was reduced to the 7 already installed. This change was due to a lack of an appropriate number of suitable sites. Windmills already procured would be used for spare parts.

(Source: Project Amendatory Agreement No. 4, 8/22/86, p. 2, PDKAH429)

D. The OPG called for the installation of 15 water systems using Baker windmills previously purchased by SANAA/PRASAR. When the Bakers proved to be plagued with rusting and design problems, USAID initially insisted that the Baker windmills be used, and prevented, as stated in Implementation 85, the use of project funds for solar pumps. In June 1985, following a considerable number of Baker failures and expensive repairs, USAID agreed to consider the use of other pumping options, provided a technical and economic analysis of each option was conducted for each community. In February 1986, USAID/Honduras approved use of a variety of pumping options for communities on Roatan: windpumpers, solar pumps, grid-connected electric submersibles, gravity-flow systems, and hand pumps.

(Source: Final Report, VITA, 7/86, pp. 4-6, PDAAU781)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: August 1986 (mgz)
Revised January 1987 (jrl)
Revised March 1987 (jrl)

---------- AID RENEWABLE ENERGY DATA BASE ----------

1. Project Number: 5220168 2. Geo: HONDURAS

3. Title: NATURAL RESOURCES MANAGEMENT

4. Project Life/PACD: 1980-85 (extended to 89)/May 31, 1989

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 16,152

   B. R.E. Components: Not specified

   (Source: Incoming Telegram, Advice of Program Change, 3/86, PDKAB593)

7. Loan or Grant/Appropriation Category (US$000):

   G / ARDN / 3,900
   L / ARDN / 12,252

   (Source: Incoming Telegram, Advice of Program Change, 3/86, PDKAB593)

8. Project Purpose:

   To increase agricultural productivity, employment, and incomes of hillside farm families, and to strengthen institutional capabilities through which Honduras' natural resources are managed.

9. Renewable Energy (R.E.) Outputs:

   Community nurseries established and cooperatives/community organizations formed; Detrimental hillside farming practices stabilized; Environmental deterioration contained; Reforestation with permanent and semi-permanent tree crops accomplished; Data collection, analysis, and dissemination capabilities strengthened and improved; Natural resource policy and planning capabilities of the Government of Honduras strengthened and improved; 5,000,000 trees produced and planted.

10. R.E. Inputs:

   Technical assistance; Equipment and commodities; Personnel and training; Contingencies.

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11. Summary of R.E. Components:

The project, which is principally concerned with hillside agriculture and environmental conservation issues, is administered through the Government of Honduras (GOH) National Agriculture Committee (CNA). CNA was not formed until January 1984, however, four years after the agreement was signed. Technical assistance is provided by Chemonics International.

The project has three components: policy and planning, data collection and analysis, and watershed management. The watershed management component, the most successful of the three, is administered by the Natural Resources Management Project (NRMP) within the Ministry of Natural Resources (MNR). As part of watershed management, pine and fuelwood species are to be planted on approximately 4,000 hectares for lumber, firewood, protection of water sources, and as live barriers. Through 1985, half of the projected LOP 5 million seedlings were produced, and 407,000 multipurpose trees had been planted. To support these efforts, 12 reforestation nurseries and over 200 community organizations have been set up. The LOP target is to establish 264 community organizations, nurseries, and cooperatives.

The project provides technical assistance to fuelwood extractors, who, when complying with the project's technical guidelines, are temporarily exempted from paying an extraction tax to COHDEFOR (the GOH agency in charge of granting permission to harvest natural or naturally regenerated stands on both private and public property).

A Women in Development component, inactive at the project's beginning, succeeded in constructing 102 improved stoves through the end of 1985, with 330 more planned for 1986. In addition, an undetermined number of agroforestry projects have been completed.

12. R.E. Project Descriptors:

Firewood; Stoves.

13. R.E. Technology Applications:

A. By December 1985, 407,000 multipurpose trees had been planted on small hillside farms to supply fuelwood, forage, and soil conservation benefits. Interviews suggested a 70% survival rate. This agroforestry effort represented 60% of the 1985 forestry planting, up from only 16% of the 1984 tree planting effort.

(Source: Second Evaluation Report, p. 6-8, 3/86, PDKAH436)

B. Field demonstrations indicated that 20 trees of Leucaena, two and a half years old, yield 800 kg of biomass. This translates into 600 kg of dry weight firewood equivalent, sufficient to supply a family for four months.

(Source: Second Evaluation Report, p. 6-8, 3/86, PDKAH436)

C. Many women complained to the evaluation team about difficiencies in the Lorena stove design: too difficult and time-consuming to build; insufficient heating by the back burners; no wood savings (or in one case, consuming more wood); problem with small firebox requiring short pieces of wood; and lack of a platform in front of the stove to serve as a place for children to sit, for storing pots, and for piling firewood. At the same time, Vermont Partners of the Americas (project 5220227) had found success with a Costa Rican stove design. Its advantages include: a longer firebox; simple construction design incorporating a front platform; metal-covered burners that can be used directly for cooking tortillas, heat rapidly, and do not blacken pots (a characteristic found particularly desirable by the women); conservation of up to 50% of the firewood normally used; and a cost about the same as a Lorena stove or improved stove (about L15 for the Lorena, L20 for the Costa Rican design). The evaluation team suggested that the Costa Rican stove and other alternatives to the Lorena be explored.

(Source: Second Evaluation Report, pp. 6-43 - 6-44, 3/86, PDKAH436)

14. R.E. Technical Reports and Publications:

A. Fuelwood and Charcoal Supply, Distribution and Consumption in the Choluteca River Basin. Peter Hughes-Hallett, May 1980, 44 pp., PNAAX909.

Estimates are made for fuelwood and charcoal consumption and sources of supply in the villages, small towns, and cities and by the industrial users of the Choluteca River Basin. Numerous tables are included. Much of the data is based on interviews with producers, distributers, and households and on visits to small industries.

B. Manual Practico de Extension (in Spanish). Peter Hughes-Hallett, Proyecto Manejo de Recursos Naturales, Tegucigalpa, August 1986, 236 pp., PNAAX925.

This manual is a collection of ideas for extension workers, drawn in part from work on the Natural Resources

Management Project and on case studies from extension work in various Latin America countries. It covers diagnosing the situation; selecting technologies; promoting and training the producers; and working with groups and leaders. It is applicable to a wide range of groups working in extension with limited resources available and under a variety of conditions.

C. Final Report of Technical Assistance Consultancy. Paul Dulin, Chemonics International Consulting Division, Washington, DC, December 1986, 52 pp., PNAAW001.

This report summarizes the work performed from June 1983 to June 1986 by Paul Dulin, as Chief of Party, and from November 5 to December 15, 1986, during a follow-up consultancy he undertook. It includes recommendations to USAID/Honduras concerning future management and support of the Natural Resources Management Project (NRMP). Appendices include a list of project publications and a memorandum (in Spanish) to the NRMP Executive Director containing recommendations.

15. Evaluations/Major Findings:

A. Project Evaluation Summary. D. Badger and N. Agudelo, Winrock International; J. Warren and O. Hernandez, USAID/H; and C. Rivas, GOH-MNR; October 1984, 14 pp., PDKAB621.

This was the first formal evaluation of the project. Most progress has been made in the project's third component, watershed management. Nurseries have been established, and trees have been planted for fuelwood and lumber, soil and water conservation, and range and pasture management.

Major findings:

- Special attention should be paid to native species when selecting species for reforestation.

- Consideration should be given to trials of forestry species with multiple uses: fuelwood, forage, soil/water protection.

- Farmer response to tree planting and conservation has been more positive than expected; this may be due to the fact that the extension workers live in the rural communities they serve.

- Subsidies do not always work, especially in areas

where people associate reforestation and conservation as "make-work" activities; it is better to demonstrate benefits to the farmers.

- Solid technical assistance early in a project can solve or avoid many implementation problems.

B. Honduras Natural Resources Management Project Second Evaluation Report. Gregory L. Morris, Joshua C. Dickinson, et al., Tropical Research and Development, Inc. (TR&D), Gainesville, Florida, March 1986, 194 pp, (plus 22-page PES of 5/20/86), PDKAH436.

The evaluators report that the project is essentially on schedule, if the first two years of inactivity are discounted, and has made excellent progress in developing and implementing a program of rural extension and natural resource conservation. More than 3,000 farm families representing about 21,000 individuals have benefited from the project, which enjoys a benefit/cost ratio of 3.7. It was found that Chemonics had done an excellent job in providing technical assistance.

Lessons learned include:

- Neither clear land title nor availability of credit are prerequisites for an effective soil conservation program. Farmers will adopt improved technologies if shown tangible short-term to mid-term benefits arising from the improved technologies.

- To extend the benefits as quickly and cost-effectively as possible, para-technicians must be trained and dispatched to augment the efforts of professionals. This, coupled with a more selected use of subsidies, would permit eventual expansion of the technically sound project experience to a national scale within the budgetary constraints of the Ministry of Natural Resources.

- Institutions tend to become compartmentalized, and efforts must be made to share information between organizations and projects.

- Benefit/cost data should be gathered on a regular basis during project life in order to assess attainment of project objectives.

The evaluators recommend a Phase II of the project, leading eventually to a nationally integrated program. They specifically recommend, among other things, that a joint NRMP-COHDEFOR commission be created to establish

procedures for preparing simplified Forest Management Plans for fuelwood and timber production on small areas. Eight recommendations concern agroforestry:

(1) On-farm management techniques must be stressed.

(2) Species selection should be diversified to include more useful multi-purpose trees.

(3) Only the best and most appropriate genetic material should be obtained and used.

(4) Forest research activities at the Pan American Agricultural School should be expanded to include species trials, emphasizing multi-prupose legumes, to provide a basis for the expansion of species selection by the project.

(5) On-farm applied agroforestry trials should be established and closely monitored to develop an appropriate technology for hillside farms. This should include evaluating fast-growing fuelwood species. In addition to the production of brief research reports, this activity should also generate a silvicultural manual synthesizing species attributes and restrictions under distinct agro-forestry practices and climatic zones.

(6) The current trend of replacing centralized nurseries with decentralized ones operated by local farmers should be encouraged.

(7) Where appropriate, seed collection should be encouraged (possibly by subsidies) by local farmer groups for Leucaena, Gliricidia, and other local species for direct seeding.

(8) The Choluteca technical support coordinator should be supported and strengthened and should document results, emphasizing qualitative over quantitative goals (i.e., survival rates more than number of trees produced in nurseries or distributed).

For the Women in Development component, the evaluators suggested that different models of improved stoves be investigated.

16. Key Persons:

A. AID/Washington:

Jim Hester
LAC/DR, Room 2239 NS, 647-8279

B. AID/Mission:

John Warren, Project Officer

C. Contractors:

Paul Dulin, Chief of Party
Chemonics/Honduras

Jean Fiester
John Lamb
Chemonics, 2000 M St NW, Washington, D.C. 20036
(202) 466-5340

D. Host Country:

Carlos Rivas, Executive Director
Natural Resources Management Project

17. Obligations by Fiscal Year (US$000):

PROJECTED EXPENDITURES*

FY80	FY81	FY82	FY83	FY84	FY85	TOTAL**
1,213	3,495	2,759	2,347	2,414	2,767	14,995

*For entire project; R.E. costs not specified separately.

**Total does not reflect increase in grant funds of U.S. $1.157 million.

(Source: Project Paper, 1980, Exhibit IV-3, p. 29, PDKAB587)

18. Host Country Funding of R.E. Components (US$000): 5,600*

*For entire project, R.E. costs not specified separately.

(Source: Project Amendatory Agreement No. 6, p. 3, 6/19/86, PDKAH433)

19. Summary of R.E. Costs (US$000):

A. By Category:*

	GRANT	LOAN
Technical Assistance.....	3,250	500
Equipment and Commodities.....	20	4,400
Personnel and Training.....	130	4,600
Contingencies.....	500	2,752
TOTAL	3,900	12,252

*For entire project; R.E. costs not specified separately.

(Source: Incoming Telegram, 3/86, PDKAB593)

B. By Component:*

Policy and Planning.....	816
Data Collection and Analysis.....	3,319
Watershed Management.....	10,860
TOTAL	14,995**

*For entire project; R.E. costs not specified separately.

**Total does not reflect increase in grant funds of $1.157 million.

(Source: Project Paper, 1980, Exhibit IV-3, p. 29, PDKAB587)

20. R.E. Component Revisions:

A. Following a recommendation of the mid-term evaluation, the PACD was extended from July 1985 until July 1987.

(Source: PES, 2/84, p. 6, PDKAB621)

B. Project Purpose reworded in Congressional Presentation to reflect a more accurate description without representing a change in the purpose.

(Source: Incoming Telegram, 3/86, PDKAB593)

C. Grant funds increased by US$1,157,000 from US$2,743,000 to US$3,900,000.

(Source: Incoming Telegram, 3/86, PDKAB593)

D. PACD extended from July 30, 1987, to May 31, 1989.

(Source: Action Memorandum of 3/10/86 mentioned in outgoing telegram of 3/86, PDKAB594)

E. The project was initially fraught with indifference by the host country government, which was in the process of changing over from military to interim to democratic government. This was overcome two years after project authorization. During most of this same period, USAID/Honduras was without a Project Officer for the project.

(Source: PES, 5/20/86, PDKAH436)

F. The land tenure situation posed a problem, for most of the small farmers had no official titles to their land and consequently could not qualify for credit. As a result, much of the funds budgeted for credit was reallocated to assist the beneficiaries in other ways.

(Source: PES, 5/20/86, PDKAH436)

G. During project implementation, focus shifted somewhat from sectoral planning toward greater emphasis on impact-oriented farmer benefits and increased production at the field level.

(Source: PES, 5/20/86, PDKAH436)

H. Plantation activity slowed down in 1985, with pure stand plantation activities giving way to agroforestry activities.

(Source: Second Evaluation Report, 3/86, PDKAH436)

I. Significant personnel changes occurred as a result of the change in government in January 1986, and to a lesser extent due to the departure of field personnel on scholarships and to normal attrition. New positions represented approximately 85% of total field personnel. The impacts on the project were many, including many farmer groups dropping out or becoming lost from the project; project resources were misdirected and numerous interpersonnel conflicts arose; project personnel were not paid on time; resources had to be redirected to train new field personnel; and lack of control over project vehicles and materials developed.

(Source: Final Report of Technical Assistance Consultancy, pp. 3-4, 12/86, PDAAW001)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: August 1986 (mgz)
Revised January 1987 (jrl)
Revised May 1987 (jrl)

1. Project Number: 5270226 2. Geo: PERU

3. Title: SMALL HYDRO DEVELOPMENT

4. Project Life/PACD: 1980-85(extended to 87)/May 19, 1987

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 10,000

   B. R.E. Components: 10,000

   (Source: Project Authorization, 10/23/80, PDKAD052)

7. Loan or Grant/Appropriation Category (US$000):

   L / FN / 9,000
   G / FN / 1,000

   (Source: DIS)

8. Project Purpose:

   To promote rural and regional socio-economic development through the establishment of an institutional base capable of providing reasonably priced hydro-generated electrical energy for social and productive uses in rural towns in the sierra and high jungle.

9. Renewable Energy (R.E.) Outputs:

   Pre-feasibility and feasibility studies conducted; Small-scale hydro facilities constructed; Preventive maintenance mechanics for hydro plants trained; Campaign aimed at promoting productive uses of electricity conducted; ELECTROPERU personnel trained.

10. R.E. Inputs:

    Technical assistance; Construction; Commodities; Training.

11. Summary of R.E. Components:

    The project consists of institutionalizing the Small Hydroelectric Program within the Public Electric Company of Peru (ELECTROPERU) through (1) the provision of technical assistance to ELECTROPERU; (2) the carrying out of

feasibility studies; (3) the installation of standardized small-scale hydroelectric plants, principally in the 100-1,000 kW range; (4) the training of mechanics for the upkeep of the above small-scale plants; and (5) the promotion of income-generating activities that use electricity within the target communities. Activities are located in the Departments of San Martin, Cajamarca, and Junin.

Originally, the project planned the construction of 28 power plants in the 100-1,000 kW range. However, only 15 sites were selected for feasibility studies. Because of funding limitations, only 10 installations took place under the project. Several of the remaining 5 will be constructed by other means. Toward the end of 1986, 3 of the 10 project plants had been built, and the other 7 were under construction.

The Ministry of Energy and Mines (MEM) has direct project responsibility. ELECTROPERU, initially through its Office of the Program for Applied Technology (OPAT), and later through the Office of Hydrogeneration of the Rural Electrification Division which replaced it, is the implementing agency. Toward the end of 1985, the Rural Electrification Division was made a Department within the Construction Division. The AID Project Office, situated within the Rural Electrification Department, is in charge of direct project implementation; it is supported by the regional Electrification Project Units (EPU), which supervise and direct the construction of the subprojects. Upon completion of the facilities, responsibility for their management, operation, and maintenance is transferred to the Regional Electric Companies.

12. R.E. Project Descriptors:

Hydroelectric power.

13. R.E. Technology Applications:

A. Constructed three small hydroelectric power plants, with seven other plants under construction:

CONSTRUCTION PROGRESS TOWARD THE END OF 1986

Subproject & Estimated Cost(US$000)*	Installed Capacity (kW)	---Status of Construction Work (% Completed)--- Civil Works	Hydroelectric Equipment	Penstock	Transmission Lines and Networks
Chongos Alto 2,476	1,000	----------Completed----------			

Cajabamba 1,277	520	----------Completed----------			
Pucara 892	400	----------Completed----------			
Cutervo 2,269	1,200**	90	Will arrive site 12/86	Completed	Stage 1 - 90% Stage 2 - 50%
Pachiza 1,015	400	20	In customs	In factory 20	95
Namora 1,465	600	40	In customs	In factory 90	20
San Marcos 1,337	330	50	In customs	In factory 90	15
Niepos 1,638	1,000	30	En route	In factory 50	Bids to be requested
Celendin 1,943	1,000	45	En route	0	Bids to be requested
Sorochuco 542	230	55	Awarding in process	55	Bids to be requested

*The costs of Chongos Alto and Cajabamba are actual final costs. The cost of Pucara is projected final cost, with subproject accounting not yet completed. Costs for remaining projects are projected costs, as indicated in the latest revision of the Project Implementation Plan.

**Cutervo is being built in two stages, one of 800 kW and a second of an additional 400 kW.

The hydroelectric facilities at Niepos, Celendin, and Sorochuco will be completed using only ELECTROPERU funds, except that AID will fund the low voltage network and residential hookups in Niepos and Sorochuco.

(Source: Project Evaluation, 11/12/86, PDAAU723)

B. Costs of different sources of electric power were calculated and compared with those of hydroelectric plants funded by the project:

COMPARISON OF COSTS OF DIFFERENT SOURCES
OF ELECTRIC POWER IN PERU

Project	Installed Capacity (MW)	Cost in US$/kW Installed	Cost of Power (US$/kWh)
LARGE HYDRO POWER PLANTS			
Expansion of Canon del Pato	65	945	.018
Jicamarca I (with reservoir)	104	951	.042
Mayush I	100	1,485	.035
Platanal	99	1,583	.030
LARGE THERMAL POWER PLANTS			
Turbovapor - residual 6	50	1,352	.062
Turbogas - diesel 2	50	368	.092
SMALL HYDRO POWER PLANTS			
Chongos Alto	1.0	1,732*	.050
Cajabamba	0.52	2,019*	.059

*Costs of distribution networks, included in subproject costs of 13.A table, above, are not included here.

(Source: Project Evaluation, Appendix 11, 11/12/86, PDAAU723)

14. R.E. Technical Reports and Publications:

A. Estudios de Factibilidad de Pequenas Centrales Hidroelectricas (in Spanish). OPTA, ELECTROPERU, Lima, August 1980, 243 pp., PDKAD110.

This is a feasibility study of the Namora hydroelectric project, Cajamarca Province, whose preparation preceded the Small Hydro Development Project by two months.

15. Evaluations/Major Findings:

A. Evaluation of AID Project No. 5270226 for the Development of Small Hydroelectric Power Plants. Arthur D. Little, Inc., Cambridge, Massachusetts, November 12, 1986, 94 pp., PDAAU723. (Spanish version: Evaluacion del Proyecto AID No. 5270226 Para el Desarrollo de Pequenas Plantas Hidroelectricas, PDAAU454.)

The evaluation team concluded that the 10 small hydroelectric power plants (SHPPs) will have been built within reasonable periods of time at reasonable costs, and will serve an estimated 18,000 rural families. Development of an indigenous manufacturing capability in electromechanical and electrical equipment for SHPPs will have been stimulated and supported, advancing the possibility of future cost reductions. A methodology to evaluate the economics of SHPPs has been incorporated into ELECTROPERU's activities, and ELECTROPERU has been trained in the preparation, evaluation, and implementation of SHPP projects.

There are, however, many problems that could erode this experience. There has been a lack of progress in promoting the productive uses of electricity (although the promotion of electricity use among potential residential customers has been successful) and in training the Regional Electric Companies (RECs) in the operation and maintenance of the SHPPs. The team recommended that an expert in rural development spend four months training and working with the newly created Electricity Promotion Service of ELECTROPERU to promote productive uses of electricity. It also recommended that, in collaboration with ELECTROPERU, ELECTROLIMA's technical schools should be upgraded by providing short-term training to the school's instructors by the manufacturers of the new electromechanical equipment and by purchasing certain school equipment. A preventive maintenance training program for the SHPPs could be developed and implemented using classrooms and workshops at the schools, and unemployed graduates could be sent to the RECs for employment or to provide on-the-job training to SHPP operators.

Another major project shortcoming was the delay in subproject construction. The team made a number of recommendations to resolve the problems, including several extraordinary measures needed to complete the seven remaining subprojects by the PACD. These included providing communication and transportation equipment to on-site construction inspectors; improving and accelerating procedures for resolving claims for cost overruns; establishing longer and more flexible work periods and possibly resorting to more than one shift; reviewing and streamlining the tendering, awarding, and contracting processes; revising the SHPP selection process, making the benefit/cost ratio analysis the primary criterion for selection; and providing the SHPP with a complete set of equipment and tools needed for efficient operation and maintenance.

Specific technical recommendations are made for improvement of the facilities visited by the evaluation team.

16. Key Persons

A. AID/Washington: Not specified

B. AID/Mission:

Alfredo Larrabure, Project Coordinator
United States AID Mission to Peru, c/o American Embassy, Lima, 1 Peru
Telephone: 286200

C. Contractors: Not specified

D. Host Country:

Emilio Chaparro Chaparro, Construction Manager
Oswaldo Moran Marquez, Manager, Rural Electrification Department
Benjamin Ibarra, Head, AID Project Office
Hernan Bustamante Dawson, Head, Rural Electrification Unit, Technical Division
ELECTROPERU, Lima, Peru

17. Obligations by Fiscal Year (US$000):

EXPECTED PROJECT DISBURSEMENTS BY YEAR

Year I	800
Year II	2,700
Year III	3,200
Year IV	2,200
Year V	1,100

TOTAL	10,000

(Source: Extracted from Table 8, p. 42, Project Paper, 9/4/80, PDKAD051)

18. Host Country Funding of R.E. Components (US$000): 6,356

(Source: Implementation Letter No. 65, Annex 2, 4/29/86, PDKAD058 or PDAAG007)

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19. Summary of R.E. Costs (US$000):

ILLUSTRATIVE BUDGET

Investment Category	AID Loan	AID Grant	TOTAL AID
I. Studies	200	0	200
II. Promotion campaign	0	100	100
III. Construction			
Civil engineering works	3,573	0	3,573
Equipment and machinery	5,170	0	5,170
Vehicles and instruments	57	0	57
IV. Technical assistance	0	870	870
V. Maintenance	0	30	30
TOTAL	9,000	1,000	10,000

(Source: Implementation Letter No. 72, Annex 2, 10/7/86, PDKAH956)

20. R.E. Component Revisions:

A. The host country government committed $1,956,000 in addition to the original $4.4 million stipulated in the project agreement, bringing the total host country contribution to $6,356,000.

(Source: Implementation Letter No. 72, Annex 2, 10/7/86, PDKAH956)

B. The PACD was extended to November 20, 1986.

(Sources: Project Agreement, 11/24/80, PDKAD053; Department of State incoming telegram, 5/86, PDKAD056)

C. The PACD was extended to May 19, 1987.

(Source: Implementation Letter No. 71, 8/28/86, PDKAH956)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: April 1987 (jrl)

1. Project Number: 5320065 2. Geo: JAMAICA

3. Title: ENERGY SECTOR ASSISTANCE

4. Project Life/PACD: 1981-86 (extended to 87)/September 30, 1987

5. Status: Active

6. LOP Funding (US$000):

A. Entire Project: 8,700*

*Reflects $4 million deobligated from Phase II, and $1 million deobligated from Phase I.

(Source: Project Loan Agreement, 9/24/81, PDKAG054; Project Loan Agreement, 7/29/83, PDKAG054; Action Memorandum for the Acting Assistant Administrator, LAC, 7/27/83, PDKAG053; Outgoing Telegram, 12/84, PDKAG053)

B. R.E. Components: 6,280**

**Does not reflect $5 million de-obligation for entire project.

(Source: Project Paper, 5/29/81, PDKAG050)

7. Loan or Grant/Appropriation Category (US$000):

L / SD* / 8,400**
G / SD* / 300***

(Sources: *DIS; **Amendments No. 2 to Project Loan Agreement, Phases I & II, 8/29/85, PDKAG055; ***Advice of Program Change, 1/23/85, PDKAG056)

8. Project Purpose:

To strengthen the institutional capacity of the Government of Jamaica (GOJ) to plan and manage energy programs; To expand and improve the GOJ's energy conservation program; To institute programs in alternative energy.

9. Renewable Energy (R.E.) Outputs:

Alternative Energy Branch of the Energy Division (ED) of the

Ministry of Mining and Energy staff trained; Standards developed for manufacture of solar water heating systems; Solar system installers trained; Solar water heaters installed; Necessary equipment for the improvement of Jamaica's meteorological data base installed; Energy Information Center developed; Energy Center established at the College of Arts, Science, and Technology; Alternative energy demonstration centers set up in the rural area; Solar crop drying program undertaken; Fuelwood study conducted; Improved energy sugar cane varieties investigated.

10. R.E. Inputs:

Technical assistance; Training; Commodity support.

11. Summary of R.E. Components:

This project has two phases. Phase I focuses on public sector activities. It has three components: (1) strengthening the GOJ institutional capacity to plan and manage energy programs; (2) expanding and improving the GOJ's energy conservation program in the public sector; and (3) instituting alternative energy activities in the public sector. The Energy Division (ED) of the Ministry of Mining and Energy (MME) is implementor for Phase I, in collaboration with other government organizations that have responsibility for energy-related activities in Jamaica: the College of Arts, Science, and Technology (CAST), the Scientific Research Council (SRC), and the Petroleum Corporation of Jamaica (PCJ). A long-term specialist will assist the ED's Alternative Energy Branch in designing a strategy for the development of indigenous R.E. resources. Renewables will be demonstrated through the installation of solar water heaters on public buildings and the establishment of alternative energy demonstration centers in rural areas. Equipment and supplies will be provided to the Jamaican Bureau of Standards to test locally made solar products and establish government standards for the industry. Climatic stations will be purchased with loan funds to expand data collection by the Meteorological Office. Training will be provided to solar system installers. Assistance will be furnished to undertake a complete assessment of forestry resources for energy purposes and to support fuelwood plantation establishment. A variety of different high-fiber sugar canes will be studied to explore higher energy content bagasse. Support will be given to the development of the Energy Center, being set up by CAST, and to the expansion of the MME library into an Energy Information Center.

Phase II of the project consists of (1) the establishment of an Energy Credit Fund (ECF) to finance private sector

conservation and alternative energy investments and to provide loans to local energy-related industries; and (2) the provision of technical assistance to help establish and upgrade local energy-related industries. Loans from the ECF will be made available to qualified borrowers from commercial banks accredited by the National Development Bank (NDB). The loans will be used to finance energy projects in conservation, alternative energy, energy industry development, and energy audits. Overall responsibility for the ECF rests with the NDB, while technical support is supplied by the Ministry of Mining and Energy.

Meta Systems, Inc. was the primary technical assistance contractor. Prior to Phase II start-up, First Washington Associates (FWA) undertook an analysis of the demand for credit in Jamaica for residential solar water heating and for capacity expansion of solar equipment manufacturers. The RONCO Consulting Corporation and Bechtel National Inc. performed a feasibility study for a cogeneration facility fueled by bagasse and sugar cane wastes.

12. R.E. Project Descriptors:

Energy conservation; Energy planning; Firewood; Solar energy; Solar heating; Water heaters; Crop driers; Information centers; Bagasse; Wind energy; Sugar cane; Solar radiation; Biogas.

13. R.E. Technology Applications:

A. First Washington Associates analyzed demand for industrial/commercial and residential solar water heating and for capacity expansion of solar equipment manufacturers.

They identified 33 energy conservation opportunities (ECOs) for five Jamaican industries and plants where Georgia Tech had conducted energy audits. (In all cases but one, potential ECOs were defined as having a payback period not exceeding eight years.) Three of the ECOs consisted of solar water heaters. It was found that flat plate collectors for water heating were a much more attractive investment when displacing electric water heaters than when replacing oil-fired heaters. Statistics are as follows:

SOLAR WATER HEATING ENERGY CONSERVATION OPPORTUNITIES

	COMMERCIAL BUILDING CAFETERIA*	HOTEL APTS.**	HOTEL LAUNDRY***
Annual energy reduction(kWh)	13,800	28,600	-876
Annual energy reduction (Imperial Gal. diesel fuel)	-	-	2,190
Annual cost reduction	$3,002	$6,000	$5,991
Estimated cost for design, acquisition, installation	10,620	19,800	47,400
Foreign exchange component of above item	900	1,680	4,000
Estimated increase in maintenance cost	250	525	500
Simple payback period	3.9 yrs.	3.6 yrs.	8.6 yrs.
Return on investment with 9% loan	6.4%	7.07%	Has yet to break even
Simple payback with 9% loan	6.6 yrs.	6.5 yrs.	10.5 yrs.
Discounted payback with 9% loan	8.0 yrs.	7.7 yrs.	13.2 yrs.

*To provide 85% of domestic hot water needs for cafeteria using 200 IG of hot water/day, 5 days/week, currently supplied by electric resistance heaters.

**To provide 85% of hot water needs of 3 apartment buildings of tourist hotel now being met by electric hot water heaters.

***To displace 85% of diesel fuel needed to heat water from 110 degrees F. to 150 degrees F. for tourist hotel laundry. (Another ECO will preheat the water to 110 degrees F.)

(Source: Jamaica Private Sector Energy Credit Fund Project. Volume Two: Energy Audit Results. June 1982, pp. 41-42, 69-70, 72-73, PDAAU779)

B. FWA identified another ECO for a sugar plant that

currently uses bagasse as fuel to meet steam and electrical needs during the sugar crop season and relies upon an oil-fired boiler to meet those needs during the off-season. The ECO involved installation of a rotary dryer, conveyors, a front-end loader, a storage shed, and modification of the boilers, aimed at reducing bagasse consumption through more-efficient firing of dry bagasse, storing the excess bagasse, and utilizing it during the off-season to displace fuel oil. Statistics are as follows:

BAGASSE ENERGY CONSERVATION OPPORTUNITY

Annual energy reduction(kWh)	-
Annual energy reduction (Imperial Gal. Bunker C oil)	246,000
Annual cost reduction	$440,000
Estimated cost for design, acquisition, installation	1,660,000
Foreign exchange component of above item	545,000
Estimated increase in maintenance cost	20,000
Simple payback period	4 yrs.
Return on investment with 9% loan	8.46%
Simple payback with 9% loan	6.9 yrs.
Discounted payback with 9% loan	8.7 yrs.

(Source: Jamaica Private Sector Energy Credit Fund Project. Volume Two: Energy Audit Results. June 1982, pp. 109-110, PDAAU779)

C. FWA found that the market for solar water heaters was small in commercial and industrial facilities since solar water heaters would have to compete with oil-fired boilers and other less-expensive ways to heat water. The following table looks at two alternatives, solar and waste heat, to oil-fired water heating for hotels:

ECONOMICS OF SOLAR AND ENERGY CONSERVATION TECHNOLOGIES FOR WATER HEATING, REPLACING OIL-FIRED BOILER

	SOLAR	WASTE HEAT RECOVERY
Before tax payback	8.6 years	2.0 years
After tax payback	10.5 years	2.9 years
After tax payback (discounted)	13.4 years	3.5 years
Return on Investment (9% loan)	-3.6%	14.6%

(Source: Jamaica Private Sector Energy Credit Fund Project. Volume Four: Market Survey Results. June 1982, Table 1, p. 39, PDAAU779)

D. FWA found that in the residential market, where solar water heaters would compete primarily with electric heaters, little demand existed (the majority of homes have no hot water); the sales of solar water heaters were normally conducted on an exclusively cash basis; and commercial credit existed to finance the few sales desiring credit.

(Source: Jamaica Private Sector Energy Credit Fund Project. Volume Four: Market Survey Results. June 1982, PDAAU779)

E. Thirty-one solar hot water heating systems were installed in hospitals, educational facilities, health centers, hotels, an office building, and markets, with two additional ones planned for 1986/87, exceeding the planned 25 systems. Annual projected savings were estimated at 2,000-2,220 Barrels of Oil Equivalent (BOE). Actual installed cost was J$2.35 million, compared to J$4.09 million estimated cost. (The exchange rate of Jamaican dollars has varied tremendously over the life of the project. In 1986, one U.S. dollar equalled approximately 5.5 Jamaican dollars.)

(Source: USAID/GOJ Energy Sector Assistance Project Annual Report, 3/31/86, p. 29, PDAAU784)

F. Eleven post-evaluations for energy conservation retrofits

and solar hot water installations were conducted to assess energy audit projections and actual energy savings. Findings show that actual energy savings are approximately 95% of the projections at 52% of the project costs. Evaluation data pertaining to solar water heaters are as follows:

SITE	AUDIT ESTIMATES		ACTUAL	
	BOE/year Savings	Cost (J$*)	BOE/year Savings	Cost (J$*)
St. Ann's Bay Hospital	55	121,303	147	89,229
Spanish Town Hospital	205	131,718	431	140,888
Casa Montego Hotel	242	142,000	265	113,658
Royal Caribbean Hotel	702	204,492	138	131,619

*US1.00 = J$5.50

(Source: Extracted from table "Post-Evaluations - Energy Conservation Projects", USAID/GOJ Energy Sector Assistance Project Annual Report, 3/31/86, p. 20, PDAAU784)

G. An Alternative Energy Demonstration Centre at Knockalva and a Standards Laboratory at the Bureau of Standards were set up.

(Source: USAID/GOJ Energy Sector Assistance Project Annual Report, 3/31/86, PDAAU784)

H. Eleven meteorological stations were established islandwide to measure solar radiation and wind energy; 9 additional stations are planned.

(Source: Joint Evaluation, 11/85, p. 52, PDAAU778)

I. At the Solar Energy Center at CAST:

- Constructed two low-cost solar water heating models, and began testing and modifications on one unit.
- Began construction of one 800-gallon shallow solar pond.

- Completed design of solar still with 7.0 liter/day of distilled water capacity; installed two stills in Montego and Camperdown High Schools.

- Acquired parabolic trough collectors and evacuated tube collectors.

- Conducted solar drying experiments on ripe bananas, ginger, peppers, coconut flowers. copra, pimento, and coffee, and compiled data on initial moisture content, percentage loss of crop during preparation, moisture content for safe storage, drying curves, packing density for drying, air flow resistance, and maximum drying temperature.

- Constructed 540 square foot industrial-type roof dryer prototype.

- Began blade design for 12-foot vertical axis wind turbine.

(Source: USAID/GOJ Energy Sector Assistance Project Annual Report, 3/31/86, PDAAU784)

J. At the Alternative Energy Demonstration Centre - Knockalva:

- Demonstrated photovoltaic (PV) and wind water pumping.

- Demonstrated solar stills and solar water heaters.

- Constructed two solar water heaters.

- Constructed two portable biogas digesters.

- Generated biogas from plastic digesters.

- Established six acres of fuelwood plantation (composed of acacia, calliandra, casuarina, and leucaena).

(Source: USAID/GOJ Energy Sector Assistance Project Annual Report, 3/31/86, PDAAU784)

K. The Fuelwood Program etablished 25 acres of fuelwood:

SITE	ACREAGE	SPECIES
Long Pond	15.0	Leucaena, Calliandra, Cassia, Casurina
Richmond	6.0	Calliandra, Acacia
Knockalva	1.5	Calliandra, Leucaena
Others	2.5	Calliandra, Leucaena
TOTAL	25.0	

(Source: USAID/GOJ Energy Sector Assistance Project Annual Report, 3/31/86, PDAAU784)

L. The following tree growth statistics were observed:

SITE	SPECIES	AGE (mos)	HT. (m)	DIAMETER (cm)
Long Pond	Leucaena	18	3.46	3.0
	Calliandra	18	5.00	3.3
	Cassia	18	2.80	3.0
Hampden	Leucaena	18	5.34	4.2
	Calliandra	18	4.15	3.1
Richmond	Calliandra	15	3.90	6.0
	Cassia	18	4.30	7.0
Knockalva	Leucaena K8	21	6.5	5.2
	Leucaena K67	21	6.13	4.8
	Acacia	19	6.31	5.5
	Casaurina	20	4.73	3.8
	Calliandra	21	5.65	4.1

(Source: USAID/GOJ Energy Sector Assistance Project Annual Report, 3/31/86, PDAAU784)

M. Evaluated the technical, economic, and financial feasibility of constructing and operating a steam-electric cogeneration facility at a major sugar cane processing facility (the Monymusk Factory), assuming three levels of annual sugar cane production: 600,000 tons, 742,050 tons, and 850,000 tons.

Cogeneration plant consists of two 50% capacity, bagasse-fired, spreader stoker type, steam generators to be connected in parallel to a single, 100% capacity, tandem

compound, condensing type turbine generator with automatic extraction at 200 psig. Facility is designed to produce 330,000 pounds of steam per hour at 900 degrees F. and 900 psig for 323 days/year. Annual production in the Base Case (742,050 tons of sugar cane) is for 785.9 million pounds of process steam supplied to the factory, with electricity generation, net of plant, estimated at 171.1 million kWh (145.241 million kWh of which would be available for sale to the national electrical utility). The Base Case predicts significant revenues resulting from sale of sugar and molasses.

Following is the fuel mix for the cogeneration plant depending upon level of sugar cane production:

FUEL MIX FOR PROPOSED COGENERATION FACILITY

SUGAR CANE PRODUCTION (TONS PER YEAR)	600,000	742,050	850,000
Annual Bagasse Supply (tons)	164,100	203,300	233,200
Annual Barbojo Supply (tons)	0	74,000	127,500
Annual No. 6 Fuel Oil Consumption (barrels)	287,750	134,900	23,460

The cogeneration facility is proposed for implementation at the same time as the World Bank-financed second rehabilitation project for the Jamaican sugar industry. Projections assuming the lowest level of sugar cane production are based on only modest investments in addition to the World Bank finances and do not include any investment for the collection and processing of barbojo. The Base Case intermediate level projections include capital expenditures (mainly for improvements to the irrigation system) to reach the 742,050 ton production level and for the supply of 74,000 tons of barbojo annually at 35% moisture content. The Best Case projections involved capital expenditures to reach the 850,000 ton level, and for the supply of 127,500 tons of barbojo yearly at 35% moisture content. Cost for the proposed power station was calculated at US$47.7 million, with an additional US$9 million required to reach the Best Case sugar cane production level. Following are the estimated economics:

SUGAR CANE PRODUCTION (TONS PER YEAR)	600,000	742,050	850,000
Internal Rate of Return	n.a.	16%	20%
Overall Economic Rate of Return	8%	17%	21%
Net Present Value (US$,000) @ 10%	-5,800	28,400	51,600
Foreign Exchange Savings (US$000)*	-1,200	4,000	7,600

*Represent average annual savings over lifetime of the project (30 years) expressed in constant US$ 1986.

Base Case pricing of electricity for sale to the national utility in 1990 was estimated to be cost-competitive with future coal steam generation units at levelized 75 mills per kWh (1986 US$).

(Source: Jamaica Cane/Energy Project Feasibility Study. Volume 1, 9/86, PDAAV308)

14. R.E. Technical Reports and Publications:

A. A Report to the U.S. Agency for International Development on Jamaica Private Sector Energy Credit Fund Project, First Washington Associates, June 1982, Volumes 1-6, 358 pp., PDAAU779.

This report consists of six volumes:

Volume One - Introduction to Report, 15 pp.
Volume Two - Energy Audit Results, 148 pp.
Volume Three - Financial System Review, 64 pp.
Volume Four - Market Survey Results, 85 pp.
Volume Five - Credit Program Guidelines, 38 pp.
Volume Six - Conclusions and Recommendations, 8 pp.

Volume Two examines Energy Conservation Opportunities (ECOs) for five representative firms, based on energy audits performed on these plants between February 22-26, 1982, by the Georgia Institute of Technology. Thirty-three ECOs are identified. Projected fuel savings, cost savings, cost considerations, and economic feasibility analysis for each ECO are presented. These ECOs included three solar water heaters, and bagasse as fuel for steam and electricity generation.

Volume Four gives the results of FWA's intensive interviews with 49 manufacturing, commercial, hotel, and other firms to ascertain their demand for energy-saving investments and how the availability of a credit program would affect that demand. The report also includes a listing of the Jamaican manufacturers and distributers of solar equipment and a hypothetical comparison of industries manufacturing solar crop dryers and a variety of energy-conserving devices.

B. Design of Solar Hot Water Systems for Jamaica. Charles J. Cromer, May 23, 1983, 254 pp., PDAAW343.

This report describes technical components of a solar water heating system and discusses calculation of the parameters needed for the selection of proper system components. It begins with a study of the solar resource and proper siting, and goes through a description of types of collectors, solar hot water heating systems, controls and controllers, and sizing methods for the solar array and components. Many graphs are included.

C. Jamaica Solar Drying and Food Preservation Training Session. Larry G. Williams and Robert J. Haggerty, University of Idaho and Postharvest Institute for Perishables, January 1986, 21 pp., PNAAU500.

This report provides a general description of a demonstration-style workshop conducted in Jamaica from January 7-9, 1986, on the construction/assembly and operation of solar food dryers and on principles of food preservation and human nutrition. Appendices include a list of names and addresses of registrants and the workshop schedule.

D. Review of Potential for Renewable Energy Sources in Jamaica. Revised draft. John H. Arnold, Meta Systems, 10 Holworthy Street, Cambridge, MA 02138, August 1983, 264 pp., PNAAX952.

Eight different R.E. technologies are reviewed: hydropower, solar, fuelwood, sugarcane, agricultural wastes, animal wastes, wind, and OTEC. R.E. resource availability in Jamaica, potential uses, conversion efficiencies, certain financial and economic costs, and estimated introduction timeframe are presented. Many tables are included.

E. USAID/GOJ Energy Sector Assistance Project Annual Report. Ministry of Mining & Energy, Kingston, Jamaica, March 31, 1986, 67 pp., PDAAU784.

This annual report reviews the project's progress since its inception. It includes a list of the 32 solar water heaters installed (or near completion), showing such characteristics as array area and gallonage, cost, and BOE savings. It also contains brief information on other R.E. technologies, including solar crop drying, parabolic trough and evacuated tube solar collectors, wind energy development, solar stills, solar equipment standards, meteorological measurements, biogas digesters, and fuelwood establishment and utilization.

F. Jamaica Cane/Energy Project Feasibility Study. Volume 1. RONCO Consulting Corporation and Bechtel National Inc., September 1986, 253 pp., PDAAV308.

This report evaluates the technical, economic, and financial feasibility of building and operating a steam-electric, cogeneration facility at the Monymusk Factory, a major sugar cane processing plant, to be implemented concurrently with a World Bank-financed second rehabilitation program for the Jaimaica sugar production industry. The plant is to be fueled by bagasse and sun-dried sugar cane waste, supplemented by No. 6 Fuel Oil. Construction is planned to begin in mid-1988, and operation in mid-1990. Economic and financial projections are made for three levels of annual sugar cane production: 600,000 tons, 742,050 tons, and 850,000 tons.

G. Executive Summary: Review of Potential for Renewable Energy Sources in Jamaica. John H. Arnold, Meta Systems, Cambridge, Massachusetts, August 1983, 43 pp., PNAAX953.

This is the executive summary of two volumes, one of which is that presented in 14. D, above, containing preliminary data on the potential of a number of renewable energy sources in Jamaica.

The volumes focus on (1) the availability of renewable energy resources; (2) costs and conversion efficiencies of the various R.E. technologies; (3) expected end-uses of resource-technology combinations; (4) the extent to which R.E. will substitute for conventional fuels or meet new energy requirements; and (5) the timeframe for projected introduction of R.E. technologies.

The data were to be used as input to the National Energy Model. Annex 1 contains data sheets prepared for each resource-technology combination for use with the model.

15. Evaluations/Major Findings:

A. Evaluation of the Government of Jamaica/U.S.A.I.D. Energy Sector Assistance Project. Kenneth Carter, Trevor Byer, and Henry Santiago, May 16, 1983, 41 pp., PDAAN263 or PDAAP334 or PDKAG074.

The major project problems uncovered by the evaluation team involved the organization of the Energy Division. Its discipline-oriented structure was not conducive to an efficient achievement of the project goals, and the team made recommendations for its reorganization along functional lines. Moreover, it was plagued with a high staff turnover, attributed to low pay and lack of career paths; a change in wage structure was proposed, with AID providing a grant to allow for the topping-up of salaries to make them more comparable to those found in the private sector.

Regarding renewables, it was noted that the tax on solar water heaters was not yet removed; the evaluators stated that the priority of this effort needs to be reconsidered in terms of a cost/benefit analysis.

B. Joint Evaluation of the Energy Sector Assistance Project. David E. Trottman, Henry P. Santiago, and Charles S. Stevens, November 1985, 103 pp., PDAAU778.

The evaluation team found that under Phase I, both energy conservation and alternative energy components had attained or exceeded project expectations, in spite of the loan deobligation, since actual costs proved to be much less than anticipated. Notable accomplishments under the alternative energy component were the organization and installation of the Energy Center at CAST; the start of operations at the Knockalva demonstration center and establishment of a second center at Bodles (underway); good progress on the installation of 20 wind gathering stations and 32 solar water heaters; and an evaluation of potential of fuelwood and bagasse as energy sources. Due to the depressed economic state of Jamaica and devaluation of the Jamaican dollar, the GOJ counterpart funds may not be provided; USAID loan advances were proposed to ease the Energy Division's cash flow. The lack of institutional development of the Energy Division, the major concern of the May 1983 evaluation, still persisted, however.

Phase II loan activity was very slow due to the continued depressed economy and resultant lack of incentive in the private sector to assume added and non-productive financial obligations, lengthy delays in processing of loan applications, high duties imposed upon importation

of needed material and equipment, and a variety of taxes. Technical assistance on a long-term basis was determined to be no longer necessary; instead, T.A. could best be provided through short-term consultancies.

Five recommendations are made, proposing that: (1) the Energy Division be restructured and its personnel provided competitive salaries; (2) import duties be waived on ECF importations; (3) PACD extensions, other than for training, and possible funding deobligations, be dependent upon the outcome of June 1986 progress reviews; (4) the Meta Systems contract be terminated and future technical assistance provided by short-term, highly specialized professional services contracts; and (5) loans be advanced to the Energy Division to fund project implementation costs.

16. Key Persons:

A. AID/Washington: Not specified

B. AID/Mission:

Dr. Frank Ahimaz
Mr. Dan Rathbun, Program Officer
Mr. Charles Mathews, Director, Office of Engineering, Energy & Environment
Mr. N. Dodd, Assistant Energy Officer
USAID/Jamaica, Mutual Life Building, 2 Oxford Road, Kingston 5, Jamaica

C. Contractors:

Meta Systems
10 Holworthy Street, Cambridge, MA 02138
(617) 868-8660

Ronco Consulting Corporation
1629 K St., NW, Washington, D.C. 20006
(202) 785-2791

Bechtel Corporation
1601 N. Kent St., Suite 914, Rosslyn, VA 22209

Mr. Delio E. Gianturco, Project Manager and President
First Washington Associates, 1501 Lee Highway, Suite 302, Arlington, VA 22209
(703) 525-0966

Mary Jane Ruhl
Ruhl Information Management Inc.
905 Enderby Drive, Alexandria, VA 22302
(703) 836-5317

D. Host Country:

Mr. Winston Boyne, Project Director
Ministry of Mining and Energy, 2 St. Lucia Avenue,
Kingston 5, Jamaica

Mr. Larry Bailey, Manager, ECF
National Development Bank

17. Obligations by Fiscal Year (US$000):

A. Phase I - Not specified.

B. ESTIMATED ACCRUED EXPENDITURE SCHEDULE FOR PHASE II (FY not specified)*

YR1		YR2		YR3		TOTAL	
AID	GOJ	AID	GOJ	AID	GOJ	AID	GOJ
1,250	850	2,250	2,300	2,400	2,450	5,900	5,600

*Does not reflect $4 million Phase II deobligation.

(Source: Project Paper Supplement, 6/16/83, PDKAG051)

18. Host Country Funding of R.E. Components (US$000):

Phase I: 4,563*

Phase II: 2,800**

(Sources: *Project Loan Agreement, 9/24/81, PDKAG054; **Project Paper, p. K-1, 5/29/81, PDKAG050. Phase II figure does not reflect subsequent changes in GOJ funding)

19. Summary of R.E. Costs (US$000):

A. PROJECTED COST ESTIMATE FOR ALTERNATIVE ENERGY FOR PHASE I AND PHASE II*

	PHASE I		PHASE II	
	FX	LC	FX	LC
Technical assistance	995	60	-	-
Public sector solar water heating program	1,530	-	-	-
Private sector solar water heating program	-	-	1,530	-
Standards: solar water industry	91	-	-	-
Meteorological data	90	-	-	-
Expansion of solar industry	-	-	623	-
Training installers	41	-	-	-
Research and development				
CAST	370	-	-	-
Solar crop drying	-	-	101	220
Assessment of alternative energy resources	199	60	-	-
Forestry resources	310	-	-	-
Alternative energy demo centers	60	-	-	-
TOTALS	3,686	120	2,254	220
GRAND TOTAL		6,280		

*Does not reflect subsequent deobligations.

(Source: Project Paper, 5/29/81, PDKAG050)

B. PROJECTED COST ESTIMATE BY COMPONENT, FOR PHASE I*

	AID		GOJ
	FX	LC	
Alternative Energy			
Consultants & misc. contracts	1,344	0	249
Training	465	60	139
Commodities	377	60	379
Engineering & construction	1,500	0	2,665
GOJ staff	0	0	1,131
TOTAL	3,686	120	4,563

*Does not reflect $1 million Phase I deobligation.

(Source: Project Loan Agreement, 9/24/81, PDKAG054)

C. PROJECTED COST ESTIMATE AND FINANCIAL PLAN* FOR PHASE II**

	AID	GOJ
Establishment Of Energy Credit Fund		
1. Loans to industrial/commercial enterprises for energy audits, retrofits, and alternative energy systems	4,000	4,000
2. Loans to energy development products and energy services firms	1,500	1,000
A) Upgrading alternative energy industry	100	400
B) Upgrading energy conservation industry	100	200
Evaluations and Audits	200	-
	---	---
TOTAL	5,900	5,600

*Does not reflect $4 million Phase II deobligation.

**For entire Phase II, R.E. costs not specified separately.

(Source: Project Loan Agreement, Annex 1, 7/29/83, PDKAG054)

20. R.E. Component Revisions:

A. As described in the Project Paper of 5/29/81, this project was to be funded at a level of $14 million. As a result of project review, a decision was made to divide the project into two phases: Phase I focusing on the public sector, and Phase II concentrating on the private sector. $7.5 million was authorized for Phase I, and subsequently $5.9 million was authorized for Phase II. The LAC Bureau's Development Assistance Executive Committee requested that the AID Mission do the following, which it did, prior to approval of the second phase: (1) Undertake an analysis of private sector demand for credit to finance conservation and alternative energy investments; (2) Determine the appropriate interest rate to be charged to the sub-borrower; (3) Establish borrower eligibility criteria; and (4) Outline procedures for

maintaining the monetary value of the revolving credit funds.

(Source: Project Paper Supplement, 6/16/83, PDKAG051)

B. The condition precedent for Phase I requiring the GOJ to eliminate the excise tax on the importation of solar water heaters was deleted from the original Project Authorization. Phase I was concerned only with the public sector installation of solar water heaters, and, since the GOJ does not pay an excise tax, this condition precedent was considered unnecessary until the start-up of Phase II.

(Source: Action Memorandum for the Acting Assistant Administrator, 9/16/81, PDKAG053)

C. The Director of the Project Implementation Unit of the MME resigned in 1982, causing a delay estimated at between one and three months.

(Source: Incoming Telegram, 9/82, PDKAG072)

D. The Project Authorization amendment furnished an additional $5.9 million in loans to fund Phase II.

(Source: Project Authorization Amendment, 7/27/83, PDKAG053)

E. An additional $300,000, in grant funds, was obligated to finance an energy specialist/coordinator, since it was determined that the required technical expertise was not available to manage the project.

(Source: Advice of Program Change, 1/23/85, PDKAG056)

F. $5 million in AID loan funds were deobligated in 1985: $4 million from Phase II and $1 million from Phase I.

(Sources: Amendment No. 2 to Project Loan Agreement Phase II, 8/29/85, PDKAG055; Amendment No. 2 to Project Loan Agreement Phase I, 8/29/85, PDKAG055)

G. GOJ counterpart Phase I funding obligation reduced to $8 million.

(Source: Joint Evaluation, 11/85, PDAAU778)

H. PACD extended to September 30, 1987, for training component only.

(Source: Joint Evaluation, 11/85, PDAAU778)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: October 1986 (jrl)
Revised January 1987 (jrl)
Revised February 1987 (jrl)

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1. Project Number: 5380049 2. Geo: CARIBBEAN REGIONAL

3. Title: CARIBBEAN DEVELOPMENT FACILITY IV

4. Project Life/PACD: 1982-83/December 31, 1983

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 12,000

   B. R.E. Components: Not specified

7. Loan or Grant/Appropriation Category (US$000):

   L / FN / 4,000
   L / EH / 2,800
   L / SD / 5,200

   (Source: Project Paper Facesheet, 3/4/82, PDKAE778)

8. Project Purpose:

   To assist the governments of the more developed, English-speaking Caribbean countries participating in the Caribbean Development Facility to maintain adequate levels of development investment by providing resources needed to carry out essential donor-assisted socioeconomic projects.

9. Renewable Energy (R.E.) Outputs: Trees planted.

10. R.E. Inputs: Loan funds.

11. Summary of R.E. Components:

   This loan to the Caribbean Development Bank (CDB) is a follow-on to projects Nos. 5380023, 5380040, and 5380045. The loan will support the efforts of the Caribbean Development Facility (CDF) to finance a program of economic stabilization and equitable growth in the participating CDB-member countries of Barbados and Jamaica. The role of the CDF, established by the Caribbean Group for Cooperation in Economic Development, a consultative group, is to coordinate the provision of supplementary financing of Caribbean projects and programs funded by international or other free-world donors. The CDB, an intermediate credit institution, will reloan $5 million to Barbados, and $7 million to Jamaica, to finance the local currency costs of eligible

donor-assisted projects in forestry, appropriate technology, and non-conventional energy production. The CDB will administer the program. The CDF Working Group, an informal group made up of representatives of the World Bank, IMF, Inter-American Development Bank, and CDB, will coordinate assistance provided through the CDF and facilitate communication between the CDB and the prime donors. The prime donor of each project receiving supplementary financial assistance through the CDF will be responsible for overall supervision and project implementation.

By November 8, 1982, six projects were approved as eligible for CDF IV funding, three in Barbados and three in Jamaica. One is the First Rural Development project, undertaken in Jamaica by the World Bank. It includes a forestation component.

12. R.E. Project Descriptors: Firewood.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

    A. AID/Washington: Not specified

    B. AID/Mission:

    William B. Wheeler, Director
    USAID Regional Development Office/Caribbean, P.O. Box 302, Gulf House, Broad Street, Bridgetown, Barbados, West Indies

    C. Contractors: Not specified

    D. Host Country:

    William G. Demas, President
    Caribbean Development Bank, P.O. Box 408, Wildey, St. Michael, Barbados, West Indies Cable: CARIBANK; Telex: WB2287

17. Obligations by Fiscal Year (US$000):

    FY 82 12,000

    (Source: Environmental Threshold Decision, 3/30/82, (PDKAE781)

18. Host Country Funding of R.E. Components (US$000):

Not specified

19. Summary of R.E. Costs (US$000): Not specified

20. R.E. Component Revisions:

A. PACD extended from March 31, 1983 to June 30, 1983.

(Source: Implementation Letter No. 7, 3/22/83, PDKAE785)

B. PACD extended to December 31, 1983.

(Source: Implementation Letter No.8, 7/7/83, PDKAE785)

C. The Congressional Presentation indicated an obligation of $16 million in loan funds and $4 million in grant funds for the project. Due to the weak economic performance of Guyana, it was decided that Guyana would not participate in the project, at least initially. The $4 million grant was included in a separate project to be provided to the less-developed island states of the Eastern Caribbean.

(Source: Project Paper, Annex XI-Advice of Program Change, 3/4/82, PDKAE778)

21. Follow-On Activities:

A follow-on CDF V project is planned.

(Source: Project Paper, 3/4/82, PDKAE778)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: October 1986 (jrl)

1. Project Number: 6030013 2. Geo: DJIBOUTI

3. Title: INFRASTRUCTURE AND ENERGY INITIATIVES

4. Project Life/PACD: 1981-86(extended to 87)/September 30, 1987

5. Status: Active

6. LOP FUNDING (US$000):

   A. Entire Project: 4,400*

   B. R.E. Components: 660**

   (Sources: *State Department telexes, 8/86 and 9/86, PDBBD427, and Quarterly Implementation Report, 9/30/83, PDBAO626; **Estimate of Donna Read, Program Officer, VITA)

7. Loan or Grant/Appropriation Category (US$000):

   G / ES / 4,400

   (Sources: State Department telexes, 8/86 and 9/86, PDBBD427; Quarterly Implementation Report, 9/30/83, PDBAO626)

8. Project Purpose:

   To assist the Government of the Republic of Djibouti (GROD) in establishing the institutional capacity to collect and organize basic energy information, to direct testing of various energy technologies, and to assist in developing policy options concerning production, consumption, and conservation.

9. Renewable Energy (R.E.) Outputs:

   Data base containing wind and solar radiation data, water pumping results using PV and windmills, etc., compiled; Socioeconomic needs assessment conducted; Survey of GROD planning priorities undertaken; Pilot interventions/ prototype research on wind and PV for water pumping conducted; Research results assessed and disseminated; Energy conservation practices developed; Bioclimatic-designed ISERST renewable energy building with 5.3 kW PV array constructed; Energy policy and planning institutional development accomplished.

10. R.E. Inputs:

Technical assistance, long-term and short-term; Commodities, including lab/workshop equipment, wind/solar measurement equipment, and prototype equipment; Construction.

11. Summary of R.E. Components:

The project is assisting the Institut d'Etudes et de Recherches Scientifiques et Techniques (ISERST) in developing the capacity to examine (1) current and future energy supply and demand in Djibouti and (2) options to conserve energy.

A national energy assessment was performed, analyzing supply options for solar, wind, and biomass resources. Assistance is being provided in the development of a National Energy Plan.

An energy-conserving building with passive cooling features, which incorporates a 5.3 kWp PV system, was designed and built to house the ISERST Renewable Energy Office, laboratory, and workshop.

The Project Paper called for renewable energies to play a significant role in the project; however, after implementation, this focus shifted toward energy conservation and energy efficiency improvements. At its inception, the project set up seven meteorological stations to collect wind and solar radiation data. Field work with R.E. technologies became confined principally to wind and PV water pumping, whereas policy planning included geothermal energy, firewood, and charcoal.

12. R.E. Project Descriptors:

Photovoltaic energy; Solar energy; Energy planning; Firewood; Charcoal; Solar radiation data; Wind data; Water pumps; Windmills; Passive cooling; Electric power generation; Waste oil; Lighting; Battery chargers; Refrigerators; Kilns; Energy conservation; Wind energy; Solar thermal energy; Geothermal energy.

13. R.E. Technology Applications:

A. Wind and Solar Measurements

- Installed seven Climatronics Weather Stations (three model 100766 units, along with four larger Climatronics units purchased by AID/Djibouti) to measure wind speed, direction, solar radiation, and temperature data. Data were monitored and analyzed. The equipment required a high level of maintenance

and repair; periodic shipments of spare parts alleviated the problem but did not solve it. Eventually, the equipment was dismantled and stored in the ISERST building.

(Sources: Djibouti Energy Initiatives Project Twelfth Quarterly Report, July-September 1985, PDAAW013; Letter of 11/23/82 from John Downey/VITA to Robert S. Kearton/Climatronics Corp.)

- Installed anemometer in Asa Gueyla to monitor wind for possible demonstration wind generator.

  (Source: Djibouti Energy Initiatives Project Eleventh Project Quarterly Report, April-June 1985, PDAAW012)

B. Wind Pumps

- Purchased two 1.7-meter diameter Sparco windmill water pumps for demonstration purposes: Sparco Model D (diaphram pump) and Model P (piston pump). Coordinated testing by French Volontaires du Progres of the diaphram model; clogging problems were experienced with the foot valve. Actual output was much lower than rated capacity; consequently, the project discontinued use of this windpump.

  (Source: Djibouti Energy Initiatives Project Fourth Project Quarterly Report, July-September 1983, PDAAW005)

- Worked with Genie Rural on program to repair and rehabilitate the rural wind pumping machines in Djibouti. For example, the project repaired a 12-foot diameter Aermotor windpump. Various other windmills were repaired and/or moved to more favorable sites.

  (Sources: Djibouti Energy Initiatives Project Quarterly Reports, July-September 1985, PDAAW013, and January-March 1985, PDAAW011, and numerous other monthly and quarterly reports)

- Repaired non-functioning 2-meter diameter Oasis (French) wind pump (on 8-meter tower, with 2-inch diameter direct action pump); installed (Badger Meter Co., Milwaukee, WI) flowmeter and (NRG Systems, Model No. 280, Bristel, VT) wind sensor, and tested in Douda, measuring wind speed for almost two months (July-August 1984) and calculating 2.94 cu. meter average daily water volume pumped (taking water measurements precise to .01 cu. m.); replaced pump

with enlarged 3-inch pump cylinder, and calculated approximately 6 cu. meters of water pumped per day from 7-meter depth.

(Sources: Djibouti Energy Initiatives Project Quarterly Reports, January-March 1985, PDAAW011, and October-December 1984, PNAAW010)

C. Wind vs Diesel vs PV Pumps

Performed an economic analysis of three pumping options--diesel, PV, and wind--for a private farmer requiring as much as 250 cu. meters per day of water pumped from a shallow well for irrigation. Determined that wind was the least cost option, and recommended that the farmer purchase a 24-foot diameter rotor Kijito windpump from Kenya.

(Source: Djibouti Energy Initiatives Project Monthly Report, June-July 1986, PDAAW020)

D. PV/Solar Pumps

- Field tested and demonstrated Solar Electric International (SEI) 300 Wp floating centrifugal pump (which uses KSB brand pump). This model suffered from a poorly attached flotation device and from a water strainer that rusted rapidly, but otherwise worked well.

  (Sources: Djibouti Energy Initiatives Project Quarterly Reports, January-March 1985, PDAAW011; July-September 1983, PDAAW005; and April-June 1983, PDAAW004)

- Tested and demonstrated newer model 400 Wp SEI 50-M floating centrifugal sunpump. Some difficulties were experienced. One pump failed after apparently running dry; inspection revealed mud in the motor and burned out control circuits. Another pump stopped working, and inspection revealed a stone wedged in the pump impeller housing; after removal of the stone the pump ran normally. The stone entered through a crack in the plastic filter; this was not the first instance of a cracked plastic filter found on the SEI pumps. The project felt that the AEG-Telefunken pump had similar performance and reliability as the SEI 50-M, but was much easier to repair.

  (Sources: Djibouti Energy Initiatives Project Monthly Reports, March-April 1986, PDAAW017, and February-March 1986, PDAAW016)

- Tested and installed two ARCO Solar 560 Wp PV pumps (with CSB 50 pumps) for UNHCR/Djibouti.

  (Sources: Djibouti Energy Initiatives Project Eighth Project Quarterly Report, July-September 1984, PDAAW009, and Sixth Project Quarterly Report, January-March 1984, PDAAW007)

- Tested A.Y. McDonald 150305DS surface-mounted centrifugal pump with 344 Wp PV array, and A.Y. McDonald 820305DS surface-mounted centrifugal pump. Experience showed that this type of pump was both rugged and reliable, and was the least expensive. One pump installed in Obock was found to be almost completely plugged with scale; once the impeller was descaled and cleaned, the pump ran normally. This demonstration showed that pumps operating in highly saline water need to be descaled periodically to assure normal operation.

  (Sources: Djibouti Energy Initiatives Project Monthly Reports, July-August 1986, XDBBE855A, and April-May 1986, PDAAW018)

- Tested output of 350 Wp AEG-Telefunken pump at various insolation levels at request of Projet de Developpement, a branch of Genie Rural.

  (Source: Djibouti Energy Initiatives Project Twelfth Quarterly Report, July-September 1985, PDAAW013)

- Helped intall PV pump purchased by the Office National d'Assistance aux Refugies et Sinistres (ONARS) at As Eyla.

  (Source: Djibouti Energy Initiatives Project Monthly Report, September-October 1985, PDAAW013)

- Built 10-meter high platform for PV water pump testing. Tested a variety of PV pumps for average daily outputs at five different heads and maximum outputs at solar noon. A data base is being developed on lab and field testing results.

  (Source: Djibouti Energy Initiatives Project Monthly Report, April-May 1986, PDAAW018)

- In continuing collaboration with Genie Rural, which is interested in determining suitability of PV water pumps for irrigation of small garden plots (with head up to 10 meters), ISERST agreed to test four PV pumps to be supplied by AFME (Agence Francaise pour la Maitrise de l'Energie) and manufactured by Total

Energy Development (TED). The TED PV pump/motor is housed in a hemispherical float chamber almost a meter in diameter; the pump projects through the bottom. The pump performed well in water, but it had no automatic cutout system (neither overspeed nor overheat protection) required for reliable operation in shallow wells that tend to run dry. The pump was awkward to handle out of water, not easily supported in a horizontal position without the entire weight resting on the foot-valve assembly at the bottom of the pump unit. ISERST also agreed to test another ten PV pumps provided under a French FAC/Genie Rural contract.

(Sources: Djibouti Energy Initiatives Project Monthly Reports, September-October and June-July 1986, both in XDBBE855A)

- Procured two A.Y. McDonald PV pumps, financed by the U.S. Embassy/Djibouti, for the villages of Khalaf and Sagalou.

  (Sources: Djibouti Energy Initiatives Project Monthly Reports, October-November 1986, in PDBBE855, and July-August 1986, XDBBE855A)

- Arranged to install a PV pump, also financed by U.S. Embassy/Djibouti, in village of Medeho.

  (Sources: Djibouti Energy Initiatives Project Monthly Reports, October-November 1986, PDBBE855, and March-April 1986, PDAAW017)

E. PV Power Generation

- Procured and installed at Lycee de Djibouti physics lab a 420 Wp PV system to supply 2 amps of DC current at 12 VDC nominal to ten student workstations in order to demonstrate PV to students; also donated and installed one 40-watt REC-12-40 fluorescent light, one Delco 2000 105 AH 12-volt battery, and one William Lamb DC ceiling fan, with 2 ARCO Solar modules.

  (Sources: ARCO Solar Sales Order No. A31644, 10/26/83, VITA office files; Djibouti Energy Initiatives Project Sixth Project Quarterly Report, January-March 1984, PDAAW007)

- Purchased educational PV test unit from Enelec Company (Mornant, France) for classroom demonstration of PV.

(Source: Djibouti Energy Initiatives Project Ninth Project Quarterly Report, October-December 1984, PDAAW010)

F. Passive Cooling Design with PV Power Generation

Designed and built a 700 sq. meter building (to house the ISERST Renewable Energy Office, laboratory, and shop facilities) with passive cooling features to serve as an energy-efficient model for future construction in Djibouti. Purchased and installed on the roof of the building a 5.3 kWp 220-volt 50 Hz PV system to power lights, fans, a small refrigerator, and small office equipment; the PV array was wired to produce 48 VDC. Contained 42 kWh battery storage (EXIDE 6E120-15) designed for two days of sunless operation. The original system included a Best M48-5000 inverter (48 VDC input/200 VAC 50 Hz output); however, the inverter circuit breaker would continually trip whenever a 40-watt fluorescent light or 700-watt photocopier was turned on, even with no other load. Repair efforts failed to remedy the problem, and a 5 kw NOVA inverter was ordered. At first, an available 1.5 kW NOVA was used on reduced load; then, two 3-kW NOVA inverters were supplied. The two inverters could not be linked in parallel, and the power supply from one alone was insufficient for successful operation due to power transients caused by the operation of the refrigerator compressor. Consequently, a 5-kW unit, ordered originally but not available, had to be produced, and it was finally installed at the end of 1986.

(Sources: Djibouti Energy Initiatives Project Monthly Reports, September-October 1985, PDAAW013, and November-December 1986, in PDBBE855; VITA In-House Evaluation of Bids Received for the Djibouti Project PV System, 7/29/83; see also additional building design reports under 14., R.E. Technical Reports and Publications, below)

G. Solar Home Lighting Systems

Demonstrated/sold six home lighting systems--two ARCO Solar Home Lighting Kits (which use one 20-watt fluorescent light) and four International Solar Products Corporation home lighting systems (with two 20-watt fluorescent lights each).

(Sources: Purchase order forms available from VITA and conversation with VITA Chief of Party)

H. PV Refrigerator and Lighting System

Designed, procured, and tested a PV refrigerator and fluorescent lighting system for Holl Holl dispensary.

(Sources: Djibouti Energy Initiatives Project Monthly Reports, September-October 1986, XDBBE855A, and October-November 1986, in PDBBE855)

I. Solar Battery Chargers

Demonstrated/sold International Solar Products Corp. Phaeton II/Phaeton III mini-PV modules (4 Wp and less) for charging nickel-cadmium rechargeable batteries.

(Sources: Purchase order forms available from VITA and conversation with VITA Chief of Party)

J. Solar Distributorship

Project support led to a distributorship agreement between SOTRACO, a local water pump dealer, and ARCO Solar. SOTRACO was to become the Djibouti agent for ARCO Solar.

(Source: Djibouti Energy Initiatives Project Ninth Project Quarterly Report, October-December 1984, PDAAW010)

K. Waste-Oil-Fired Kiln

Trained the head of the Djibouti Pottery Cooperative in waste-oil-fired kiln technology. Built and tested a 2-cubic meter prototype "Friendship" waste-oil-fired kiln and a waste-oil stove for institutional cooking.

(Sources: Djibouti Energy Initiatives Project Fifth Project Quarterly Report, October-December 1983, PDAAW006; Sixth Project Quarterly Report, January-March 1984, PDAAW007; Third Project Quarterly Report, April-June 1983, PDAAW004)

L. Wood and Charcoal Consumption

Conducted a series of rural surveys to ascertain consumption of wood and charcoal in Djibouti. Estimated 1986 fuelwood consumption for the country at 27,600 tonnes, and charcoal consumption at 1,200 tonnes. Calculated approximately 35,500 tonnes at total amount of wood required for both biomass fuels.

(Source: Djibouti Energy Initiatives Project Monthly Report, August-September 1986, XDBBE855A)

14. R.E. Technical Reports and Publications:

A. Building for the Maritime Desert: Climate, Construction, and Energy in Djibouti. Daniel Dunham, Volunteers in Technical Assistance (VITA), Arlington, VA, August 1983, 69 pp., PNAAX886. (French version: Construire Dans la Region du Desert Maritime: Climat, Construction, et Energie a Djibouti, 73 pp., PNAAX887)

Climatic conditions in Djibouti are reviewed. Ideas on bioclimatic designs that consider solar and wind factors to improve indoor conditions are presented. Topics include building shape and orientation, materials selection, shading, ventilation, and natural lighting.

B. Djibouti Energy Initiatives National Energy Assessment. Matthew Milukas, Jesse Ribot, and Peter Maxson, Volunteers in Technical Assistance (VITA), Arlington, VA, September 1984, 468 pp., PNAAX888 (French version: Initiatives Energetiques de Djibouti: Evaluation Energetique Nationale, which includes a June 1985 revised executive summary, not included in the English version, based on recommendations from the mid-term evaluation, PNAAX926.)

This report describes the energy situation in Djibouti. It analyzes information on energy flow from supply through conversion to end use--source to consumer--examining current energy policies, prices, and institutions, and projected energy demand and its impact on the national economy. Finally, it looks at the potential to conserve energy. Wind energy, numerous solar technologies, and biomass are examined as potential supply sources.

C. Reducing Energy Consumption in Buildings: the Potential for Conservation in Djibouti. Seymour Jarmul, Volunteers in Technical Assistance (VITA), Arlington, VA, July 1984, 90 pp., PNAAR372. (French version: Reduire la Consommation d'Energie Dans les Batiments: Les Possibilites de Conservation d'Energie a Djibouti, PNAAR373)

This report has three main sections. The first describes current energy consumption in Djiboutian buildings and includes a summary of energy audits of typical buildings. The second presents recommendations for reducing energy consummption in present and future construction. The third section explores various options for achieving these reductions. Appendices include a guide to conducting energy audits, and energy audit findings for various buildings.

D. Djibouti Urban Development Project: Energy Conserving Design for Salines-Ouest Housing. Daniel C. Dunham, Volunteers in Technical Assistance (VITA), Arlington, VA, January 1985, 26 pp., PNAAX889. (French version: Projet de Developpement Urbain a Djibouti: Conception Permettant la Conservation d'Energie Pour le Projet de Logement a Salines-Ouest, PNAAX890)

Recommends energy conserving features to incorporate into the four low-cost housing designs to be built by World Bank/AID assistance in Salines-Ouest. The new features are designed to reduce radiant temperatures, to increase ventilation and air movement, and to reduce electrical consumption by a number of appliances. Estimated costs are provided.

E. Solar Pump Testing Procedure, no date or author, 6 pp., available from VITA, P.O. Box 12438, Arlington, VA 22209, (703) 276-1800.

Describes two simple procedures for testing PV water pumps. Test 1 determines maximum output, and consists of measuring output for various heads (at least three times for each head) at solar noon. Test 2 determines daily output, measuring daily water pumped for five consecutive days, each day at a different head. A sample blank data sheet is included for each test.

15. Evaluations/Major Findings:

A. Final Report: Djibouti Energy Initiatives Project. Meta Systems Inc., Cambridge, MA, January 1985, 50 pp., PDAAV996. (French version: PDBAW773)

This is a mid-term evaluation performed in December 1984. The project lacked coherent guidance from AID and suffered from conflicting objectives built in the project paper, grant agreement, contract, etc. Nonetheless, the evaluation team concluded that VITA had fulfilled or exceeded virtually all of its responsibilities.

Most of the notable accomplishments of the project dealt with energy conservation, institutional development, and increasing awareness of the energy supply/demand situation in Djibouti. The project had set the stage for a program of energy conservation and energy efficiency improvement which could bring about foreign-exchange savings of millions of dollars over the next decade. VITA and AID had determined that R.E. was not very appropriate to Djibouti, and the evaluators commended

them for recognizing this and taking appropriate action. The solar and wind data collection activity was viewed as well-designed and justified, but in need of reassessment in view of technical problems with the Climatronics data loggers. The evaluators agreed with the National Energy Assessment (see 14. B, above) that windmill and PV water pumping were least cost options under certain circumstances, and that one should not expect a substantial portion of water pumping to be performed in Djibouti by these technologies.

Eleven of the 37 recommendations deal with R.E. The evaluation recommended that an expert be brought in to improve the solar and wind data collection equipment, or, if this is not possible, that this activity be stopped and the equipment stored. The evaluation team also encouraged continued collaboration between ISERST/VITA and Genie Rural wind/PV water pumping and provided specific support to continued windmill-pumping development. Recommendations generally concur with those of the National Energy Assessment. It was suggested, however, that PV refrigeration plans be dropped since dispensaries currently are supplied with grid electricity. It was further recommended that a fan-wheel wind pump of 8 feet or more diameter be procured for demonstration at the ISERST building to replace the Sparco machine currently planned for this use, since the Sparco was considered too small.

16. Key Persons:

A. AID/Washington: Not specified

B. AID/Mission:

Jon Lundgren
USAID, Djibouti

C. Contractor:

Martin Bush, Chief of Party
Volunteers in Technical Assistance, 1815 N. Lynn Street, Suite 200, Arlington, VA 22209
(703) 276-1800

D. Host Country:

Abdourahman Farah Hassan
Institute for Higher Scientific and Technical Research and Studies (ISERST), B.P. 486, Djibouti

17. Obligations by Fiscal Year (US$000):

1982	1,520
1983	327
1984	1,133
1985	433
1986	587

TOTAL	4,000*

*Does not include $400,000 increase in LOP funding.

(Source: Project Paper, 5/6/81, PDBAH268)

18. Host Country Funding of R.E. Components (US$000): 1,350*

*For entire project; R.E. costs not specified separately.

(Source: Project Authorization, 6/81, PDBAH269)

19. Summary of R.E. Costs (US$000):

A. Proposed costs:

Data base	548
Prototypes/pilot projects	2,267
Assessment	523
Dissemination of research results	424
Conservation	238

TOTAL	4,000*

*Does not include $400,000 LOP increase; for entire project, R.E. costs not specified separately.

(Source: VITA project files)

B. Actual Costs:

Salaries	664.375
Fringe benefits	140.462
Occupancy	31.257
Overhead	522.107
Consultants	168.409
Allowances	257.699
Travel/transport	186.088
Other direct costs	166.697
Construction	896.244
Project equipment	352.196
Participant training	74.466
Fixed fee	40.000

TOTAL	$3,500.000*

*Represents contractor budget only, not total LOP; for all project components, R.E. costs not specified separately; and does not include $400,000 LOP increase.

(Source: PIO/T 603-0013-3-30009, 9/8/85, VITA office files)

20. R.E. Component Revisions:

A. Project emphasis shifted away from renewable energy prototype development, per memo of March 8, 1983 from Wes Fisher, REDSO/ESA. Four of the six original planned R.E. interventions were dropped: solar distillation, solar fish drying, solar fish smoking, and wind-electric generation.

(Source: Final Report: Djibouti Energy Initiatives Project, 1/85, pp. 6, 16, PDAAV996)

B. The project was redirected to emphasize (1) energy conservation--fostering of building code revisions, training, public awareness activities, retrofitting of certain buildings, and private sector activities; and (2) water pumping.

(Source: Project Implementation Letter No. 15, 6/18/85, PDBBB706)

C. The original contractor for construction of the Renewable Energy Office Building was considered in default after falling more than a year behind the construction deadline and was replaced by a new general

contractor. Because of these events, it was estimated that final construction costs would be between $844,000 and $891,000, exceeding the orignial $803,000 estimate.

(Source Project Implementation Letter No. 14, 3/17/85, PDBBB706)

D. The PACD was extended from September 30, 1986, to March 30, 1987.

(Source Project Implementation Letter No. 12, 2/9/84, PDBBB706)

E. A number of modifications were made to the VITA contract, including (1) an increase to VITA home office support to ensure adequate backstopping of field operations, and (2) provision of additional local hire staff, short-term assistance in the preparation of the national energy assessment, and a full-time VITA technician for two years to manage the weather gathering program and establish the laboratory/workshop at the new Energy Section offices.

(Source Project Implementation Letter No. 12, 2/9/84, PDBBB706)

F. LOP funding was increased by $400,000 and added to the VITA contract.

(Sources: State Department telexes, 8/86 and 9/86, PDBBD427; Amendment No. 5 to contract No. 603-0013-C-00-2001-05, VITA office files)

G. The PACD was extended six months to September 30, 1987, and the VITA contract extended nine months to September 30, 1987.

(Source: State Department telex, 8/86, PDBBD428)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: January 1986 (mjr)
Revised May 1987 (jrl)

1. Project Number: 6080158.01 2. Geo: MOROCCO

3. Title: CIDERA SCHOOL GRANT--FARM DEVELOPMENT

4. Project Life/PACD: 1979-82/March 31, 1982

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 124

   B. R.E. Components: 36

   (Source: Final Evaluation, 2/83, PDAAN304)

7. Loan or Grant/Appropriation Category (US$000):

   G / FN / 124

   (Source: DIS)

8. Project Purpose:

   To improve the economic viability and development capability of the Centre d'Education Rurale Africain (CIDERA) school farm by increasing yields of agricultural products and improving livestock production.

9. Renewable Energy (R.E.) Outputs:

   Ten solar collector water heaters installed; One solar oven/furnace installed.

10. R.E. Inputs:

    Financial assistance; Purchase of materials.

11. Summary of R.E. Components:

    Catholic Relief Services (CRS) received an OPG to assist CIDERA in three ways: increase the economic viability and development capability of the CIDERA model farm; demonstrate practical rural applications of solar energy; and establish a CIDERA Health Rehabilitation Center. To demonstrate small-scale applications of solar energy, CIDERA installed solar collectors to heat water for student dormitories and a farm workers' shower/washing building. A solar oven/furnace, which could produce steam for sterilization, canning, and

production of electricity, was planned; construction was completed in April 1983, after the PACD.

12. R.E. Project Descriptors:

Solar collectors; Solar heating; Water heaters; Heating; Furnaces; Canning; Electric power generation; Food preparation.

13. R.E. Technology Applications:

A. Installed ten solar collector systems at students' dormitories and farm buildings to heat water for domestic use. Each solar collector panel was connected with a 150-liter water tank and a piping distribution system. The solar system was linked through a bypass system to an 800-watt electrical resistance heater with 75-liter water tank; the solar system can be used alone, however. Water was heated to 50-70 degrees Celsius. Monitoring revealed that the solar system achieved approximately 50% savings in electricity consumption compared to the normal electric water heaters. The cost of the solar water heating system was approximately DH 3,500.00. Assuming a DH 0.40 kw-hr cost for electricity, and a 20% annual increase in electricity, the system would be amortized at the beginning of the seventh year.

(Source: Final Evaluation, 2/83, PDAAN304; Progress Report and Evaluation - Final, 1983, PDAAV560)

B. The construction of the solar oven/furnace was completed at the end of April 1983. This 11 kW thermal solar facility consists of an electronically controlled, hydraulic, 30 square meter heliostat containing 60 mirrors, a 20 square meter concentrator made up of 208 mirrors, a twin-chamber bread-baking oven on rails, and a tripod-mounted kiln for ceramics firing. Possible applications include baking, sterilization, canning, treatment of minerals, fusion of metals, ceramics production, and steam production. Traditional baking of bread was modified and bread baking successfully carried out in the solar oven, as judged by a jury of tasters. It was calculated that the solar oven could bake a maximum of 160 450-gram (1-pound) loaves per day (but could be modified to accommodate 400 loaves per day), allowing the plant to be amortized in 10 years. Experiments in a specially adapted kiln for ceramics firing reached a maximum temperature of 850 degrees C., and work is proceeding to modify the pre-heating chamber to attain 1,000 degree C. temperatures.

(Source: Progress Report and Evaluation - Final, 1983, PDAAV560)

14. R.E. Technical Reports and Publications:

A. Pilot Project to Demonstrate Rural Applications of Solar Energy - CIDERA. Progress Report and Evaluation (Final). Michael Sheehan, Catholic Relief Services, [1983?], 13 pp., PDAAV560 (available only in paper).

This report is an overview and status of the solar oven/furnace project rather than a formal evaluation. It includes several photos of the solar oven/furnace, a newspaper article describing the project, and a 5-page English translation of an agreement between the Ministry of Agriculture and Agrarian Reform and the Ministry of Energy and Mines, which entrusts the CDER of the MEM to have full and entire rights to use of the solar oven/furnace facility. A brief description of the facility is included.

15. Evaluations/Major Findings:

A. Report on the Final Evaluation of the Cidera Project (plus 4-page PES). Michael Sheehan (CRS), Ursula Nadolny (USAID), A. Acedo, and M. Hanafi. USAID, Rabat, Morocco, February 1983, 6[illegible] pp., PDAAN304.

The evaluation reviews the three project components: the CIDERA model farm, the CIDERA Health Rehabilitation Center, and solar energy. For solar energy, energy (electricity) savings and economics of the solar heating system are calculated through comparison of conventional electric water heaters with a solar-assisted water heater. The solar collectors used to heat water seem viable economically; the systems would be amortized by the beginning of the seventh year.

B. Project Evaluation Summary. Conchita Sanborn, Catholic Relief Services, March 1980, 18 pp., PDAAG040.

Evaluation of the first six months of the project. A preliminary feasibility study had been carried out on the solar energy activities by an engineer from GEFOSTAT. No findings mentioned.

16. Key Persons:

A. AID/Washington: Not specified

B. AID/Mission:

Ursula Nadolny, Evaluation Officer
USAID/Morocco

C. Contractors:

Michael Sheehan, Director
Catholic Relief Services
1011 First Avenue
New York, NY 10022
(212) 838-4700

D. Host Country:

R.P. George Coutourier, le Directeur
CIDERA
Temara, Morocco

17. Obligations by Fiscal Year (US$000):

Actual disbursement of funds:

FY 80	91.0
FY 81	17.0
FY 82	15.8
TOTAL	123.8

(Source: Final Evaluation, 2/83, PNAAN304)

18. Host Country Funding of R.E. Components (US$000): Not specified

19. Summary of R.E. Costs (US$000):

By Category, for Solar Energy, Final Financial Report:

Construction Materials	27.7
Tools and Equipment	2.3
Water Heaters	1.7
Solar Mirrors	2.8
Pulley Block	1.0
TOTAL	35.5

(Source: Final Evaluation, 2/83, PDAAN304)

20. R.E. Component Revisions:

A. LOP funding for entire project was increased by $6,000 to $124,000, and the PACD was extended one year to March 31, 1982.

(Source: Final Evaluation, 2/83, PDAAN304)

B. The solar oven/furnace component experienced delays due to problems with locally manufactured mirrors. A

decision was made to import mirrors. Installation was scheduled for March 1983, and the first technical tests and demonstrations for April 1984 (after PACD).

(Source: Final Evaluation, 2/83, PDAAN304)

C. During 1982, ownership of the project site, the Temara Agricultural School, was transferred from the Jesuit Fathers to the Ministry of Agriculture; the latter signed an agreement with the Ministry of Energy and Mines allowing it full and free use of the solar facility, initially for a 2-year period, but with possibility of indefinite extension. The Centre pour le Developpement des Energies Renouvelables (CDER), within the Ministry of Energy and Mines, assumed management responsibility for the solar oven/furnace.

(Source: Progress Report and Evaluation - Final, 1983, PDAAV560)

21. Follow-On Activities:

A. Funding for the solar oven/furnace was provided to CRS from the Geneva Travel Loan and Development Fund until June 1982. After that date, the French government provided funding through the French organization GEFOSAT (Groupement pour Etude de Fours et Outils Solaires et l'Assistance en Technologies Appropriees). Technical support has continued through GEFOSAT. CDER took over management responsibility in mid 1982 and has borne the cost of project personnel. It was not certain whether funding would be available for 1984. In December 1983, however, a French volunteer engineer was due to arrive from France to replace the present volunteer assigned to CDER to head up the on-site team, and a Moroccan engineer was to return from training at GEFOSAT in France. Immediate plans for the fall of 1983 called for the construction of a wind shelter for the concentrator and fine tuning of the electronic control system.

A senior GEFOSAT engineer was scheduled to arrive in October 1983 to undertake a study of Morocco's needs in high-temperature processes. It appears that this may include an assessment of the potential market for the solar oven/furnace technology and recommendations for its future development.

(Source: Progress Report and Evaluation - Final, 1983, PDAAV560)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: July 1986 (mgz)
Revised February 1987 (jrl)

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1. Project Number: 6080159 2. Geo: MOROCCO

3. Title: MOROCCO RENEWABLE ENERGY DEVELOPMENT

4. Project Life/PACD: 1980-86(extended to 87)/March 30, 1987

5. Project Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 9,200

   B. R.E. Components: 9,200

   (Source: Fifth Amendment to Project Grant Agreement, 7/27/84, PDHAD501)

7. Loan or Grant/Appropriation Category (US$000):

   G / SD / 600
   G / ARDN / 8,600

   (Source: DIS)

8. Project Purpose:

   To assist the Government of Morocco (GOM) Ministry of Energy and Mines (MEM) in creating a Center for Renewable Energy Development with the professional staff and facilities to carry out a wide range of applied research and design activities, studies, and analyses to identify the most effective ways to exploit Morocco's renewable enery potential and to develop programs to develop its efficient use throughout the country.

9. Renewable Energy (R.E.) Outputs:

   A Center for Renewable Energy Development established; 30 Moroccan staff members trained for the Center; 3 small, remote hydroelectric generation pilot plants established; 10 wind, solar, and biomass projects installed and functioning.

10. R.E. Inputs:

    Long-term technical assistance; Short-term technical assistance; Training; Commodities; Small projects fund; Studies and evaluations.

11. Summary of R.E. Components:

The project financed the creation of the Centre de Developpement des Energies Renouvelables (CDER), which conducts studies and demonstraticns of renewable energy technologies. Staff for the Center was trained, and laboratory equipment was purchased. A small projects fund was established to enable CDER to support renewable energy activities in the private and public sectors. Pilot projects were designed for small hydropower, photovoltaics, biomass, wind energy, and solar energy.

The prime contractor was Research Triangle Institute (RTI), working under a host country contract to CDER. RTI retained a number of subcontractors, including A.T. Kearney, Inc.

12. R.E. Project Descriptors:

Wind energy; Solar energy; Biomass; Biomass digestion; Photovoltaic energy; Hydroelectric power plants; Biogas; Electric power generation.

13. R.E. Technology Applications:

A. Biomethanation Project

Almost all digesters installed to date in Morocco have 6-10 cubic m capacity. They were designed for manure loading rates of 125-150 kg/day, but current rates are typically 20-25 kg/day. The time required to reach loaded capacity is 5 to 6 times the design rate. Gas production and byproduct sludge production fall proportionally. A special evaluation recommended that CDER experiment with digester designs that are better matched to current loading rates and gas requirements. The evaluation also suggested looking at biomethanation as a system and considering use of manure substitutes such as agricultural wastes. (Note: a biogas digester is performing well on Chabini Farm, producing biogas for lighting and heating.)

(Sources: Evaluation on Biomethanation Program, 3/86, PDAAT010; and Implementation Letter No. 15, 3/17/83, PDHAD507)

B. Sidi Bounouar Wind Generation Pilot Project

Wind pumping site is on a large farming cooperative, where currently there are two non-operating windmills (one almost new) at the edge of an olive orchard.

(Source: Implementation Letter No. 16, 11/17/83, PDHAD507; SERI Trip Report, 2/3/83, p. 7, PDHAD538)

C. CRAFA Pilot Photovoltaic-Powered Pumping Project

Contract was issued to Solar Engineering Services (SES) of Olympia, Washington, for the following: 7 kWp PV array (190 Solarex SX-120 modules); Solarex torque tube support structures for array mounting; 6 inverters and switch boxes; 6 submersible pumps with drop cables; grounding wires for lightning protection; wiring and hardware for system interconnection; spare parts; measurement apparatus for monitoring; and installation costs (labor and travel). Original contract was for $99,946, later amended to $119,000.

Equipment was shipped to Morocco in Spring 1985, and SES installed the PV array during May 13-31, 1985. Pumps were not installed due to sand in the wellwater. Reservoir and irrigation systems were incomplete. On September 17, 1985, the date of the site visit by the evaluation team, the installation was still incomplete.

(Source: Evaluation Report, 11/85, p.C-3, PDCAR414)

D. Wind Energy Pilot Project, Ain Tolba - Dar el Hamra

The project, approved for $53,900, proposes to equip Ain Tolba with a 5 kW wind generator and Dar el Hamra with a 4.5 kW machine to service a regional water distribution system. Water is to be pumped from a spring at Ain Tolba to the settlement of Dar el Hamra where it would be gravity fed to the settlement of Hachleff and pumped to the settlement of Rmilat. Life-cycle cost analysis revealed that the Ain Tolba wind generator would cost approximately the same as a diesel, while the Dar el Hamra system would be slightly more expensive than the diesel alternative.

(Source: Implementation Letter No. 27, 9/84, PDHAD507; Evaluation Report, 11/85, p. C-7, PDCAR414)

E. Tabant-n' Ait Imi Micro-Hydro Pilot Project

This was intended to be a demonstration project providing 200 kilowatts of power for up to 3,300 people. Total project budget is approximately $500,000, of which $200,000 has been used for two 100 kW turbines imported from the United State. There were problems with completion of civil works by the Office National de l'Electricite (ONE) due to funds passing first through CDER before going to ONE. Project PACD was extended to December 30, 1986, to allow sufficient time for installation. As of September 1985, ONE had issued an RFP for completion of the civil works, and USAID had

prepared an RFP for the purchase, shipping, and on-site installation of two turbines by an American firm.

(Source: Evaluation Report, 11/85, PDCAR414)

F. Sidi Yahia Wind-Powered Electrical Generation Project

Application mentioned only, not described.

(Source: Implementation Letter No. 15, 3/17/83, PDHAD507)

G. Ecole des Mines, Marrakech (EMM) Solar-Powered Pumping (Photovoltaics) Project

Application mentioned only, not described.

(Source: Implementation Letter No. 15, 3/17/83, PDHAD507)

14. R.E. Technical Reports and Publications:

A. Review of Biomethanation Program, Centre de Developpement des Energies Renouvelables (CDER), Morocco. Norman L. Brown, Washington D.C., March 24, 1986, 19 pp., PDAAT010.

This report reviews the biomethanation program under way in Morocco. The author suggests that CDER should collect data and design digesters to suit conditions and needs in Morocco, rather than use the ill-suited Chinese digesters currently installed. The role of CDER in the program and future activities for it are discussed; recommendations are presented. The report focuses on programmatic issues; technical topics are not reviewed. Appendix B covers the planning of biomethanation systems.

B. Trip Report to Morocco. Eugene L. Maxwell, Solar Energy Research Institute (SERI), Golden, Colorado, February 3, 1983, 22 pp., PDHAD538.

The report describes the three week trip to Morocco of three SERI staff members. The principal objective of the trip was to conduct a seminar in Marrakech on solar and wind resource assessment, but the team also traveled to project sites and held technical discussions with officials in Rabat.

C. Trip Report to Morocco. Andrew McWilliams, A.T. Kearney Inc., January 31, 1984, 136 pp., PDHAD538.

This progress report assesses the potential rural demand for renewable energies in Morocco. The report evaluates 20 energy applications in the rural sector, identifying

14 with sufficient potential to warrant further research and development. The report does not describe the on-going work in the CDER pilot projects but it does examine the technologies being demonstrated.

D. Research Report: Biomass for Energy in Morocco. Pieter Hoejstra, Kjell Christophersen, and Jerry Jones, USAID/USDA, Washington, D.C., August 1980, 106 pp., PDHAD534.

The research team advised on facility design for the CDER Center and assessed the potential of forestry and agricultural biomass for energy production. The team concluded that animal waste and municipal solid waste offer modest potential for energy conversion, but the greatest potential is with woody feedstock, from either planted plantations or forest products residue.

The report also analyzes conversion technologies, specifying several with moderate or high potential for converting biomass to energy in Morocco. Thirteen biomass conversion projects are discussed, and a preliminary economic appraisal is performed.

15. Evaluations/Major Findings:

A. Project Evaluation Summary for the Period August 1982-September 1983. Terence Hart, James Howe, and Kennell Touryan, Sheladia Associates Inc., Riverdale, Maryland, March 1984, 6 pp., PDHAD536.

The evaluation team reported that the project was very promising thanks to an abundance of renewable energy resources in Morocco, technologies available to exploit them, strong GOM and CDER support, and rapid progress on technical tasks. Recommendations were made, however, to revise strategic, staffing, training, and procurement plans in light of construction delays on the CDER building. The team also made suggestions for improving selection of future pilot projects, emphasizing the need for market penetration.

Miscommunication among USAID, CDER, and the contractor was attributed to the use of a host country mechanism for contracting U.S.-based technical experts; a direct contract mechanism through AID would have been more effective. Recommendations were made on several administrative matters, including extending the PACD one year.

B. The Renewable Energy Development Project in Morocco Needs To Make Progress in 1984 or the Project Should Be Redesigned or the Funds Deobligated. Regional Inspector

General for Audit/Nairobi, July 13, 1984, 12 pp., PDHAD537 or PDAAP495.

The auditors state that the project has made minimal progress and that unless significant progress is made in 1984 the project design should be reconsidered. If that is not possible, the funds should be deobligated. The auditors state explicitly that they disagree with the positive findings of the 1984 evaluation.

C. Evaluation Report. Daniel F. Kohler and Frank Kreith, Energy/Development International, Washington, D.C., November 1985, 108 pp., PDCAR414.

From the viewpoint of institution building, the project was found to be a success, since CDER was created and operating reasonably well after a relatively short time. The evaluation team, nonetheless, felt that the project needed reorientation. On one hand, it should concentrate on a few promising technologies; on the other, it should broaden its approach to consider financial, economic, and sociological problems.

The team also expressed its opinion that the greatest obstacle to dissemination of renewable energy technologies in Morocco was neither technical nor sociological, but rather due to the economic policy environment, which supported conventional energy sources. CDER could make a valuable contribution in the area of energy policy analysis, especially fiscal and pricing policy.

The team found training insufficient, and did not support wholeheartedly RTI's shift from long-term academic training to short-term technical training. Quality of reports was found unsatisfactory, as was preparation of second-round pilot projects.

The evaluation gives sixteen specific recommendations. Principal ones among them are the following: (1) CDER must define its mission; (2) CDER must strengthen its analytical capabilities; (3) The PACD should be conditionally extended; (4) The project should be more carefully monitored; (5) New pilot projects should be reconsidered, evaluated not on the basis of the energy they produce, but rather on the basis of the information they generate, the training opportunities they provide, or their demonstration effects; and 6) RTI/A.T. Kearney must improve the quality of reports.

16. Key Persons:

A. AID/Washington:

Carolyn Coleman
ANE/TR/ENR, Room 4440 NS
(202) 647-9734

B. AID/Mission:

Dianne Tsitsos, Project Officer
Office of Technical Projects

C. Contractors:

Albert Himy, Resident Technical Coordinator
Research Triangle Institute (RTI), P.O. Box 12194,
Research Triangle Park, North Carolina 27709
(919) 541-6000

A. T. Kearney, Inc.

D. Host Country:

Mr. Mohamed M'Zabi, Secretary General
Centre de Developpement des Energies Renouvelables
(CDER), B.P. 38, Marrakech, Morocco

17. Obligations by Fiscal Year (US$000):

FINANCIAL PLAN FOR DISTRIBUTION OF PROJECT FUNDS

Fiscal Year:	1983*	1984	1985	1986	TOTAL
Contribution:	1,836.2	1,887.6	2,508.3	2,967.9	9,200

*Actual expenditure up to and through FY83.

(Source: Implementation Letter No. 28, 4/12/85, PDHAE901)

18. Host Country Funding of R.E. Components (US$000): 5,550

(Source: Project Status Report, 10/25/85, PDGAD476)

19. Summary of R.E. Costs (US$000):

By Input Component, as of June 24, 1986 (only $7.65 million of the LOP $9.2 million had been obligated by that date):

Category	Obligated	Planned
Preparatory workshops and studies	714	714
Priority equipment	83	83
Technical assistance	4,594.3	4,594.3
Laboratory materials	920	1,427.8
Training	258.7	258.7
Small hydro pilot projects	350	350
Solar & wind pilot projects	400	400
Biomass pilot projects	22	22
Future solar and wind projects	0	98
Future biomass pilot projects	0	62
Small projects fund	107	345
Evaluations	78	128
Training (AID)	71	71
Contingencies	50	646.2
TOTAL	7,648	9,200

(Source: Sixth Amendment to Project Grant Agreement, 6/24/86, PDCAR407)

20. R.E. Component Revisions:

A. Decision was made to fund only one of the three planned small hydropower pilot projects. Funds amounting to $375,000 were shifted from those pilot projects to Evaluation ($135,000) and Contingencies ($240,000). There is no mention of why the two pilot projects were canceled.

(Source: Implementation Letter No. 28, 4/12/85, PDHAE901)

B. The PACD was extended to March 30, 1987.

(Source: Implementation Letter No. 30, 3/18/86, PDCAR411)

21. Follow-On Activities:

A. The Ghouiba biodigester was produced and financed locally by a farm owner. This work has helped CDER to gain experience in constructing and operating a biogas digester, and some of this experience has been transferred, with apparent success, to the Offices

Regionaux de Mise en Valeur Agricole (ORMVAs), particularly in Agadir province, where an increasing number of farmers are constructing digesters of their own. The farmers receive technical advice from the ORMVA staff, who in turn are backed by CDER engineers.

(Source: Evaluation Report, 11/85, PDCAR414)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: July 1986 (mgz)
Revised February 1987 (jrl)

---------- AID RENEWABLE ENERGY DATA BASE ----------

1. Project Number: 6080180 2. Geo: MOROCCO

3. Title: ENERGY PLANNING ASSISTANCE

4. Project Life/PACD: 1984-89/September 30, 1989

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 4,000*
   4,443**

   B. R.E. Components: Not specified

   (Source: *Project Status Report, 10/24/85, PDGAD526; **DIS)

7. Loan or Grant/Appropriation Category (US$000):

   G / SD* / 4,000*
   4,443**

   (Sources: *Project Status Report, 10/24/85, PDGAD526; **DIS)

8. Project Purpose:

   To strengthen the analytical and policy advisory capabilities of the recently established Energy Planning and Evaluation Service (SPD) within the Government of Morocco's (GOM) Ministry of Energy and Mines (MEM).

9. Renewable Energy (R.E.) Outputs:

   Energy pricing structures, including R.E. analyzed; National energy components prioritized; Energy investment proposals reviewed; Critical energy studies, including those on wood and charcoal, conducted; Energy data base maintained; Inter- and intra-ministerial policy dialogue maintained.

10. R.E. Inputs:

    Technical assistance; Training; Commodities.

11. Summary of R.E. Components:

    The project is a follow-on to projects 9365703 and 9365728. The principal objective is to provide technical assistance to

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upgrade the capabilities of the SPD within the MEM in the areas of energy pricing, investment planning, conservation, research, information management, and policy dialogue.

Specific R.E. activities include a survey of household energy consumption, especially fuelwood, and a review of wood and charcoal markets, especially pricing/production structure. A comprehensive computer-aided model of the Moroccan energy sector will examine renewable energy options to incorporate them into (1) an investment portfolio to help to meet future energy needs; (2) an energy pricing review and analysis; and (3) recommendations for measures to promote conservation and efficiency.

12. R.E. Project Descriptors: Charcoal; Firewood.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications:

    A. Application of the Forestry Resources Analysis and Planning (FRAP) Model: An Assessment and Projection of Fuelwood Supply and Demand in Morocco and an Investigation of Possible Interventions. Robert D. Kirmse and Asif M. Shaikh, International Science and Technology Institute, Inc. (under contract to Energy/Development International), Rabat, October 1986, 88 pp., PDAAV309.

    This report describes the FRAP (a simulation model written with Lotus macros) which is capable of interacting with INVEST (a related model) allowing the user to create and cost a series of potential investments, including fuel substitution, supply measures, and device efficiency. The report provides many computer-generated tables and graphs showing fuelwood supply/demand data with a number of breakdowns, such as demand by end-use, fuelwood for household cooking by rural/urban area, etc. A fuelwood supply and demand projection is made by region for the next 20 years. Five scenarios investigating the effects of investment programs on supply and demand balances over a 20-year period are discussed, and the computer-generated results are presented in graph form.

15. Evaluations/Major Findings: Not specified

16. Key Persons:

    A. AID/Washington:

    Carolyn Coleman
    ANE/TR/ENR, 4440-19 NS, 647-9734

B. AID/Mission:

Mohammed Oubnichou, USAID Project Manager
Robert Kahn, USAID Project Manager
USAID/Morocco

C. Contractors:

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Rick Huntington, Desk Officer
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Claude Garrigues, Energy Efficiency Advisor
International Development and Energy Associates (subcontractor to ISTI), 1025 Connecticut Ave., NW, Suite 705, Washington, D.C. 20036, (202) 955-5744

Energy/Development International (subcontractor to ISTI), 1015 18th St. NW, Suite 802, Washington, D.C. 20036, (202) 822-8817

D. Host Country:

Ahmed Bouhaouli, Energy Director
Ministry of Energy and Mines

17. Obligations by Fiscal Year (US$000):

Estimated Expenditures:

FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	TOTAL
2	670	978	1,133	724	493	4,000

(Source: Grant Agreement, Table 2 to Annex 1, 8/28/84, PDHAD912)

18. Host Country Funding of R.E. Components (US$000): 1,400*

*For entire project; R.E. costs not specified separately.

(Source: Project Paper, 8/84, PDHAD910)

19. Summary of R.E. Costs (US$000):

A. Projected Expenditures:*

Technical Assistance (long term)	2,058
Technical Assistance (short term)	415
Technical Assistance (information systems)	556
Training (energy planning)	131
Academic Training (AID/W, energy component)	149
Short Term Training (AID/W, energy component)	62
English Language Training (USAID/Morocco)	17
Information Systems Needs Assessment	61
Commodities (information systems)	80
Energy Audits/Industrial Conservation	63
Evaluations	75
Contingency (USAID/Morocco)	333
TOTAL	4,000

*For entire project; R.E. costs not specified separately.

(Source: First Amendment to Project Grant Agreement, 6/25/85, PDHAD912)

B. Budget Expenses, by Category, ISTI Contract Only:

Training	84.5
Commodities	38.8
Technical Assistance	2,105.7
Fees	187.4
TOTAL	2,416.4

(Source: ISTI Contract, pp. B-1,B-2, 9/30/85, PDGAD524)

20. R.E. Component Revisions: Not specified

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: July 1986 (mgz)
Revised February 1987 (jrl)

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1. Project Number: 6150205 2. Geo: KENYA

3. Title: RENEWABLE ENERGY DEVELOPMENT

4. Project Life/PACD: 1980-84 (extended to 86)/December 31, 1986

5. Status: Terminated

6. LOP Funding (US$000):

   A. Entire Project: 4,800

   B. R.E. Components: Not specified

   (Source: Quarterly Progress Review, 6/30/85, PDBBE009)

7. Loan or Grant/Appropriation Category (US$000):

   G / ST / 4,800

   (Sources: Quarterly Progress Review, 3/31/85, PDBAV779; Project Implementation Report, 9/30/84, PDBAV779)

8. Project Purpose:

   To stimulate development and dissemination of renewable energy technologies; To promote/expand afforestation and fuelwood conservation efforts; To support institutional development of Ministry of Energy.

9. Renewable Energy (R.E.) Outputs:

   Agroforestry centers established; Energy Development Fund set up (and later terminated); Energy Data Bank and library established; Surveys of technology, of R.E. activities, and of wood/charcoal pricing, marketing, and distribution conducted; Improved wood and charcoal stoves developed, demonstrated, and disseminated through training of stove manufacturers; Fuelwood production and more efficient charcoal production stimulated; Sustained-yield forest management promoted.

10. R.E. Inputs:

    Technical assistance; Commodities; Credit.

11. Summary of R.E. Components:

The project provided assistance in the following areas: planning and surveys on energy conservation and fuelwood and forestry production in support of the Ministry Of Energy (MOE)/Beijer Institute Fuelwood Cycle Planning Project; development of R.E. and energy conservation technical, analytical, and extension expertise in the Ministry of Energy, supporting ministries, and nongovernmental organizations; applied research and demonstration aimed at stimulating development and dissemination of simple, low-cost R.E. technologies able to meet the basic needs of Kenya's urban and rural poor and of other R.E. technologies capable of substituting for scarce petroleum, wood, and charcoal-based fuels; and monitoring and evaluation.

Applied R&D activities focus on rural afforestation and agroforestry; improved wood and charcoal cookstoves and cooking methods; and improved charcoal production technologies. Major successes were achieved in improved charcoal stoves.

Six agroforestry centers were established, involved mainly with seedling and seed production, R&D, and extension and training. By mid-1983, the centers had succeeded in producing 1.7 million seedlings and had a combined capacity of 7 million seedlings per year, compared to 1.2 million per year targeted under the project.

Energy/Development International (E/DI) was the prime contractor under an AID-host country contract with the Government of Kenya. Energy Systems Research Group provided computer programming support and training. The Beijer Institute and Clark University were subcontractors for the expanded (Phase II) Kenya Fuelwood Cycle Study. Peace Corps volunteers were assigned to assist with the project. The Ministry of Energy was the implementing agency. The Ministries of Agriculture and of Environment and Natural Resources (Forestry Department) participated on the fuelwood/ agroforestry component. The Kenya Energy Nongovernmental Organizations Association (KENGO) was a subcontractor. Training of stove testing personnel, testing of new charcoal stove prototypes, and development of standard testing procedures for Kenya charcoal stoves benefited from collaboration with the British ITDG Stoves Project. Aprovecho Institute assisted in the identification and simple testing of ceramic materials.

12. R.E. Project Descriptors:

Charcoal; Firewood; Stoves; Coffee husks; Wood shavings; Biomass; Solar energy; Water heating; Cookstoves; Briquettes; Agroforestry.

13. R.E. Technology Applications:

A. Coffee Husks and Wood Shavings as Fuel

The project assisted a local packaging manufacturer in obtaining an import permit for a biomass extruder. He used the machine to briquette coffee husks and wood shavings, thus achieving about a $57,000 per year reduction in fuel oil use. A project case study examined a proposal to convert the East African Industries to coffee husk fuel.

(Source: Quarterly Progress Report No. 7: April-June 1983, July 1983, PDBA0195)

B. Hybrid Solar and Fuel-Oil Hot Water System

A draft evaluation of the economics and technical experience of a hybrid solar and fuel-oil-fueled hot water system installed at Egerton College under a USAID-financed project was prepared.

(Source: Quarterly Progress Report No. 7: April-June 1983, July 1983, PDBA0195)

C. Jiko Charcoal Stove

The project redesigned a traditional charcoal-burning stove--the scrapmetal jiko--by adding a low-fired terracotta and/or cement/vermiculite lining. The project also arranged mass production of both stove elements, conducted limited laboratory and household tests, and conducted training workshops for both trainers and artisans.

In lab PHU2 tests, which measure the percent of the charcoal's heat utilized in boiling and evaporating 2.0 liters of water for 60 minutes, the traditional jiko measured 20-22% PHU, while the improved bell-bottom shaped jiko measured 29-32% PHU, resulting in a 34% fuel savings. The improved stove is easier to light: in lab tests the improved stove required 20 minutes for lighting and the boiling of 2 liters of water, while the traditional jiko required 28-32 minutes. However, it had several drawbacks: it required greater care in handling and it tended to crack if it came into contact with water while hot.

Production nationwide had reached 500 stoves per month by October 1983. By late 1986, 125,000 improved jikos had been sold in Kenya, primarily in and around Nairobi, through this and an ATI follow-on project. A 1985 ATI

study indicated that the average unit production cost (excluding profit) for the most common size improved jiko was 44-56 Kenyan shillings (K.S.), depending on the capacity of the enterprise and the production rate; material costs accounted for 52-66% of total costs, while labor accounted for 14-18%. Traditional jikos retailed for K.S. 35-45 depending on stove size and location, compared to K.S. 85-125 wholesale and K.S. 125-250 retail for the improved stoves when demand outstripped supply. In mid-1985, the factory price for improved jikos was K.S. 60-85 in Nairobi and K.S. 125 in western Kenya, while the retail price at sales outlets was K.S. 90-125 in Nairobi and up to K.S. 145 in western Kenya. Despite the higher costs, demand was greater than supply.

ATI designed and built a simple motorized mold, called the "jilo-jolly," which produces clay liners of a uniform shape, size, and consistency at a faster rate than hand molding; plans call for a similar manual version. Several were purchased by agencies in neighboring countries for use in their stove programs. One producer adopted the jolly in Kenya, and by late 1986 had used it to capture 30-50% of the market for liners in the Nairobi area. ATI is also introducing simple methods of testing, modifying, and processing clay mixtures to improve the quality of clay liner production.

Several businesses have entered into improved jiko stove production:

- Clayworks, the country's principal brick producer, sold 7,600 liners to traditional jiko makers in Nairobi between November 1982 and August 1983. The quality was reported to be poor. By August 1983 they had reached a monthly production level of 2,600, after which they stopped production.

- Jerri International manufactured 3,500 ceramic liners in the first nine months of 1983: 1,500 were sold to jiko makers, the remainder were assembled into finished stoves and sold to retailers. Jerri International also supplies the Kenya Farmers' Association (KFA), a country-wide retailer, whose sales are reportedly brisk (100/month alone at the Nanyuki KFA). The owner of Jerri is seriously pursuing production of improved jikos, and plans to produce 400 per day at a price of K.S. 25 each. He has hired two skilled workers from Clayworks, installed a new kiln exclusively for stove liners, and bought a new clay crusher.

- Twenty-two artisans were making 2,600 metal claddings a month at Shauri Moyo, Nairobi; about one-third were

assembled on the spot or wholesaled through shops, and the rest sold to Jerri International or Clayworks.

- Miaki Jikos Co., owned by Maxwell Kinyanjui, the project manager for the project's jiko stove component, began production of high-quality liners which are wholesaled to metal artisans; completed jikos are sold to households. By March 31, 1985, this firm had accounted for almost 14% of the liner production.

- Ilesi Pottery at Kakamega produced 300 liners and 45 all-ceramic wood-burning stoves prior to October 1983.

- Production of stoves with cement/vermiculite linings and either bell-bottom or straight claddings was started in May 1983 at Mtwapa, Mombasa; 250 had been sold by October of that year.

The following table compares the improved jiko with the traditional stove and with two improved stoves developed by UNICEF:

COMPARISON OF KENYAN TRADITIONAL AND IMPROVED CHARCOAL STOVES

	Traditional Jiko	Bell-Bottom Stove	Umeme Stove	Haraka Stove
Retail price in Nairobi (K.S.)	40	60-85	85*	70*
Parts needing replacement	Metal grate	Ceramic liner/grate & insulation	Metal grate	Metal grate
Price of replacement parts in Nairobi (K.S.)	10	30**	15-20	20
Frequency of replacement of parts (months)	3	8-12	6-12	6-12
Expected lifetime at full use (months)	12	24	48	24
Efficiency in laboratory tests (%)***	20-22	29-32	33-36	28-31

*These prices are subsidized, since the artisans receive scrap metal from UNICEF at reduced prices. In a totally free market system, the Umeme stove might sell for K.S. 120, and the Haraka stove for K.S. 100.

**Includes labor.

***PHU2--percent of charcoal's heat utilized in boiling and evaporating 2.0 liters of water for 60 minutes.

(Sources: Economics of Improved Charcoal Stoves in Kenya, 11/85, p. 5, PNAAX806; Mid-Term Evaluation, 12/83, pp. 23-25, 79-88, PDAAV957; Strategy of Decentralized Production and Distribution of Improved Charcoal Stoves in Kenya, 12/9/85 (table taken from this source), PNAAX807; Improved Charcoal Stoves (Jikos) in Kenya, Appropriate Technology Bulletin No. 8, 2/87, available from VITA, P.O. Box 12438, Arlington, VA 22209, (703) 276-1800; see also additional stove reports under 14., R.E. Technical Reports and Publications, below)

D. Biomass Inventory

The production of agricultural residues, wood, and animal wastes in Kenya was estimated for the years 1980 and/or 1981.

(Source: Inventory of Biomass in Kenya: A Conditionally Renewable Energy, 2/82, PNAAX808)

14. R.E. Technical Reports and Publications:

A. The Economics of Improved Charcoal Stoves in Kenya. Eric L. Hyman, Appropriate Technology International, Washington, DC, November 1985, 27 pp., PNAAX806.

This report reviews the charcoal supply and demand situation in Kenya, the history of the introduction of both the project-developed bell-bottom jiko and the Umeme stove developed by UNICEF, the characteristics and construction of the two improved stove models, and the results of an ex-post financial and economic analysis of the jiko component of this project and an ex-ante analysis of an ATI-funded follow-on project.

B. The Strategy of Decentralized Production and Distribution of Improved Charcoal Stoves in Kenya. Eric L. Hyman, Appropriate Technology International, Washington, DC, December 9, 1985, 36 pp., PNAAX807.

This report reviews the history of the introduction of the improved project-developed bell-bottom jiko and the UNICEF-developed Umeme stove. Particular emphasis is

placed on the jiko: achievements in production, manufacturers of stoves and stove components, training, demonstration, and dissemination strategy are described.

C. How To Make the Kenyan Ceramic Jiko. Maxwell Kinyanjui and Laurie Childers, Energy/Development International, Nairobi, June 1983, 22 pp., PNAAX821.

This a step-by-step guide to producing and operating an improved charcoal-burning ceramic jiko at the village level. Includes construction of a metal cladding, making and firing a pottery liner, and insertion of a cement/vermiculite, diatomite, or ash thermal insulation layer.

D. Improved Charcoal Stoves (Jikos) In Kenya. Appropriate Technology Bulletin Number 8. Eric Hyman and J.F. Swartzendruber, Appropriate Technology International, Washington, DC, February 1987, 4 pp., available from VITA, P.O. Box 14238, Arlington, VA 22209 (703) 276-1800.

This bulletin describes an ATI-funded follow-on project on the production and dissemination of the Kenyan-developed bell-bottom improved jiko.

E. The Kenya Charcoal Stoves Program: Interim Report. M. Kinyanjui, Energy/Development International, Nairobi, June 1984, 45 pp., PDAAR936.

Activities undertaken during the period of March 1982 to March 1984 in developing and introducing fuel-efficient charcoal-burning cookstoves for household use are reviewed. Topics include progress on social needs and technology assessment surveys, prototype development, and production development. A preliminary assessment is included.

F. The Thai Claystove Industry. Maxwell Kinyanjui, Energy/Development International, Washington, DC, May 1982, 23 pp., PDAAV955.

This report presents the findings of an 18-day tour of of the Thailand claystove industry. Small-scale Thai stove factories, their production processes, stove prices, marketing and distribution, and stove utilization are described. An attachment is entitled "Proposed Standard Procedures to be Followed when Introducing Improved Cookstoves for Charcoal and Wood in Kenya."

G. Establishment of Ceramic Jiko Liner Production at Ilesi Pottery, Kakamega, Kenya. Laurie Childers, Energy/ Development International, Washington, DC, June 25, 1983, 37 pp., PDAAV956.

Production of ceramic liners for improved jiko cookstoves is described, and suggestions/recommendations are made for standardization of production procedures, improving quality control, demonstration and dissemination in the Kakamega Market, and training artisans.

H. Inventory of Biomass in Kenya: A Conditionally Renewable Energy. Keith Openshaw, The Beijer Institute, Stockholm, Sweden, February 1982, 35 pp., PNAAX808

Estimates of annual production of agricultural residues, wood, and animal wastes in Kenya for the years 1980 and/or 1981 are made.

I. Costs and Benefits of Proposed Tree Planting Programme for Satisfying Kenya's Wood Energy Requirements, Part I and Part II. Keith Openshaw, The Beijer Institute, Stockholm, Sweden, undated, 72 pp., PNAAX809.

This report is a comprehensive study of wood production costs in Kenya. Costs and potential production for agroforestry, managed natural forests, replanted forests, and various types of plantations are covered. Part II consists of tables on such topics as capital and operating costs of a 2-cubic-meter/day biogas plant; available energy for cooking/heating from felled wood at different moisture contents; economic transport radius for fuelwood at different moisture contents and for densified wood and charcoal produced in different kilns/retorts; and plantation establishment costs.

15. Evaluations, Major Findings:

A. Kenya Renewable Energy Development Project: Mid-Term Evaluation. Henry Kernan, Peter Little, and Ianto Evans, Institute for Development Anthropology, Binghamton, New York, December 1983, 132 pp., PDAAV957.

Noticeable achievements were the development and dissemination of an excellent charcoal stove, and considerable progress in energy conservation and policy planning. Hindrances included a serious Government of Kenya (GOK) budgetary crisis in March 1983, problems with commodities procurement, and a much heavier administrative burden on the technical staff than envisioned originally.

No progress had been made on woodstove development, charcoal production, sources of site-specific renewable energies, or wood-producing strategies other than agroforestry. Little progress had been made with the Beijer Fuelwood Cycle Study. The Energy Development Fund

(EDF), set up to fund small R.E. projects, was viewed as a failure.

The evaluators made ten recommendations, including: the energy/agroforestry centers should become renewable energy centers and serve as focal points of innovation and synthesis under the Ministry of Energy; the range of influence of the centers should be extended, and their administration improved; EDF operations should be simplified and redirected toward financing studies and stimulating energy-related enterprises in the private sector; women should participate to a greater extent; the project should undertake wood production schemes other than agroforestry; and the project should undertake studies on (1) charcoal production and marketing and the effect of government policies on these activities, (2) possibilities of improving the yield of pit kilns, and (3) the extent to which wood use in the kitchen can be improved and methods of achieving the improvements.

B. Attempts Should Be Made To Sustain the Successful Aspects of Kenya's Renewable Energy Development Project: Audit Report No. 3-615-85-5. December 11, 1984, 17 pp., PDAAQ333.

The auditors found the development of the improved jiko stove, the establishment of six agroforestry centers, and energy conservation efforts the outstanding achievements of the project. On the other hand, creation of an Energy Development Fund, community water supply activities, and improved charcoal kilns work never got off the ground, and implementation of an energy planning model and an energy data bank and library achieved only minimal success. Failures were attributed to the overly ambitious nature of the project design, the newness of the Ministry of Energy, and the weak financial condition of the GOK. The auditors expressed concern about the ability of the GOK to take over project activities after termination of USAID support. GOK support of Peace Corps volunteers had been insufficient, and the supply of vehicles to the project was not satisfactory. The auditors made four recommendations: (1) USAID/Kenya should undertake a budget review to see how remaining funds could be reprogrammed to support project activities effectively; (2) an agreement should be reached on initiating the EDF or else reprogramming those funds; (3) USAID/GOK should project operating costs for those aspects of the project to be supported by local currency funds to allow the GOK to assume takeover of activities according to AID policy on recurring costs; and (4) USAID should monitor Peace Corps volunteer assignments to ensure that counterparts are provided, that PCVs are used in an advisory/training capacity rather than displacing

Kenyans, and that logistical support arrangements are being complied with.

16. Key Persons:

A. AID/Washington:

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AFR/PD/EAP, 2450 NS
647-8286

B. AID/Mission:

Dwight Walker, Project Officer
USAID/Kenya, P.O. Box 30261, Nairobi, Kenya

C. Contractors:

I.M. Ndooli, Project Manager

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D. Host Country:

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Phone: 749747

17. Obligations by Fiscal Year (US$000):

PROJECTION OF EXPENDITURES BY FISCAL YEAR

81	1,209
82	1,736
83	1,167
84	688

TOTAL	4,800

(Source: Extracted from Table IV-2, pp. IV-10 to IV-11, Project Paper, 8/80, PDBAQ982 or PDBAU426)

18. Host Country Funding of R.E. Components (US$000): 1,700*

*For entire project; R.E. costs not specified separately.

(Source: Action Memorandum for the Acting Director, USAID/Kenya, 8/29/80, PDBAQ982)

19. Summary of R.E. Costs (US$000):

Technical assistance	3326.9
Participant training	53.0
Agroforestry Center support	895.0
Energy Development Fund	44.0
Monitoring & evaluation	100.0
Beijer/Clark	111.1
Commodities & supplies	270.0

TOTAL	4800.0*

*For entire project; R.E. costs not specified separately.

(Source: Quarterly Progress Review, 6/30/85, PDBBE009)

20. R.E. Component Revisions:

A. The PACD was extended from September 30, 1984, to December 31, 1985, to complete the planning and energy conservation component (including training).

(Source: Implementation Letter No. 30, 5/22/84, PDBAR129)

B. The PACD was extended to December 31, 1986, to further develop and institutionalize the agroforestry component of the project.

(Source: Implementation Letter No. 40, 6/21/85, PDBAW488)

C. After initial project assessments, the decision was made to de-emphasize most of the R.E. technologies, such as hydraulic rams, biogas, water-pumping windmills, and mini-hydro, in order to concentrate on forestry and cookstoves.

(Sources: Project Implementation Order/Technical Services, 5/26/83, PDBA0187; Quarterly Project Review, 3/31/85, PDBAV799)

D. The Energy Development Fund component was discontinued and the funds reallocated to agroforestry.

(Source: Quarterly Project Review, 12/31/85, PDBBB762)

21. Follow-On Activities:

A. ATI provided a grant of K.S. 4,065,550 to the Kenya Energy Nongovernmental Organizations Association (KENGO) to stimulate production and dissemination of the improved jiko model beyond Nairobi. Funding will cover training, technical assistance, and loans for 75% of the capital costs of setting up improved stove production at up to 20 traditional jiko makers, as well as public education, marketing, and a quality control certification process.

(Source: Economics of Improved Charcoal Stoves in Kenya, 11/85, PNAAX806)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: March 1987 (jrl)
Revised May 1987 (jrl)

1. Project Number: 6250937.03 2. Geo: WEST AFRICA REGIONAL/ CAPE VERDE

3. Title: ACCELERATED IMPACT PROGRAM. SUBPROJECT 03: RENEWABLE ENERGY PROJECT

4. Project Life/PACD: 1980-83/December 31, 1983

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 500

   B. R.E. Components: 500

   (Source: Project Implementation Report, 4/1/84, PDBAS459)

7. Loan or Grant/Appropriation Category (US$000):

   G / DA-Reg. / 500

   (Source: Project Implementation Report, 4/1/84, PDBAS459)

8. Project Purpose:

   To assist the Government of Cape Verde in identifying and developing renewable energy resources, principally wind and water.

   (Source: Quarterly Implementation Report, 7/1/83, PDBAN012)

9. Renewable Energy (R.E.) Outputs:

   Water-pumping windmills installed; Wind measurement equipment installed; Mechanics trained.

10. R.E. Inputs:

    Commodities; Training; Technical assistance.

11. Summary of R.E. Components:

    The project was funded jointly by USAID and the Directorate-General of International Co-operation (DGIS), the aid agency of the Government of the Netherlands. USAID's contribution consisted essentially of equipment, tools, and the provision of transport facilities. DGIS provided technical assistance, workshop construction, transport facilities, and windmills

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and related hardware. DGIS's contribution was handled by the DHV Consulting Engineers on behalf of the Steering Committee--Wind Energy Developing Countries (SWD). Responsibility for the project within the Government of Cape Verde (GCD) lay with the Division of Renewable Energies (DER), a subdepartment of the Direction of Rural Improvement, within the Ministry of Rural Development (MDR).

Although the original focus of the project was to develop a variety of renewable energies, in 1982 a decision was made to concentrate DER's efforts exclusively on wind energy. Consequently, installing windmills for the pumping of water for irrigation and domestic water supply became the project's major task. This included the funding of five windmills produced locally in Mindelo. A minor component dealt with the establishment of a baseline survey for solar energy potential.

12. R.E. Project Descriptors:

Wind energy; Windmills; Water pumps; Irrigation; Domestic water supply; Data collection.

13. R.E. Technology Applications:

A. Purchased five type-8 windmill/water pumps from JOTUNAVE, a manufacturer in Mindelo, Cape Verde.

(Source: Project Implementation Order/Commodities # 625-0937.03-4-00008, 4/15/83, PDBAN011)

B. Installed and/or gathered data from several types of wind measurement equipment: installed an MS 778 data logger on Achada Lem, council of Santa Catarina, Santiago, to assess the characteristics of the wind in the wake of the central mountains and to evaluate the possibility of a future wind generator at the site; installed a Stewart wind run odometer near a tubewell at Ribeirao Manuel to evaluate the possibility of using a mechanical windpump at the tubewell; continued data collection from an MS 778 on Achada de Sao Filipe, WP-4000s on Achada de Sao Filipe, Casella on Achada Baleia; made preparations for the installation of an MS 778 in Salineiro and a WP-4000 on Maio.

(Source: Bilateral Project between Cabo Verde and the Netherlands: "Renewable Energies" - Report VII: Progress July-September 1982, 9/82, PDAAQ574)

14. R.E. Technical Reports and Publications:

A. Solar Energy - Cape Verde. C.F. Kooi, USAID/Praia, Praia, Cape Verde, August 31, 1983, 142 pp., PDAAX810.

This report addresses the three major energy needs in Cape Verde--the provision of water by pumping and desalination, electricity supply, and conservation of cooking fuels--and how they are being met by the following five technologies: windmills, salt gradient solar ponds, improved cookstoves and cooking methods, petroleum-fueled engines, and photovoltaics.

Wind and insolation data for Cape Verde are provided. The performance of windpumps and solar stills in operation in Cape Verde is reviewed. A technical and financial evaluation is performed for a number of R.E. and petroleum-fueled technologies. Finally, recommendations are made concerning future project activities.

B. Bilateral Project Between Cape Verde and The Netherlands "Renewable Energies" Final Report Phase 2: 1981-1984. Daniel Rodriques Livramento, David Antonio Cardoso, Filomeno Ferreira Silva, Niko Pieterse, and Kees Versteegh, Consultancy Services Wind Energy Developing Countries (CWD), the Netherlands, July 1984, 128 pp., PDAAQ971. (A 126-page Portuguese version is also available, PDAAQ970.)

Progress is described for the second phase of the joint Cape Verde/Netherlands Renewable Energies Project, to which AID contributed material, equipment, and tools for the new workshop of the Division of Renewable Energies (DER). Consequently, most of the project accomplishments received only indirect AID funding. This report includes in-depth reporting of windmill activities supported not only by the Dutch and AID assistance, but also by a number of other groups. Topics cover end use and economics of windpumps, a revised view of the potential for windmill water pumping in Cape Verde, technical aspects of operation and maintenance of windpumps, site selection procedures, water pumping strategies, wind data at various sites in Cape Verde, and performance measurements. A summary of DER activities during Phase I is included.

15. Evaluations/Major Findings:

A. Water from Wind Power: Report of the Evaluation Mission of the MDR/DER Renewable Energy Project, Cape Verde. Joaquim Delgado, Antonio Gomes, Allan H. Miller, and Kees Kempenaar, SAWA (Consultancy Group for Sanitation and Water Management), Utrecht, Netherlands, January 1984, 143 pp. plus 8-page PES (dated 6/13/84), PDBAT313 or PDAAP491.

The principal reason for this evaluation was to justify an additional phase supported by the Netherlands Aid Program. The report looks at the social, economic, and institutional factors affecting future activities, and evaluates water and wind energy resources, types of windmills, the possibility of local windmill manufacture, and project personnel needs.

The evaluators concluded that continuation of the project was justified.

The team found a lack of Cape Verdian participation at the highest project level, which was being filled by Dutch experts. The latter had difficulty in transferring their know-how due a lack of Cape Verdian mechanical and electrical engineers. The situation at the middle and working levels was somewhat better. The team recommended the addition of a mechanical engineer, an electrical engineer, and a design draftsman. The project was working well; however, due to its small size, there was a lack of a well defined organizational structure and responsibilites, a lack of skilled technicians, and inadequacies in management experience. These handicaps would need to be addressed before the project could be expanded.

Promotion of local windmill manufacture was urged for the next phase, as was water pumping by wind generators (if an electric engineer could be added to the staff). It was recommended that USAID relax procurement requirements that tied aid to U.S. goods and U.S. transport, since this hindered the project. The team stated that the current project staff is insufficient to handle solar and biogas activities (as planned originally), but that the National Institute for Technical Investigations (INIT) has the capacity to take over those components. Other recommendations cover such topics as water resources and windmill maintenance.

16. Key Persons:

A. AID/Washington:

L. Meserve

B. AID/Mission:

Frank Dimond, Field Project Officer

C. Contractors:

Steering Committee - Wind Energy Developing Countries (SWD)

D. Host Country:

Daniel Rodrigues Livramento (Project Director)
Director, Ministerio de Desenvolvimento Rural/Divisao das Energias Renovaveis (DER)

17. Obligations by Fiscal Year (US$000): Not specified

18. Host Country Funding of R.E. Components (US$000): Not specified

19. Summary of R.E. Costs (US$000): Not specified

20. R.E. Component Revisions:

A. Due to lack of competent project management and personnel on the part of the Government of Cape Verde during crucial periods in the project's implementation, a decision was made in 1982 to eliminate most of the planned project activities and to concentrate on wind energy. Construction of a biogas digester, begun in June 1982 at the agricultural centre of San Jorge, remained unfinished at the time of the final evaluation in late 1983. Although a solar still design was completed for Ilha de Maio, construction was not begun because of insufficient personnel.

(Sources: Project Implementation Report, p. 3, 4/1/84, PDBAS459; PES, 6/13/84, PDBAT313 or PDAAP491)

B. The Aerowatt wind-electric generator did not perform well in field tests, as the generator burned out frequently. Inquiries to the manufacturer were unanswered. As a result of this poor field experience, work with Aerowatt equipment was halted.

(Source: Water From Wind Power Evaluation, p. 23, 1/84, PDBAT313 or PDAAP491)

C. The PACD was extended from August 31, 1983, to December 31, 1983, to complete equipment procurement.

(Source: Amendment No. 2 to the Project Grant Agreement, 8/31/83, PDBAN003)

21. Follow-On Activities:

A. The U.S. contribution to the R.E. project was expected to be continued under the Watershed Development Project, and possibly the Food Crop Research Project (project numbers unspecified).

(Source: PES, 6/13/84, PDBAT313 or PDAAP491)

B. Dutch assistance continued with the Government of the Netherlands extending their contribution by three years through June 1987 (Phase 3).

(Source: Bilateral Project Between Cape Verde and The Netherlands "Renewable Energies" Final Report Phase 2: 1981-1984, 7/84, PDAAQ971)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: April 1987 (jrl)

1. Project Number: 6250937.07 2. Geo: SENEGAL

3. Title: RENEWABLE ENERGY ACCELERATED IMPACT PROJECT (AIP)

4. Project Life/PACD: 1980-82(extended to 84)/December 31, 1984

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 600

   B. R.E. Components: 600

   (Source: Quarterly Implementation Report, 9/30/83, PDBAV493)

7. Loan or Grant/Appropriation Category (US$000):

   G / SH / 600

   (Sources: Quarterly Implementation Report, 3/31/83, PDBAV493; Energy, Forestry and Natural Resources Activities in the Africa Region, AID/Bureau for Africa, 1/84, pp. 108-109, PNAAR322)

8. Project Purpose:

   To develop, test, and diffuse wood and charcoal burning cookstoves made with local materials; To design, test, and diffuse simple solar fish (tent) dryers; To promote wider use of an improved method of charcoal production.

   (Source: Quarterly Implementation Report, 9/30/83, PDBAP619)

9. R.E. Outputs:

   Wood and charcoal-burning cookstoves tested, developed, and constructed; Stove builders trained; Cookstoves program users attitude survey conducted; Cookstove audio-visual material created and media campaign conducted; Charcoal producers trained; Solar fish dryers developed and tested.

10. R.E. Inputs: Training; Commodities; Technical assistance.

11. Summary of R.E. Components:

    This subproject contained three components: improved wood- and charcoal-burning cookstoves; improved charcoal production; and solar (tent) fish dryers.

The stove program was popularly known as the "Ban ak Suuf" program, which in Wolof means clay and sand. The Center for Studies and Research on Renewable Energy (CERER) was the implementing agency. At least eight different wood or charcoal-burning stoves made of clay and sand were developed and tested. Aprovecho Institute furnished stove designs during consultancies in 1980 and 1981. As of June 1983, more than 900 stove builders were trained in stove construction, and more than 5,500 stoves were built. CERER collaborated with other private and governmental agencies such as Peace Corps, Promotion Humaine, Centres d'Expansion Rurale, Association Francaise des Volontaires du Progres, CARITAS, ENDA, SODEVA, and Volontaires Italiens in training their members in stove building techniques.

The charcoal production component trained charcoal producers in operation of the Casamance kiln, an inexpensive kiln similar to the traditional kiln but with a portable metal chimney. It produces higher yield, a higher quality charcoal, and condensate tars that can be recovered, all in a shorter time than the traditional kiln. The Forestry Service (Eaux et Forets) implemented the project.

The Food Technology Institute (ITA) was in charge of the fish dryer activities. This component developed and tested simple solar "tents," which produced a higher quality dried fish product with reduced microbial activity and insect infestation and increased nutritional value. Initial dissemination through loosely organized fish drying associations was done poorly, however, and large-scale diffusion was never implemented.

12. R.E. Project Descriptors:

Charcoal; Firewood; Stoves; Solar energy; Drying; Fish; Sand; Clay; Wood; Food preparation.

13. R.E. Technology Applications:

A. Developed and tested eight wood or charcoal-burning stoves, all constructed of sand and clay:

- the "modele de base" or "Coumba Gueye," a simple one-pot wood-burning stove with a single entry for fuel and no chimney, which evolved from the "Louga Stove" and was proposed by Aprovecho Institute;
- a one-pot wood-burning stove built on a raised foundation with a single fuel entry and chimney;
- a stove similar to the preceding one but somewhat larger due to pot-holes;

- a two-pot wood-burning stove with two separate fuel entries and a single chimney;
- a one-pot, chimneyless charcoal stove similar to the first stove in appearance, but with a grate and somewhat smaller dimensions;
- a one-pot charcoal stove with chimney;
- a charcoal stove with two pot-holes, one fuel entry, and one chimney; and
- a charcoal stove with two pot-holes, two fuel entries, and one chimney.

B. Performed laboratory water-boiling tests on the traditional open fire with metal tripod (with wood as fuel), traditional metal charcoal stove, and four each of improved sand and clay wood or charcoal-burning stoves. Calculated open fire efficiency of 12%; improved wood-burning stoves ranged from 17-22% efficiency, indicating a 30-44% fuel savings; improved charcoal stoves were 27-31% efficient, compared with the 25% efficiency of the traditional charcoal stove, thus achieving 7.5-19% fuel savings.

C. In field tests conducted during the spring and summer of 1981 in 100 households, women extension workers measured fuel consumption and reported 20 households experiencing negligible fuel savings, 20 households with 10% fuel savings, and 60 households with 41% fuel savings. One week was spent measuring fuel used in cooking in the traditional manner; the second week was spent measuring fuel consumption using the improved stove.

D. Conducted surveys during February-June 1982 of 985 rural stove sites. Average stove was eight months old. Of the 87% of stoves extant, most were in good condition and 75% were used regularly. 65% of the stoves were the simplest one-pot model built by women who had been trained by women; 90% of these were used regularly. However, it was noted that stoves destroyed by rain or misuse were never rebuilt, and badly cracked stoves showed no signs of repair. Stoves with chimneys revealed soot accumulation, causing a serious loss in efficiency.

E. Constructed 32 Casamance kilns. The Casamance kiln is a modified traditional kiln, developed by Ed Karch, which incorporates a portable metal chimney to draw off exhaust gases from the bottom of the mound. A total of 1,782 steres of wood yielding 202,295 kg of charcoal were processed, representing more than 113 kg/stere. This compares favorably to the 70 kg/stere reported by Karch

for traditional charcoal kilns, and exceeds the 103 kg/stere average obtained by Karch himself with the Casamance. Average burning time was just under one hour/stere, considerably less time than required by the traditional kiln.

F. Conducted 7 training sessions on Casamance kiln construction and operation between June 1980 and June 1983 for total of 166 participants. Planned two additional sessions before PACD.

G. Assembled 6 experimental solar dryers on a terrace roof at the Dakar headquarters of ITA. Monitored inside and outside temperatures and relative humidity, as well as windspeed for a two-month period.

H. Constructed 12 solar dryers of two different models at two coastal villages, M'Bour and Joal, three of each model per village. Dryers were susceptible to wind damage, requiring heavier polyethylene and improved construction design.

I. Conducted field and laboratory tests on direct-gain solar dryers during March-December 1982. This included comparing banco dryers with Brace model dryers at Karabande with respect to changes in temperature, relative humidity (with dryers both empty and filled with fish) and the speed of air leaving the upper vent. Ambient wind speed and sky conditions were also recorded but not related to other measurements. Similar measurements were made at Joal and M'Bour with both Brace and banco dryers. Monitored production rates for various types of fish in kg/sq m/hour, with drying conducted by local people using Brace and banco models. Although details are sketchy, data in three separate trials indicate solar drying to be 34-41% faster.

(Source for all above: Final Evaluation of Renewable Energy AIP, 11/1/83, PDAAU785)

14. R.E. Technical Reports and Publications:

A. Trip Report: Senegal Renewable Energy Project. Carol A. Ulinski, November 30, 1978, PDAAV571.

This trip was designed to assist in the early stages of the design of the Senegal Renewable Energy Project. The report includes a table of experimental activities in solar, wind, and biogas in Senegal as well as a listing of solar energy projects in the country.

15. Evaluations/Major Findings:

A. Final Evaluation of Renewable Energy AIP. Dr. Timothy S. Wood, Volunteers In Technical Assistance, Arlington, VA, November 1, 1983, 42 pp., PDAAU785. (A nine page PES for this evaluation is available as PDBAS458 or PDBAR717)

Concerning the cookstove component, it was observed that very little effort was made to develop the stoves technically, even though tremendous efforts and resources went into dissemination. Technical problems were quite serious. The evaluator indicated an urgent need for the long-term services of a professional, innovative technician. Although the stove materials, sand and clay, may be inexpensive, the stoves are difficult to build properly, require frequent repair, and must be rebuilt every year or so. The original assumption that once a woman had her stove she would know how to use and maintain it properly was revealed to be incorrect. Although there was a lack of data on stove life-span, it was noted that most stoves may not survive past their first year. An economic analysis revealed that the total overhead costs of the 5,500 stoves built were between US$25.71-32.28 per stove; benefits and fuel saving could only be justified by the construction of additional stoves by already trained builders.

The charcoal production component was found to be technically impressive, and charcoal laborers reported a 30% increase in earnings over the traditional method. However, the project was constrained by socio-economic, operational, managerial, and institutional problems. The major impediment involved the relations between the dealers and the laborers, which caused a lack of incentives for the latter to adopt the improved technology.

Solar dryers that were successful in preventing insect infestation and spoilage, reducing microbial activity, increasing the nutritional value of the dried fish, and shortening drying time (except during the rainy season) were developed. Nonetheless, technical flaws, inadequate testing, poor construction, and lack of collaboration between the project personnel and potential users seriously plagued this component. The evaluator stated the need to reanalyze the problem to determine if solar drying was the proper answer; if so, a new series of projects could be designed.

16. Key Persons:

A. AID/Washington:

Henderson Patrick
Rose Marie Depp

B. AID/Mission:

Daby Diallo, USAID Project Manager
USAID/Senegal, B.P. 49, Dakar, Senegal

C. Contractors:

Aprovecho Institute, 80574 Hazelton Road, Cottage Grove, OR 97424, (503) 942-9434

D. Host Country:

Lamine Diop, GOS Project Manager
Center for Studies and Research on Renewable Energy, (CERER)

Bassirou Diedhiou, GOS Project Manager
Eaux et Forets

Ousmane Kane, GOS Project Manager and Directeur
Niokhor Diouf and Mamadou Sarr, technicians
Food Technology Institute (ITA), B.P. 2765, Hann-Dakar, Senegal

17. Obligations by Fiscal Year (US$000):

1980	300
1981	0
1982	300
1983	0
1984	0

TOTAL	600

(Source: Energy, Forestry and Natural Resources Activities in the Africa Region, AID/Bureau for Africa, 1/84, pp. 108-109, PNAAR322)

18. Host Country Funding of R.E. Components (US$000): 80

(Source: Energy, Forestry and Natural Resources Activities in the Africa Region, AID/Bureau for Africa, 1/84, pp. 108-109, PNAAR322)

19. Summary of R.E. Costs (US$000):

A. R.E. Costs by Activity

Technical assistance	126
Analysis & studies	36
Training	170
Testing & demonstration	118
Dissemination	150

TOTAL	600

(Source: Energy, Forestry and Natural Resources Activities in the Africa Region, AID/Bureau for Africa, 1/84, pp. 108-109, PNAAR322)

B. R.E. Costs by Component

Improved cookstoves	317.7
Charcoal production	110.8
Solar fish dryers	40.0

TOTAL	468.5

(Source: Final Evaluation of Renewable Energy AIP, 11/1/83, PDAAU785)

20. R.E. Component Revisions:

A. The project's PACD was extended several times. The last extension was for one year to December 31, 1984, to ensure a smooth transition to GOS management of the project under Title III funding.

(Source: Quarterly Implementation Report, 9/30/83, PDBAV493)

B. The goals of the improved cookstoves component were greatly expanded by consultants from the Aprovecho Institute following their visits in 1980 and in 1981. The stoves were to achieve 50% fuel savings over the traditional open fire. A total of 10,000 persons were to be trained in stove building techniques and would subsequently build stoves for 500,000 rural and 250,000 urban households in 1984.

(Source: PES, approved 4/3/84, PDBAS458)

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C. Phase II of the solar fish drying component (which consisted of large-scale diffusion) was never implemented as a result of failure of the prototype development under Phase I.

(Source: Final Evaluation of Renewable Energy AIP, 11/1/83, p. 28, PDAAU785)

21. Follow-On Activities:

A. The Senegal Forestry Service requested a two-year extension of the Charcoal Production Training Program for 1984 and 1985 using Title III funding.

(Source: Final Evaluation of Renewable Energy AIP, 11/1/83, p. 23, PDAAU785)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: November 1986 (jrl)
Revised March 1987 (jrl)

1. Project Number: 6320206 2. Geo: LESOTHO

3. Title: RENEWABLE ENERGY TECHNOLOGY

4. Project Life/PACD: 1979-82 (extended to 84)/September 30, 1984

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 1,600

   B. R.E. Components: 1,600

   (Source: Project Implementation Report, 9/30/84, PDBAV192)

7. Loan or Grant/Appropriation Category (US$000):

   G / SDA / 1,600

   (Source: Project Implementation Report, 9/30/84, PDBAV192)

8. Project Purpose:

   To disseminate a set of renewable energy technologies throughout rural pilot areas and simultaneously to establish the institutional basis for their dissemination nationwide--through self help, entrepreneurial, and government programs--if they prove socially, technically, and economically feasible.

9. Renewable Energy (R.E.) Outputs:

   Data on the energy needs of Lesotho's rural poor collected and analyzed; Development and introduction of improved stone paola stoves, a metal stove, a Lorena mud stove, passive solar greenhouses and growholes, retained heat cookers, food drying and preservation techniques, low-cost solar water heaters, solar ovens, and energy-conserving building designs; Personnel trained within the Appropriate Technology Section of the Ministry of Cooperatives and Rural Development; An R&D laboratory established; Library set up; A regional training center, office/dissemination center, and rural workshop/dissemination center set up.

10. R.E. Inputs:

    Technical assistance; Training; Commodities; Construction.

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11. Summary of R.E. Components:

The project involved the development, lab and field testing, and dissemination of a variety of renewable energy technologies, and the development of the institutional capacity of the Appropriate Technology Section (ATS) of the Ministry of Cooperatives and Rural Development (MINRUDEV) to conduct work in renewables. R.E. technologies were selected to meet critical needs: cooking, water heating, energy-efficient housing, and food production and preservation. Consequently, the project involved the development of energy-efficient housing designs, a stone paola stove, a grow-hole (cold frame), a retained heat cooker (fireless or haybox cooker), a food dryer, a metal stove, an improved paola stove, an earthen stove, a solar water heater, and a solar oven. Training courses in production of the R.E. technologies were conducted. Dissemination was accomplished through media campaigns, production and distribution of literature, and collaboration with a variety of extension or "multiplier" groups working in development.

Associates in Rural Development, Inc. (ARD) was the prime technical assistance contractor. Peace Corps furnished volunteers. The ATS of the Ministry of Cooperatives and Rural Development was the local implementing agency.

12. R.E. Project Descriptors:

Cookstoves; Greenhouses; Passive solar energy; Crop driers; Food preparation; Solar energy; Water heaters; Ovens; Building design; Hydroelectric power; Cold frames; Fireless cookers.

13. R.E. Technology Applications:

A. Stone Paola Stoves

Developed a stone paola stove design; presented training programs in its construction to "multiplier" groups involved in its dissemination; designed a jig to produce grates for stone paolas, and trained local metalworkers to copy and operate it and to produce pot supports. By mid-March 1984, more than 300 stone paolas had been built by home owners trained by the project.

(Sources: Final Report, 3/31/84, PDBAT397; PES, 1/20/84, PDBAR894; see also additional stove reports under 14., R.E. Technical Reports and Publications, below)

B. Improved Metal Paola Stoves

Improved the traditional paola stove (produced from a bucket or kerosene can) by (1) the addition of a grate and protective wind shield for the pot and (2) reduction in the firebox volume. Tests revealed that the stove was more than 20% more efficient than the traditional paola in simulated cooking trials, but only equally efficient in radiant space heating trials. The final design incorporated a square base, with an associated slight decrease in fuel efficiency over the cylindrical base model, because of greater ease of construction.

(Source: Final Report, 3/31/84, PDBAT397; see also additional stove reports under 14., R.E. Technical Reports and Publications, below)

C. Lorena Stoves

Studied a number of parameters affecting thermal performance of Lorena stoves, and built several stoves in mountain homes. User acceptance was poor, due mainly to problems with appearance, durability, and maintenance and the prevailing desire to have cast iron or steel stoves.

(Source: Final Report, 3/31/84, PDBAT397; see also additional stove reports under 14., R.E. Technical Reports and Publications, below)

D. Retained Heat Cookers

Tested various insulating materials, including hay, chaff, sawdust, and paper, and examined a variety of container materials, such as wicker baskets, cardboard, metal boxes, and stone- and mud-walled enclosures, for construction of retained heat cookers (also referred to as fireless or haybox cookers). Tested and developed recipes for the preparation of traditional foods in the retained heat cooker, and prepared recipe booklets and guides for making and operating fireless cookers.

(Source: Final Report, 3/31/84, PDBAT397; see also additional stove reports under 14., R.E. Technical Reports and Publications, below)

E. Multi-Fuel Metal Stoves

Developed the fuel-efficient multi-fuel RET metal stove, which can burn dung, coal, shrubs, and/or agricultural residues. Secondary air was introduced to reduce smoke (produced traditionally in abundance when burning dung, the most common fuel used in Lesotho) and to increase fuel efficiency. The design includes a large ash

collection drawer, since the burning of dung has a high ash content. The stove also has removable lids and an interior baffle design to accommodate traditional, three-legged cast-iron pots with round bottoms. It can accommodate newer, flat-bottomed aluminum pans as well by replacing the lids in the stove's top. In addition to cooking, the stove was also field-tested successfully for space heating in Lesotho's cold mountain climate.

(Source: Final Report, 3/31/84, PDBAT397; see also additional stove reports under 14., R.E. Technical Reports and Publications, below.)

F. Metal Stove Model 3

The RET Metal Stove Model 3 was produced in two different locations in 1983: at Malefiloane and in a small lowlands workshop. The following table indicates production costs:

RET METAL STOVE MODEL 3 PRODUCTION COSTS
AT TWO WORKSHOP LOCATIONS

	Malefiloane Costs* (maluti)	Workshop Percent	Lowlands Costs** (maluti)	Workshop Percent
Materials	168.85	32.2	142.87	46.4
Generator time (or grid)	225.00	43.0	35.10	11.4
Labor	65.00	12.4	65.00	21.1
Shop time	65.00	12.4	65.00	21.1
TOTAL (for six stoves)	523.85		307.97	
COST (per stove)	87.31		51.32	

*Based on data from Malefiloane Workshop.
**Estimated costs assuming 10% transport charges on materials, grid electricity at M0.06 per kilowatt-hour, and a 9-kilowatt demand.

The higher cost of production at Malefiloane is primarily the result of expensive generator costs, demonstrating the need for inexpensive electricity to keep final costs as low as possible.

(Source: Research, Development and Dissemination of Cooking Technologies by the Lesotho Renewable Energy Technology Project, Table 20, p. 42, 2/18/86, PDAAW045 (available to AID staff only); see also additional

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stove/cooking reports under 14., R.E. Technical Reports and Publications, below)

G. Solar Food Dryers

Following examination of a variety of solar food dryers, which ranged in sophistication and cost from inexpensive, homemade cardboard box dryers to locally manufactured sheet metal and fiberglass units, the project developed and concentrated its efforts on food dryer kits (which include materials for the plastic cover and screen trays) for owner-built cement block or stone wall dryers.

(Source: Final Report, 3/31/84, PDBAT397)

H. Solar Water Heaters

Tested designs for several simple, low-cost solar water heaters, and advised government architects and other institutions on the selection of commercially available solar water heaters.

(Source: Final Report, 3/31/84, PDBAT397)

I. Solar Ovens

Tested two solar oven designs, one developed by the Rural Technology Unit at Thaba Tseka, and the other by a similar organization in Lucknow, India. The Lucknow-type oven gave higher performance results, and this was modified to accommodate local cooking pots.

(Source: Final Report, 3/31/84, PDBAT397)

J. Cold Frames

Developed a grow-hole (i.e., a cold frame), which consists of an owner-built stone enclosure topped by a removable translucent cover, to protect the interior seedbed from frost and extend the growing season for a number of plants. Demonstrated the units through a Food-for-Work program at several schools. Prepared the Grow-Hole User's Guide, which addresses Lesotho's particular climatic and horticultural conditions.

(Source: Final Report, 3/31/84, PDBAT397; see also additional grow-hole reports under 14., R.E. Technical Reports and Publications, below)

K. Energy-Efficient Housing Designs

Developed plans for four energy-efficient housing designs: an improved rondavel (the traditional round,

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thatched-roof house) and three modern designs for different income levels. Depending on investment and user sensitivity, it was projected that the designs could achieve up to 90% energy savings. None of the modern designs was ever built, due to lack of approval by USAID and the Government of Lesotho to build a demonstration house and/or project office building. Design features are being adapted by local architects, however, and incorporated into their designs. The project advised on the design of about 20 homes, clinics, and hospitals, most of which have been built or are under construction, and monitored the thermal performance of many of these buildings. For example, the project assisted in the design of the passive solar clinic at Hilltop in the Qacha's Nek District, which incorporated clerestory windows and a trombe wall for space heating, a solar water heater, and a photovoltaic module.

(Source: Final Report, 3/31/84, PDBAT397; see also additional housing reports under 14., R.E. Technical Reports and Publications, below)

L. Small Hydro Power

Projections of costs per installed kilowatt are made for several potential hydropower sites. (Hydropower components were subsequently dropped.)

(Source: Lesotho: Recommended Activities in Small Hydropower Development, 1982, PNAAP546)

M. Financial Analysis of Technologies

The following financial analysis was performed for each of the technologies developed by the project:

Technology	Cost to Consumer (maluti)	Annual Estimated Fuel Savings (maluti)	Pay Back Period to Consumer (years)
Solar oven	66.5	20.80*	3.2
Retained heat cooker	22.7	15.34*	0.7
Earthen stove	29.0	81.12**	0.4
Stone paola	4.0	101.40**	0.04
Food dryer	60.0	na	1.4
Greenhouse/ growhole	135.0	na	2.8
Solar rondavel	295.0	77.00**	3.8
		326.00*	0.9
		82.00***	3.6

na = not applicable.
*Kerosene is the fuel saved.
**Wood/dung is the fuel saved.
***Coal is the type of fuel displaced.

(Source: Extracted from Table 1, p.6, Economic Evaluation of Village Renewable Energy Technologies in Lesotho, 5/83, PNAAT970)

14. R.E. Technical Reports and Publications:

A. Lesotho Renewable Energy Technology Project Final Report. Associates in Rural Development, Inc. (ARD), Burlington, VT, March 31, 1984, 126 pp., PDBAT397.

Overview of the entire project, with status report on the 10 priority R.E. technologies. Appendices include comprehensive listing of reports and publications generated by the project. See Technology Applications above, for details.

B. Stove Consultancy for Lesotho RET Project. Margaret Thomas and Glenn Burket, Associates in Rural Development, Inc., Burlington, VT, January 1983, 128 pp., PNAAR237.

This report describes five cooking technologies--(Lorena-type mud stoves, RET metal stoves, stone paolas, improved metal paolas, and retained heat cookers--including initial cooking test results and recommendations for future work. It also describes Lesotho cooking practices. Appendices include cooking test forms and procedures as well as blueprint for the RET Model 3 metal stove including production jigs, templates, and chimney system.

C. Results of Kitchen Performance Tests on RET Metal and Earthen Stoves in Nine Households in the District of Mokhotlong (Laboratory Testing Report Number 10). Koranta Matete, David Palasits, and Gary Klein, Associates in Rural Development, Inc., Burlington, VT, January 9, 1984, 30 pp., PNAAX811.

Report describes testing of traditional and improved stoves in nine households (five households tested RET Metal stoves and four households tested earthen stoves) using a variety of different fuels, especially cow dung. Results are analyzed for statistical significance. Appendices contain sample questionnaires and data sheets, fuel consumption data, and "t-TEST" procedure and table.

D. Production and Marketing of the RET Metal Stove (Model 3) - Preliminary Findings (Laboratory Testing Report Number 14). Doug McLean and Gary Klein, Associates in Rural

Development, Inc., Burlington, VT, February 28, 1984, 22 pp., PNAAX812.

The initial experience of producing 18 improved RET Model 3 Metal stoves at two workshop locations is explained. A limited market test of the stoves is described. Tables are included on paraffin stoves, solid fuel stoves, and commercial fuel prices in Mokhotlong as of September 1983.

E. Lesotho: Recommended Activities in Small Hydropower Development. Bard Jackson and Martin Johnson, National Rural Electric Cooperative Association, Washington, DC, December 1982, 34 pp., PNAAP546.

This report reviews the hydrology of Lesotho, evaluates the potential of 14 sites visited, projects cost per installed kilowatt for installations at five sites, recommends activities for the RET project, and discusses institutional aspects.

F. Toward a Warmer Rondavel: Energy Conservation Techniques for the Traditional House of Lesotho. David Norris, Associates in Rural Development, Inc., Burlington, VT, undated, 11 pp., PNAAX813.

This pamphlet presents, in simple language aided by numerous drawings, easy inexpensive ways to improve the thermal comfort of the traditional Lesotho house using locally available materials. Includes mention of passive solar applications.

G. Lesotho Village Energy Survey Report. Judith Gay and Mamello Khoboko, Associates in Rural Development, Inc., Burlington, VT, November 1982, 185 pages, PNAAU647.

This report covers the first stage of the village energy survey, conducted in six villages of the Mokhotlong District between March and May 1982. Included are demographic, social, and economic background data, as well as detailed data on energy resources, use patterns, and needs in the participating villages. The survey instrument is provided in the appendices.

H. The Economics of Improved Energy Technology in Lesotho: Notes for a Seminar in Economic Evaluation. Frederic March, Associates in Rural Development, Inc., Burlington, VT, August 1982, 20 pp., PNAAX814.

This paper is an instructional presentation on economic analysis, presented in question and answer format.

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I. Economic Evaluation of Village Renewable Energy Technologies in Lesotho. Frederic March, Associates in Rural Development, Inc., Burlington, VT, May 1983, 22 pp., PNAAT970.

This report is based on a three-week consultancy in Lesotho performed during July/August 1982. A simple payback period is estimated for project technologies (solar oven, retained heat cooker, earthen stove, stone paola, solar rondavel, greenhouse/grow-hole, and food dryer), based principally on estimated annual fuel savings and unit price. A brief description of each technology is included.

J. Dissemination Plan for the Lesotho Renewable Energy Technology Project. Erika Morgan, Associates in Rural Development, Inc., Burlington, VT, March 1983, 52 pp., PDAAV958.

A plan is presented for an overall public education approach for disseminating R.E. technologies throughout Lesotho. The audience, purpose, advantages, and disadvantages of various public education tools (newsletters, audiovisuals, etc.) are described. A detailed dissemination plan for 10 R.E. technologies is presented. See also 14. K, below.

K. Disseminating Renewable Energy Devices in Lesotho: A Consultancy Report. Erika Morgan, Associates in Rural Development, Inc., Burlington, VT, March 1983, 69 pp., PDAAV959.

This report provides the background and contextual information for the project's public education dissemination plan. Included are a discussion of personnel requirements, planned accomplishments under different assumptions of project extension, and three budget scenarios. Recommendations for implementation of the dissemiantion plan are made. See also 14.J., above.

L. Passive Solar Design in Lesotho: A Consultancy Report. David Norris, Associates in Rural Development, Inc., Burlington, VT, July 1982, 23 pp., PDAAV960.

This report describes work undertaken in Lesotho from May 13 to July 28, 1982. It involved heat-loss calculations and Pascalc solar analyses, instruction in the use of these analysis techniques, and preparation of four specific energy-conserving housing designs. Recommendations are made for future activities.

M. Passive Solar Heating in Lesotho Housing: Potential, Problems, Performance Analysis and Four Prototype House

Designs. David Norris, Associates in Rural Development, Inc., Burlington, VT, July 21, 1982, 72 pp., PNAAX815.

This report describes energy-conserving and passive solar principles, and how these might be incorporated into Lesotho housing designs. Three prototype energy-efficient housing designs, based on standard ones developed by the Lesotho Housing Corporation, are described, with modifications explained. An economic analysis of energy-saving options for one of the designs is performed using the Total Environmental Action PASCALC computer program. Appendices include architectural drawings of some solar and energy-conserving features and a description of the PASCALC II program.

N. Growhole Performance Comparisons: Winter Crop Production - Lowlands (Laboratory Testing Report Number 2). Gary Klein and Rick McGowan, Associates in Rural Development, Inc., Burlington, VT, November 29, 1983, 29 pp., PNAAX816.

This report describes a controlled experiment conducted in the lowlands of Lesotho in growing four different crops in seven different pairs of growholes (free-standing and against a wall). Sketches of the growholes are provided. Monthly average interior temperatures and weight of produce grown are presented. Sample data sheets are included in appendices.

O. Growhole Performance Comparisons: Winter Crop Production - Mountains (Laboratory Testing Report Number 3). Rick McGowan and Gary Klein, Associates in Rural Development, Inc., Burlington, VT, December 8, 1983, 27 pp., PNAAX817.

This report describes a controlled experiment conducted in the mountains of Lesotho in growing four different crops in three different pairs of growholes (free-standing and against a wall). Sketches of the growholes are provided. Monthly average interior temperatures and weight of produce grown are presented. Sample data sheets are included in appendices.

P. Energy-Conserving (EC) Housing Designs:

- A3-EC, 15 pp., in PNAAX815.

  This is a set of architectural drawings of solar and energy-conserving features of the A3-EC housing design, including general construction notes for the house. The A3-EC is a modified A3 design--a middle class house design containing three bedrooms, an inside bathtub and outside pit latrine toilet, small kitchen with sink, and combined lounge/dining area.

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Modifications to the standard design are listed. (Full house plans are not included.)

- C4-EC, 13 pp., in PNAAX815.

  This is a set of architectural drawings of solar and energy-conserving features of the C4-EC housing design, including general construction notes for the house. The C4-EC is a modified C4 design--a two-room, low-income "self-help" dwelling with external latrine and no running water, built of concrete block with corrugated iron sheets for the roof. Modifications to the standard design are listed. (Full house plans are not included.)

- Pitso-EC, 15 pp., in PNAAX815.

  This is a set of architectural drawings for solar and energy-conserving features of the Pitso-EC housing design, including general construction notes for the house. The Pitso-EC is a modified Pitso Mark 5 design--an upper class house design intended for civil servants and expatriates, containing three bedrooms, one and a half baths, servant's quarters, and a covered car park. Modifications to the standard design are listed. (Full house plans are not included.)

Q. Status Report on Stove Work: Lesotho RET Project. Associates in Rural Development, Inc., Burlington, VT, March 1982, 29 pp., PDAAV961.

This report focuses on the consultancy performed by stove specialist Ianto Evans from January 7 to March 3, 1982. In addition, some early preliminary stove work and subsequent stove activities are described. Rough schematic drawings with hand-written comments present technical ideas for promising cooking technologies.

R. Cook Stove Testing and Development at the Lesotho RET Project. Howard S. Geller, Associates in Rural Development, Inc., Burlington, VT, May 1983, 10 pp., PDAAV962.

This report briefly describes the consultancy undertaken by the author from April 15 through April 22, 1983. The author reviews current stove testing procedures and recommends (1) methods to improve data analysis and (2) changes to conform to the new provisional international testing standards. Suggestions are also made regarding tests to determine optimum grate-to-pot distances.

S. Research, Development and Dissemination of Cooking Technologies by the Lesotho Renewable Energy Technology Project. Gary Klein, Associates in Rural Development, Inc., Burlington, VT, February 18, 1986, 113 pp., PDAAW045 (available to AID staff only).

Project activities in relation to cooking technologies are described in-depth. These activities cover needs assessment, technology matching, prototype development, and dissemination. Technologies covered are the stone paola, metal stoves, earthen stoves, the retained heat cooker, solar water heaters, and solar cookers. Recommended future actions are furnished. An economic analysis of stove technologies is included.

T. Mollo O Kae? (Where is the Fire?): Solar Energy Experimentation and Training in the Mountains of Lesotho--Phase III). Gary Klein, Rural Technology Unit-Thaba Tseka, Maseru, Lesotho, December 1980, 211 pp., PNAAX818.

This final report describes renewable energy activities undertaken by the Rural Technology Unit (RTU) at Thaba Tseka, with financial assistance provided by Appropriate Technology International. Although most of the activities predate the RET project, many of the project technologies had their origins in or were influenced by the RTU work. Topics include the climate in Thaba Tseka, solar water heaters, solar dryers, photovoltaic systems, cooking technologies, solar stills, bioclimatic-designed housing, greenhouses, and cold frames. Graphs, drawings, and photos are included.

15. Evaluations/Major Findings:

A. Project Evaluation Summary: Renewable Energy Technology. March 10, 1982, 20 pp., PDBAJ569, PDBAA535 or PDAAJ460.

A long delay occurred between the issuance of a PIO/T in December 1979 and the signing of a technical assistance contract with ARD in February 1981, in part caused by AID/Washington's insistence for more budgetary details on proposed lab equipment. ARD fielded a highly qualified team, but at roughly $330,000 in real costs over that projected by the Project Paper (PP), which assumed the hiring of Americans living in-country at a relatively low pay/fringe benefit level, which did not occur. The Government of Lesotho (GOL) failed to fill positions in the Appropriate Technology Section and to provide adequate workshop space. And, although the PP called for institution building, project funds, objectives, and efforts were focused on a pilot project. Twelve recommendations are given, including these: that GOL take immediate steps to fill vacancies in the Appropriate

Technology Section, or if this is not accomplished by April 30, 1982, serious consideration should be given to terminating the project; that the project be scaled down to include only one rural district, Mokhotlong, supported by the Maseru office and workshop; that the project prioritize technologies and place more emphasis on the testing and dissemination of proven R.E. technologies; that mini-hydro and biogas be dropped from project activities because of other donor involvement; that energy-efficient building design be de-emphasized and more efforts be given to peri-urban and low-income urban housing; and that the Maseru workshop be housed at Basotho Enterprises Development Company (BEDCO) while awaiting the provision of a permanent workshop by the GOL.

B. Project Evaluation Summary: Renewable Energy Technology. January 20, 1984, 38 pp., PDBAR894 or PDAAP173.

This PES contains a summary of recommendations from the project evaluation of March/April 1983; an executive summary dated March 14, 1984; and a project summary from the evaluation.

Recommendations are that the project be broadened to include other technologies and systems aimed at increasing agricultural production; the dissemination strategy be redefined to include small enterprises and target multiplier organizations; the PACD be extended to allow for dissemination; overall project administration and project direction be improved, including development of a plan for the long-term utilization of the Khubetsoana workshop; plans be developed to guide the technology development process, stressing cost-effectiveness and competition in the marketplace; training programs be planned for professional development of ATS staff; a strategy be developed for acquiring and analyzing additional data required to identify energy and rural development needs; a short-term consultant be engaged for not less than three months to design and implement market research and survey strategies for fully developed R.E. products or those approaching that stage; and a plan be devised with the Ministry of Cooperatives and Rural Development to coordinate and/or provide information exchange among all major appropriate technology activities.

16. Key Persons:

A. AID/Washington:

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2884 NS, 647-8818

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B. AID/Mission:

Dean Bernius, PRO
USAID, c/o American Embassy, P.O. Box MS 333, Maseru, 100, Lesotho

C. Contractors:

Mr. Jay Stryker, Project Coordinator,
Dr. Judith Gay, Field Supervisor,
Mr. Gary Klein, Laboratory Supervisor,
Associates in Rural Development, Inc.
72 Hungerford Terrace, Burlington, VT 05401

D. Host Country:

B. Kanetsi, Solar Engineer
M. Mahooana, Assistant Solar Engineer
Ministry of Cooperatives and Rural Development,
Appropriate Technology Section, P.O. Box 686, Maseru 100, Lesotho

17. Obligations by Fiscal Year (US$000):

FY 80	473
FY 81	492
FY 82	418
FY 83	217
TOTAL	1,600

(Source: Project Paper, Table 4, p. 54, 7/19/79, PDBAJ553 or PDAAG097)

18. Host Country Funding of R.E. Components (US$000): 77

(Source: Project Grant Agreement, 8/30/79, PDBAA528)

19. Summary of R.E. Costs (US$000):

Technical assistance	554
Commodities	583
Training	101
Construction	64
Support costs	65
Inflation	127
Contingency	106
	1,600

(Source: Project Grant Agreement, 8/30/79, PDBAA528)

20. R.E. Component Revisions:

A. In the Project Paper, a major research and development lab in Maseru and three regional training centers located at the Ministry of Agriculture's Farmers Training Centers (FTCs) were specified; however, the number of centers and the time-frame were trimmed back, since at the project's initiation the ATS consisted of only one staff member and a small workshop.

(Source: Final Report, 3/31/84, PDBAT397)

B. Although the grant agreement was signed in August 1979 and a PIO/T issued in December 1979 by USAID/Lesotho, a technical assistance contract was not signed with ARD until 14 months later, seriously delaying project implementation. One reason for the long delay was AID/Washington's insistence for more budgetary details on proposed lab equipment. Because of this long delay, the PACD was extended to March 31, 1984, at USAID/Lesotho's request, to allow for the original three year implementation period.

(Source: Project Evaluation Summary, 3/10/82, PDBAJ569)

C. The PACD was extended from March 31, 1984, to July 31, 1984, to September 30, 1984, to continue essential dissemination work and to retain skilled ATS staff while the follow-on Energy Initiatives in Africa (698-0424) project design was being finalized.

(Sources: PIL No. 13, 3/30/84, PDBAR892, Project Implementation Report, 9/30/84, PDBAV192)

D. A feasibility study on the use of biogas in Lesotho found that only a limited potential existed for this technology. Moreover, non-USAID donors were already conducting biogas activities. Consequently, it was decided that the project would not undertake R&D activities on biogas as specified in the Project Paper.

(Source: Final Report, 3/31/84, pp.64-65, PDBAT397)

E. The project personnel decided not to develop micro-hydroelectricity power, as specified in the Project Paper, following a consultancy by the National Rural Electric Cooperative Association (NRECA), which assessed the potential for micro-hydro and reported that all sites examined were not economically feasible for development.

(Source: Final Report, 3/31/84, p.66, PDBAT397)

F. Although the Project Paper design specified that USAID/ Lesotho would handle commodity procurement, this proved to be expensive (because of the high overhead) and unfeasible, due to many, often urgent requests which overwhelmed the Mission. To help resolve the problem, a separate bank account was established (not under the contractor), although the contractor was obliged to administer it. The problem was finally resolved when the account was transferred to the Government of Lesotho.

(Source: Final Report, p. 81, 3/31/84, PDBAT397)

G. The PP called for dissemination through Village Energy Technicians (VETs), who would derive their income or a large portion thereof from the production and sale of R.E. products. This has proven unrealistic. In some cases, the skills and equipment required for production exceeded what the technicians possessed. Considerable marketing knowledge and resources would be needed to market through commercial channels. And, where the technologies were owner-built, the technology precluded the need for a VET. The VET dissemination strategy was consequently dropped. The costs and efforts involved in demonstration and dissemination were also underestimated by the project. As a result, USAID requested assistance from the Energy Initiatives in Africa project to help with dissemination of the project-developed products.

(Source: PES, 1/20/84, PDBAR894)

H. The project did not have use of most of the Farmers Training Centers facilities, as assumed by the Project Paper, due to inter-ministry conflict between the FTCs and project personnel (who belonged to another ministry).

(Source: Final Report, p. 81, 3/31/84, PDBAT397)

21. Follow-On Activities:

A. Dissemination of the R.E. technologies developed by the project was carried out by a follow-on project: Energy Initiatives in Africa (EIA): Improved Rural Productivity through Marketing and Dissemination Energy Technologies (698-0424.32), but with only limited funding.

(Sources: Project Implementation Report, 9/30/84, PDBAV192; Final Report, p. 83, 3/31/84, PDBAT397)

B. The Women's Bureau within the Prime Minister's office undertook an effort to disseminate the stone paola and retained heat cooker to Village Development Committees nationwide. Several small businesses have begun producing bars and grates, components for the stone

paola, and workshops around the country are producing food dryer kits, grow-hole covers, and metal stoves on a limited basis.

(Source: Final Report, 3/31/84, PDBAT397)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: March 1987 (jrl)
Revised May 1987 (jrl)

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1. Project Number: 6330209 2. Geo: BOTSWANA

3. Title: BOTSWANA RENEWABLE ENERGY TECHNOLOGY

4. Project Life/PACD: 1980-85/September 26, 1985

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 3,304

   B. R.E. Components: 3,304

   (Source: Project Implementation Report, 3/31/85, PDBAV964)

7. Loan or Grant/Appropriation Category (US$000):

   G / ESF / 3,304

   (Source: Project Implementation Report, 3/31/85, PDBAV964)

8. Project Purpose:

   To introduce village renewable energy technologies (RETs) that are inexpensive and easily reproduced; To research, develop, and put into use RETs that can reduce Botswana's dependence on vulnerable supplies of increasingly expensive fossil fuels.

9. Renewable Energy (R.E.) Outputs:

   Energy needs assessment conducted in 8 villages/towns; 20 anemometers installed and data collection and computer analysis initiated; 3 solar radiation monitoring stations procured, and training conducted in their installation and operation; 50 water pumping systems--employing windmill, photovoltaic (PV), biogas, animal-power, human-power, hand-power, diesel power, and grid electric pumps--procured and/or installed for field and comparison testing; 13 PV systems procured and 10 installed for lighting and refrigeration; Low-cost solar water heater development work undertaken; Monitoring equipment for domestic solar water heating testing program procured; 11 passive solar buildings designed and constructed; Method for analysis of thermal performance of buildings using a hand calculator and computer spreadsheets developed; R&D work, analysis, field testing, and pilot dissemination performed for earthen stoves, portable sheet metal stoves, retained heat cookers, improved building

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designs, and simple solar water heaters; 3,000 metal stoves produced.

10. R.E. Inputs:

Technical assistance; Training; Commodities; Construction.

11. Summary of R.E. Components:

The Botswana Renewable Energy Technology (BRET) project investigated and disseminated a number of technologies:

- Stoves and cookers: After two years of intensive R&D, the project concluded that high-mass earthen stoves were not appropriate for Botswana. Tinsmiths and a commercial company were trained in the production of metal stoves, and 3,000 were produced by the PACD, 1,500 of which had been sold or disseminated. A retained heat cooker, known as the "Wonder Box," was highly regarded after two years of field study indicating fuel savings of 50%; workshops trained 150 women in making these cookers.

- Wind and solar assessments: A wind energy assessment was begun in collaboration with Met Services, the University of Botswana, the Botswana Technology Centre (BTC), and other organizations to examine Botswana's wind resources. The project collaborated with Met Services in establishing three sites for solar radiation measurement.

- Water pumps: A comprehensive comparative testing program, examining technical, financial, social, and institutional aspects, was performed on a variety of water pumping technologies, including PV, windmills, biogas, animal traction, hand- and human-power, diesel, and grid-connected submersible electric pumps. More than 40 pumps were installed, monitored, and evaluated.

- Solar water heaters: Seven prototype simple batch solar water heaters were designed, built, and tested.

- Photovoltaics: The BRET collaborated with several government ministries in the installation and monitoring of PV systems for lighting and/or refrigeration in health clinics and in village schools.

- Passive solar designs: The BRET constructed 11 passive solar buildings in five locations, including an international award-winning solar office building for the Botswana Technology Centre.

Associates in Rural Development, Inc. (ARD) was the prime contractor. Peace Corps provided volunteers. The Ministry of Mineral Resources and Water Affairs (MMRWA) was the local

implementing agency. The BTC housed the BRET project and furnished personnel. The Rural Industries Innovation Centre (RIIC) was the major R&D organization participating in the project. The Wind Technology Group Serowe (WTGS), the Department of Water Affairs (DWA), the Ministry of Local Government and Lands (MLGL), the Ministry of Health (MOH), other GOB ministries and agencies, and non-governmental organizations working in Botswana collaborated on various components of the project.

12. R.E. Project Descriptors:

Stoves; Cookstoves; Wind energy; Wind measurements; Solar radiation measurements; Retained heat cookers; Passive solar buildings; Water pumps; Photovoltaic energy; Diesel engines; Animal traction; Human power; Biogas; Refrigerators; Lighting; Solar energy; Water heaters; Solar heating; Energy use surveys; Energy-efficient building design.

13. R.E. Technology Applications:

A. Energy Use Surveys

A rural energy use survey was conducted in two dissimilar villages: in the small village of Ditshegwane during a three-week period in May-June 1982, and in the medium-sized village of Shoshong during a five-week period in October-November 1982. This survey was supported by an intensive fuel measurement study undertaken the following year in the same villages to assess village energy use quantitatively. Cooking was found to be the predominant end-use for firewood.

A urban energy use and attitude sample survey was also undertaken among 576 households in three towns and three major villages during three different seasons in 1984: the hot summer, the fall, and the cold winter.

(Source: Botswana Village Energy Survey Report, 9/83, PNAAX893; Domestic Energy Use in Two Villages, 9/85, PNAAX894; Botswana Urban Domestic Energy Use and Attitude Survey, 8/85, PNAAX895)

B. Metal Stoves in Gaborone and Ditshegwane: Financial and Social Benefit/Cost Analysis

A financial and social benefit/cost analysis of the BRET metal stove was conducted for two different locations, Gaborone and Ditshegwane:

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GABORONE FINANCIAL ANALYSIS
BRET METAL STOVE

Benefit/cost ratio:	3.88
Net present value:	74.86
Cutover:	Net present benefits will first exceed costs in year 1
Internal rate of return:	Exceeds 200%

Assumptions include a five-year lifespan for the stove; constant price of fuelwood for the life of the BRET stove; little or no substitution of other fuels for wood for domestic cooking during the stove's lifespan; the value of time saved by women during the cooking process assigned a value of zero; the price of spare parts is likely to increase by no more than 10% annually; and skilled tinsmiths will be available to produce the spare parts--replacement grate, liner, and door--in years three through five.

GABORONE SOCIAL BENEFIT/COST ANALYSIS
BRET METAL STOVE

Benefit/cost ratio:	5.74
Net present value:	123.26
Cutover:	Net present benefits will first exceed costs in year 1
Internal rate of return:	Exceeds 200%

Critical assumptions are similar to those for the above financial analysis, except that the time of urban and rural women has a real value given by the value of the highest alternative use.

DITSHEGWANE FINANCIAL ANALYSIS
BRET METAL STOVE

Benefit/cost ratio:	1.39
Net present value:	11.35
Cutover:	Net present benefits will first exceed costs in year 3
Internal rate of return:	1.06

Assumptions are similar to those for above Gaborone financial analysis with the exception that the price of the stove will be 20% higher in Ditshegwane than in Gaborone due to additional transportation costs either for the finished stove or for the raw materials. In addition, no allowance is made for an increase in the price of spare parts.

DITSHEGWANE SOCIAL BENEFIT/COST ANALYSIS
BRET METAL STOVE

Benefit/cost ratio:	1.85
Net present value:	24.73
Cutover:	Net present benefits will first exceed costs in year 2
Internal rate of return:	Exceeds 200%

Critical assumptions are similar to those for the Ditshegwane financial analysis, except that the value of time saved by women during cooking and fuel gathering will be assigned a minimal but positive value of .03 Pula per hour.

(Source: Financial and Social Benefit/Cost Analysis of Renewable Energy Technologies in Botswana: A Consultancy Report, Appendix B, 3/84, PNAAX891; see also Financial and Economic Analysis of Selected Renewable Energy Technologies in Botswana, 7/18/85, PNAAX903, and additional stove reports under 14., R.E. Technical Reports and Publications, below)

C. Stoves and Cookers: Financial and Economic Analyses

Financial and economic analyses were conducted on BRET metal stoves and retained heat cookers (also known as fireless or haybox cookers). Results include the following:

- Based on research and development experience with over 2,500 units, BRET stoves are economic under a broad range of assumptions concerning technical performance, discount rates, and alternative energy prices. This conclusion holds for both the financial and economic analyses.

- Because fuelwood is least plentiful in urban areas and because urban communities have greater cash incomes than rural ones, the primary market for BRET stoves is in the estimated 23 urban communities with populations of 4,500 persons or greater.

- Based on survey evidence and recent demographic projections, the urban market for wood stoves is estimated at just under 60,000 households as of 1985, with a projected annual increase of approximately 20 percent per year through 1991, to a level of between 165,000 and 187,000 households.

- Since BRET stoves can achieve fuelwood savings of between 10 and 20 percent under normal household

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use and since they can be produced economically by trained Botswana artisans and local firms, government support of dissemination and commercialization efforts is warranted as part of Botswana's efforts to achieve sustainable energy security.

- Research and development experience with over 150 BRET retained heat cookers, or "wonderbox" units indicates that this is an economically marginal energy technology. As long as the wonderbox is used by households at least 50 percent of the time, as long as the fuelwood saved is valued at least at a real price of 4 thebe per kilo, and as long as the value of extra cooking time through use of the wonderbox carries no economic cost to the user, then the wonderbox may be considered to be financially viable to households and economic to society as a whole.

- Given the possible competitive costs under which the BRET wonderbox could be produced in comparison with a currently available South African commercial model, the most likely market for the wonderbox is in urban areas with populations of at least 4,500 persons.

- Since BRET staff estimates of potential energy savings from use of the wonderbox amount to between 5 and 10 percent of household wood equivalent energy consumption, a modest program of public support to further assess the role of retained heat cookers in Botswana should be investigated.

(Source: Financial and Economic Analysis of Selected Renewable Energy Technologies in Botswana, 7/18/85, PNAAX903; see also additional stove reports under 14., R.E. Technical Reports and Publications, below)

D. Water Pumping

The BRET project conducted a comparative testing and evaluation on more than 40 relatively small water-pumping systems powered by diesel, grid-connected electric submersibles, biogas, animal traction, wind, photovoltaics (PV), and hand- and human-power. Labor charges (for operators/attendants) were found to be the most significant projected cost for all of the pump types tested. The BRET project developed special monitoring equipment for the pumping tests.

- Wind Pumps

  Eleven wind pumps of the following seven makes or models were tested: Climax 10, Climax 12 (three),

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Southern Cross 14, Kijito (two), Wind Baron Mark IV 150, RIIC "Motswedi" (two), and WTGS. The Climax and Southern Cross machines were available on the local market. The Wind Baron was imported from Arizona; the Kijito pumps were imported from Bob Harries Engineering Ltd. (BHEL) of Thika, Kenya. The RIIC and WTGS pumps were built locally, the latter manufactured by Momoso Engineering. Cost comparisons were based on the predicted output of each wind pump for a common head--37 meters--and wind speed--2.5 meters/second--calculated using measured data and a computerized output prediction model, rather than using performance data directly. A financial analysis revealed unit water costs as follows:

FINANCIAL ANALYSIS OF WINDPUMPS

WINDMILL	UNIT COST (Pula/cu m x head in m)*
Climax 10	0.039
Climax 12	0.029
Southern Cross 14	0.018
Kijito	0.024
Wind Baron	0.015
RIIC	0.021
WTGS	0.024

*US$0.57 = one Pula

An economic analysis revealed the following:

ECONOMIC UNIT WATER COST

WINDMILL	UNIT COST (Pula/cubic meter)
Climax 10	1.20
Climax 12	0.92
Southern Cross 14	0.56
Kijito	0.86
Wind Baron	0.56
RIIC	0.68
WTGS	0.81

Characteristics for the above windmill water-pumping systems are as follows:

WIND PUMP MODEL	ROTOR DIAM (m)	PUMP TYPE	CYLINDER DIAM (in)	PUMPING HEAD (m)	SITE
Climax 10	3.0	Recip. Piston	2.75	35	Kgoro
Climax 12	3.7	Recip. Piston	3	30	Dipotsana
Climax 12	3.7	Recip. Piston	2.7	27	Sedibeng
Climax 12	3.7	Recip. Piston	3.5	19	Tlharesel
S. Cross 14	4.3	Recip. Piston	3	35	Malesane
Kijito	6.1	Recip. Piston	3.25	35	Mochudi
Kijito	6.1	Recip. Piston	3.25	23	Pitsane-B
Wind Baron	6.4	Recip. Piston	3.75	33	Mochudi
RIIC	6.2	Mono ES-10	--	53	Malau
RIIC	6.2	Mono ES-15	--	37	Mochudi
WTGS	6.2	Mono ES-15	--	37	Mochudi

o PV Pumps

Five PV systems with fixed arrays were tested. Three were direct-coupled to Jacuzzi submersible pumps and installed at Mahalapye, Malopowabojang, and Mochudi. The fourth, at Mmathubudukwane, was a Mono pump coupled to a constant voltage tracker (CVT). The fifth, at Otse, was a Mono pump with batteries for energy storage and starting torque. Each Mono pump was coupled to a surface-mounted Honeywell motor. The Jacuzzi at Mahalapye was also tested with a CVT, but it was found that the incremental water output did not offset the cost of the CVT. The CVT in the Mono system was the most problematic component of the system. From preliminary data collection, the following analyses were conducted:

FINANCIAL ANALYSIS OF SOLAR PUMPS

	Mahalapye Jacuzzi	Mochudi Jacuzzi	Molapow Jacuzzi	Otse Mono/ batt.	Mmathub. Mono/ CVT
Avg. Output (cu m/day)	30	16	21	13	16
Total Pump Head (m)	7	36	24	9	45
Array output (Wp)	516	1376	1376	280	1548
Unit cost (P/cu m x head in m)	0.024	0.014	0.016	0.037	0.012

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An economic analysis revealed the following:

ECONOMIC UNIT WATER COST

PV PUMP	UNIT COST (Pula/cubic meter)
Mahalapye Jacuzzi	0.15
Mochudi Jacuzzi	0.52
Molapowabojang Jacuzzi	0.38
Otse Mono/batteries	0.30
Mmathubudukwane Mono/CVT	0.55

o Diesel Pumps

Five water pumping systems using Mono positive-displacement, progressive-cavity pumps coupled to Lister diesel engines were examined. Characteristics of the motor/pump combinations are:

Site Name	Engine Type	Mono Pump Model	Total Head (meters)	Daily Output (cu meters/day)
Bonwapitse	Lister ST-1	ES-30S	58	19
Malotwana	Lister SR-1	ES-15S	48	10
Mmankgodi	Lister LT-1	ES-15	82	22*
Mogobane	Lister ST-1	ES-30	74	104
Oodi	Lister 8/1	ES-15	101	39

*This pump normally delivered 22 cubic meters of water per day, but the other pumps in the village were broken, so it was delivering 65 cubic meters daily, pumping 24 hours a day at the time of the test.

Tests showed the following results:

Site Name	Water Output (cu meters/hr)	Fuel Use ml/hr	Fuel Use ml/cu m	Overall Efficiency (%)
Bonwapitse	7.66	780	100	15
Malotwana	3.24	520	160	8
Mmankgodi	2.70	405	148	14
Mogobane	8.67	820	95	20
Oodi	3.86	740	192	14

The results of a financial analysis are as follows:

Site name	Annualized Life Cycle Cost (Pula/cu m x head in m)
Bonwapitse	0.010
Malotwana	0.023
Mmankgodi	0.007
Mogobane	0.002
Oodi	0.005

An economic analysis revealed the following:

Site name	Annualized Life Cycle Cost (Pula/cubic meter)
Bonwapitse	0.411
Malotwana	0.746
Mmankgodi	0.440
Mogobane	0.149
Oodi	0.377

- Hand, Human-Traction, Animal-Traction, and Biogas Pumps

  Testing was also undertaken on hand pumps, refurbished human-traction pumps, a human-traction pump redesigned to increase both output and long-term reliability, animal traction pumps, and biogas-fueled water pumps. It was found that 30 meters was the practical acceptable head limit for hand pump use. The redesigned human-traction pump was presumably capable of pumping from a depth of 100 meters, but no actual pumping was done at this level. Results, as well as an economic and financial analysis, are available in the sources.

(Sources for all of the above pumping tests: Wind Pump Field Tests in Botswana--Preliminary Technical and Cost Comparisons, 3/24/86, PNAAX898; Water Pump Field Tests in Botswana, 4/15/86, PNAAX892; see also additional water-pumping reports under 14. R.E. Technical Reports and Publications, below)

E. Solar-Powered Wind Instrumentation Systems

Installed two Natural Power (New Boston, New Hampshire) wind instrumentation systems, each consisting of a Model A30-101 Compilator I coupled to a Model A75-104, 3-cup wind speed sensor, powered entirely by a 12-volt battery system charged by an ARCO Solar PV module, and mounted on

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a 10-meter, guyed tower. With funding support from the Swedish International Development Agency (SIDA), this was expanded to twenty-five 10-meter-high anemometer sites. Details are provided in the sources.

(Sources: Wind Energy Technology for the BRET Project: A Consultancy Report, 5/83, p. 5, PDAAV997; Wind Pump Field Tests in Botswana--Preliminary Technical and Cost Comparisons, 3/24/86, p. 1, PDAAX898)

F. PV Refrigerators and Freezers

The BRET project purchased ten photovoltaic (PV) refrigerator/freezer (R/F) units and installed five, three on a permanent basis and two temporarily, in three rural clinics. The models purchased were one Western Solar Refrigeration (WSR) unit; three Sun Frost Vaccimax units (56-liter interior volume each); one Polar Products RR-2 (127-liter interior volume) and three RR-50L (50-liter interior volume) models; and two Marvel 4RTD (127-liter interior volume) units, a modified version of the WSR R/F. All are top-opening chest models, except for the Sun Frost units, which are front-loading. The Marvel and Sun Frost units do not have on-board battery charge controllers, which must be purchased separately. The Polar Products RR-2 unit has two compressors; all the other models have one. The system configurations are as follows:

- Lensweletau site: A WSR R/F, nine ARCO Solar 16-2000 modules, four 110-AH shallow-cycle batteries, ARCO BP-12 battery charge controller, and five 20-watt fluorescent lights. The WSR R/F experienced problems and was replaced by a Polar Products RR-50L unit. Other modifications included replacement of the BP-12 controller by a SCI-1 controller; replacement of the 20-watt lights by 15-watt lights; addition of a 37.5-watt high-intensity light for the delivery room and a rechargeable flashlight for emergency use.

- Shoshong site: A Polar Products RR-2 R/F, twelve ARCO Solar 16-2000 modules, six 110-AH batteries, nine 20-watt fluorescent lights, a rechargeable flashlight, a high-intensity light, and an ARCO Solar Universal Charge Controller (replaced later by a SCI-1 charge controller). The RR-2 was later replaced by a Marvel 4RTD after a perceived problem with the RR-2, which was diagnosed as simply a misunderstanding of how to set the thermostat correctly. The Marvel was then replaced, after a

two-month successful operation except for occasional and yet unexplained blowing of fuses, with a Sun Frost unit, which was operating without problem at the conclusion of the project.

- Mabule site: A Polar Products RR-50L R/F, twelve ARCO Solar 16-2300 modules, six 110-AH batteries, seven 15-watt fluorescent lights, an ARCO Solar UCC controller, a 37.5-watt high-intensity light, a rechargeable flashlight, and radio communications.

All PV refrigerator/freezers operated reasonably well except for the first (WSR) unit installed, which caused the clinic personnel to lose faith in the technology. Even though the replacement worked with no problem, the clinic was offered and accepted a gas-driven unit, which was used primarily for vaccine storage. The replacement PV unit was used essentially to keep beverages and food cold. The PV clinic installation was plagued with a lack of skilled personnel, due to their involvement with other aspects of the BRET project, and a lack of sites, since the poor performance of the first unit made other clinics reluctant to rely on PV units.

(Source: Photovoltaic Electrification of Health Clinics and Village Schools in Botswana, 9/18/85, PNAAX899)

G. PV Lighting Systems

Four PV lighting systems were installed in schools in 1985:

- In a 50 square meter classroom in Oodi: six 15-watt DC fluorescent lights; two 100-AH shallow-cycle batteries; two ARCO Solar M-63 self-regulating modules; and one analog voltmeter.

- In a 50 square meter classroom in Ditshegwane: fourteen 15-watt DC fluorescent lights; three 100-AH shallow-cycle batteries; three ARCO Solar M-53 modules; and a Botswana Technology Centre (BTC) charge controller.

- In a 95 square meter classroom in Shoshong: six 50-watt (40-watt nominal) AC fluorescent lights; six 100-AH shallow-cycle batteries; eight ARCO Solar M-63 modules; two BTC charge controllers; and two 300-watt inverters.

- In a 50 square meter classroom in Molapowabojang: nine 15-watt DC fluorescent lights; three 100-AH

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shallow-cycle batteries; two ARCO Solar M-63 self-regulating modules; and one BTC charge controller (used due to its low-voltage disconnect capability).

(Source: Photovoltaic Electrification of Health Clinics and Village Schools in Botswana, 9/18/85, PNAAX899)

H. Batch Solar Water Heaters

Seven prototype simple batch solar water heaters were designed, built, and tested: (1) a 5-liter tin painted black; (2) a concentrator collector consisting of a 10-liter bucket painted black and placed within a galvanized sheet metal inverted cone, both of which were placed in a larger container made from a half 200-liter drum or from a plastic bucket; (3) two 20-liter large insulated boxes (of different dimensions) with fitted spigot and inclined glazing cover, one painted white, the other black; (4) an insulated box with 15-mm insulating bottom air space and a glazed cover for two or three black 5-liter tins; (5) an uninsulated box with glazed cover for two or three black 5-liter tins; (6) three varieties of solar pillows made of black or clear vinyl and incorporating a spout for filling and emptying; and (7) two 20-liter capacity flat boxes of different dimensions with glazed cover, one painted silver, the other black. The uninsulated box with three tins performed the most consistently and emerged as the most popular model among users. The uninsulated model was disseminated through training workshops: two construction workshops were held in Shoshong; a village carpentry workshop with a solar water heater construction component was held in Ditshegwane; and water heater construction was included in larger workshops aimed at introducing R.E. technologies to extension workers. By the end of 1984, 27 units had been built through the various workshops, with 21 installed in households.

Although user acceptance was high, economic analysis indicated that the solar water heaters did not appear to be economical under a broad range of operating asumptions.

(Source: Development and Dissemination of Village Solar Water Heaters, 8/30/85, PNAAX914; Financial and Economic Analysis of Selected Renewable Energy Technologies in Botswana, 7/18/85, PNAAX903)

I. Energy-Efficient Building Design

o Experimental Buildings: Overview

Designed and constructed a number of experimental

buildings to evaluate various design concepts, materials, and components for energy efficiency. Buildings included the Botswana Technology Centre (BTC) office, a library, and a shop in Gaborone (see below for details); the Shakawe-EC passive solar house in Gaborone (see below for details); the village training facilities in Shoshong and Ditshegwane; and the Self Help Housing Agency (SHHA) demonstration houses in Gaborone West, Gaborone North, Francistown, and Lobatse. The BTC design won an award of merit in the commercial category at the Second U.S. Passive Solar Design Competition in July 1982. The BTC facility and the Shakawe-EC passive solar house were monitored and their performance analyzed.

(Source: Botswana Renewable Energy Technology Project: Final Report, 12/20/85, PDAAW030; see additional building design reports under 14., R.E. Technical Reports and Publications, below)

o Passive Solar Building Design: BTC Complex

The BRET designed and built a passive solar and energy-conserving main office building and library as part of the Botswana Technology Centre (BTC) complex. The 240 square meter main office building is oriented along an east-west axis; the majority of the windows face north and south and are minimized on the east and west walls. The library has 88 square meters of floor area. Both buildings have a central roof monitor with operable windows intended to exhaust warm air and furnish daylighting. The ceilings of both buildings are insulated, and the space between ceiling and roof is ventilated. The outside of the walls of both are insulated with a coat of plaster. Both buildings are equipped with a system of shading louvres on the north and west walls to reduce solar gain in the summer. The anticipated passive cooling strategy involved the daytime closing and shading of windows to reduce heat gain, and the opening up at night for ventilation. Although the original design anticipated the need for a small amount of additional heating, no auxiliary heating equipment was installed. An Aeolian Kinetics PDL-24 microcomputer data acquisition system with 19 sensors was installed to monitor performance. Performance was found to be essentially consistent with original predictions.

For a typical summer day, the daily indoor temperature swings were found to vary by less than 3 degrees C., compared to the ambient temperature difference between night and day exceeding 14 degrees

C. Indoor temperatures are closer to the ambient nightime temperature than the ambient daytime temperature. During the hottest time of the day, the outdoor temperature was more than 7 degrees C. higher than the indoor temperature. With light clothing, the comfort level was maintained even with no significant air movement.

On the hottest summer day, indoor peak temperatures remained a full 9.1 degrees C. less than maximum outdoor temperatures. Nonetheless, this meant that indoor temperatures reached 30.3 degrees C. (as opposed to 39.4 degrees C. ambient). With no significant air movement, indoor temperatures were found to be slightly uncomfortable before noon, but quite uncomfortable during the afternoon.

For a typical winter day, indoor temperatures rose from 17-17.9 degrees C. to a high of 21.2 degrees C., compared to the ambient swing from 4.8 degrees C. to 21.0 degrees C. This was clearly not comfortable for most office workers. For the coldest day, conditions were very uncomfortable. The ambient rose from 2.1 degrees C. to 16 degrees C., while the indoor temperatures increased from 15 degrees C. in the morning to a high of 17-18 degrees C. The need for auxiliary heating was evident.

Total daily electricity consumption amounted to 17.9 kWh in the summer, compared to a typical load of more than 40 kWh/day for similar office space. Winter consumption averaged 25.8 kWh per day.

An economic analysis revealed that if the BTC office were heated and cooled to the standard office comfort range of 20-25 degrees C., the operating cost savings would be five times greater than the annualized increase in construction cost in the first year alone. Over a 30-year timeframe, the savings would be approximately seven times greater than the cost of the improvements. At a discount rate of 6%, the net present value of these savings is P59,058, compared to a P10,874 net present value of costs.

(Source: Performance Evaluation of the Botswana Technology Centre's Passive Solar Buildings, 9/26/85, PNAAX910; see additional building design reports under 14., R.E. Technical Reports and Publications, below)

- Passive Solar House Design: Shakawe-EC

A standard Botswana Housing Corporation house design,

the Shakawe-A Type II, was revised to incorporate passive solar principles and a demonstration model was constructed. Referred to as the Shakawe-EC, it is a high-cost house whose passive design features could nonetheless be applied to medium- and low-cost houses. These features included north-facing windows, a Trombe wall, roof overhangs, vents, and a breezeway. Thermal performance of the house was monitored from July 1983 to March 1984 using an Aeolian Kinetics PDL-24 microcomputer data acquisition system and 14 sensors. Data were collected on an hourly basis and transferred to a LOTUS 1-2-3 program for analysis. The house was fully occupied during the testing period, and the occupants were requested to refrain from using any auxiliary heating or cooling devices. Reasonable comfort levels were maintained throughout the monitoring period. Average indoor daily temperatures during the winter months were 6 degrees C. higher than ambient. Average summer indoor and outdoor temperatures were similar, although the new design reduced the day-night temperature swings from over 12 degrees C. to under 4 degrees C. The house experienced average indoor temperatures below 20 degrees C. for 3.2% of the monitoring period, and temperatures over 28 degrees C. for 34.9% of the monitoring period. On the day the ambient temperature climbed to its maximum of 43.1 degrees C., the indoor temperature reached a maximum of 34.4 degrees C. The house thermal mass, however, did not cool off at night as rapidly as might be desired, and, as a result, the house remained somewhat warmer than ambient.

A CALPAS3 computer simulation model, version 3.13, was used for comparative analysis. If the Shakawe-EC were maintained at temperatures between 20 and 28 degrees C. using heating and air conditioning, the annual auxiliary heating load was calculated at 2.4 Gigajoules and the auxiliary cooling load at 20.4 Gigajoules. This compares to a predicted 9.9 Gigajoule heating load and a 51.6 Gigajoule cooling load for a similar non-solar house. This represents a 63% energy savings and, assuming electrical heating and air conditioning, an annual savings of 6,417 kWh.

(Source: Measured Performance Analysis of the Shakawe-EC: A Prototype Passive Solar House for Botswana, 10/84, PNAAX904; see additional building design reports under 14., R.E. Technical Reports and Publications, below)

14. R.E. Technical Reports and Publications:

A. Financial and Social Benefit/Cost Analysis of Renewable Energy Technologies in Botswana: A Consultancy Report. John H. Ashworth, Associates in Rural Development, Inc., Burlington, VT, March 1984, 92 pp., PNAAX891.

This report describes two consultancies: the first provided BRET project staff and GOB officials with training in financial and economic analysis; the second examined the project's reporting of lab and field data and provided training in research methodology and technical report writing to BRET/Gaborone staff and the village facilitators. A financial analysis of the BRET metal stove is included, as are questionnaires designed to gather data for benefit/cost analysis of the other BRET project RETs.

B. Comparative Testing for Water-Pumping Systems Installed in Botswana: General Research Methodology and Specific Field Implementation Instructions. Richard McGowan and John Ashworth, Associates in Rural Development, Inc., Burlington, VT, July 9, 1984, 97 pp., PNAAT151.

This report describes the PV, windmill, and diesel water pumping systems and instrumentation, the testing methodology, and the analytical procedure for data collection and analysis that the BRET project will use to undertake comparative testing and monitoring of those water pumping systems. The testing will focus on the amount and cost of water produced and on system reliability, and will provide detailed information on operating problems and maintenance and training requirements. System data collection sheets are included in appendices.

C. Water Pump Field Tests In Botswana. Richard McGowan and Jonathan Hodgkin, Associates in Rural Development, Inc., Burlington, VT, April 15, 1986, 135 pp., PNAAX892.

This report presents the results of a comparative testing and evaluation program for water pumping systems undertaken by the BRET project. More than 40 systems, consisting of diesel, grid-connected electric submersibles, animal traction, biogas, wind, photovoltaics, and hand- and human-powered water pumps, were tested and monitored. Contains tables, charts, and graphs.

D. Botswana Village Energy Survey Report. Judith Oki and Julia Majaha-Jartby, Associates in Rural Development, Inc., Burlington, VT, September 1983, 76 pp., PNAAX893.

An energy needs survey conducted in the small village of Ditshegwane, during a three-week period in May-June 1982, and in the medium-sized village of Shoshong, during a five-week period in October-November 1982, is described. Includes survey instruments, methodology, implementation, and results. See also 14. E., below.

E. Domestic Energy Use in Two Villages: Addendum to Botswana Village Energy Survey. Judith A. Oki, Associates in Rural Development, Inc., Burlington, VT, September 16, 1985, 13 pp., PNAAX894.

This report describes an intensive fuel measurement study undertaken in 1983 to quantitatively assess energy use in the villages of Shoshong and Ditshegwane. It complements the 1982 village energy use survey performed in the same two villages, but which did not include quantitative fuel use measurements. The methodology is explained, and detailed results and conclusions are presented. See also 14. D, above.

F. Botswana Urban Domestic Energy Use and Attitude Survey. John Gay and Carl P. Zietlow, Associates in Rural Development, Inc., Burlington, VT, August 1985, 86 pp. PNAAX895.

Presented are the research methodology, findings, and conclusions of a domestic energy study undertaken among 576 households in three towns and three major villages of Botswana during summer, fall, and winter 1984. Many tables are provided.

G. Awareness Plan and Implementation Guide for the Botswana Renewable Energy Technology Project. Erika Morgan, Associates in Rural Development, Inc., Burlington, VT, February 1983, 126 pp., PNAAX896.

Methods to prepare public awareness tools are presented in a simple, easily understood, how-to fashion. The materials can be used by the project's village-based training facilitators.

H. Wind Energy Technology for the BRET Project: A Consultancy Report. Roy Smith, Associates in Rural Development, Burlington, VT, May 1983, 148 pp., PDAAV997.

Reviews wind data collection in Botswana and BRET project plans in this area. Briefly examines the engineering design of the RIIC windmill and makes suggestions for its improvement. Examines a variety of windmills, some under development in Botswana and others with potential for water-pumping use there, and recommends a set of

windmills for a comparative testing program. Presents economic analysis of the performance of several different wind systems, assuming wind regimes of 8, 12, and 16 km/hr and pumping heads of 30 and 100 meters. Reviews wind energy training provided under the project. Appendices include wind data in Botswana collected by the Meteorological Services, performance curves for several families of windmills, detailed methods for analyzing and interpreting wind data, a syllabus for a one-week training program for windmill installation and maintenance, and a listing of hand-operated water pumps undergoing lab tests by the UNDP/World Bank.

I. Solar Pump Field Tests in Botswana--Preliminary Technical and Cost Comparisons. Richard McGowan and Jonathan Hodgkin, Associates in Rural Development, Inc., Burlington, VT, April 7, 1986, 109 pp., PNAAX897.

This report reviews photovoltaic water pumping as part of a comparative water pumping program involving a number of renewable and conventional water pumping technologies. System designs, data collection and analysis methodology, technical performance results, economic and financial analyses, and a discussion of constraints to widespread dissemination are covered.

J. Wind Pump Field Tests in Botswana--Preliminary Technical and Cost Comparisons. Jonathan Hodgkin and Richard McGowan, Associates in Rural Development, Inc., Burlington, VT, March 24, 1986, 124 pp., PNAAX898.

As part of a comparative water pumping program involving a variety of renewable energy and conventional water pumping technologies, this report focuses on windmills. A review of the BRET involvement in wind data collection and analysis, descriptions of the windmills tested, testing methodology, performance results, comparative financial and economic analyses, and limitations to dissemination are covered. Results are preliminary, as they are based on a monitoring period of less than one year.

K. Photovoltaic Electrification of Health Clinics and Village Schools in Botswana. Richard McGowan and Jonathan Hodgkin, Associates in Rural Development, Inc., Burlington, VT, September 18, 1985, 84 pp., PNAAX899.

This report describes a pilot/demonstration program involving four photovoltaic (PV) lighting systems installed in rural schools and five PV lighting and refrigerator/freezer (R/F) systems installed in rural clinics in Botswana. Data collection methodology is described, and results from limited testing are

presented. A preliminary financial/economic analysis is included. Appendices include a detailed description of the PV systems and R/F manufacturers' brochures.

L. Prototype Metal and Mud Wood-Burning Cook Stoves for Botswana. Howard S. Geller, Bai Leteemane, Theresa A.M. Powers, and James Sentle, Associates in Rural Development, Burlington, VT, May 1983, 48 pp., PNAAX900.

This report describes the project's work on cookstoves through April 1983. A description of the prototype stoves constructed, techniques used to evaluate their performance, results of the first phase of stove testing, conclusions, and near-term plans are included. Several metal and mud stove designs were tested.

M. Technical Adaptation: BRET Wood-Conserving Metal Stoves. Eric Brunet and John H. Ashworth, Associates in Rural Development, Inc., Burlington, VT, July 1984, 43 pp., PNAAX901.

Development of "B" and "Delta" models of improved metal stoves through adaptation of the initial prototype Model 3 stove is described. Results of water-boiling tests are presented. Drawings of the stoves and blueprints for Model Super "B" are included.

N. Botswana Renewable Energy Technology Project: Final Report. Associates in Rural Development, Inc., Burlington, VT, December 20, 1985, 175 pp., PDAAW030.

This report describes the accomplishments of the various components of the BRET project since its inception and covers: energy assessments; water pumping; PV electrification; commercial solar water heaters; passive solar design, construction and promotion; earthen stoves; portable sheet metal stoves; retained heat cookers; earthen bread ovens; simple batch solar water heaters; institutional assessments; awareness and outreach; training; the development of GOB and Botswana capabilities; and lessons learned under the project. Many photographs are included.

O. Financial and Economic Analysis of Selected Renewable Energy Technologies in Botswana. Phillip LeBel, Associates in Rural Development, Inc., Burlington, VT, July 18, 1985, 86 pp., PNAAX903.

This report gives a financial and economic analysis and a sensitivity analysis of three BRET technologies: four

models of the BRET metal stove, the retained heat cooker, and a 15-liter batch solar hot water heater. A detailed discussion of the methodology used and its shortcomings is included.

P. Measured Performance Analysis of the Shakawe-EC: A Prototype Passive Solar House for Botswana. Blair Hamilton, Associates in Rural Development, Inc., Burlington, VT, October 1984, 80 pp., PNAAX904.

Test results from computer monitoring of the thermal performance of the passive solar Shakawe-EC house from July 1983 to March 1984 are presented. Hourly data were collected on magnetic tape and transferred to IBM-PC compatible diskettes and subsequently to a LOTUS 1-2-3 program for analysis. Monthly and seasonal performance is examined. The house was occupied during the testing period, and no electricity or coal was used for auxiliary heating or cooling. Performance was then compared with that of a similar traditional house by means of a CALPAS3 calibrated simulation model. Extensive graphs, charts, and tables are included.

Q. Development and Dissemination of Retained Heat Cookers. Judith A. Oki, Associates in Rural Development, Inc., Burlington, VT, August 30, 1985, 72 pp., PNAAX905.

This report describes the adaptation of known models of retained heat cookers (RHCs) to fit local three-legged pots and local foods in Botswana. Methods to determine fuel savings, demonstrations, dissemination, and follow-up studies are covered. Appendices include a guidebook in comic book form illustrating operation and use, with recipes for local foods; a sensitivity analysis based on a financial analysis; and user questionnaires.

R. Passive Solar Design in Botswana: A Consultancy Report. Associates in Rural Development, Inc., Burlington, VT, May 1984, 27 pp., PDAAV998.

This report summarizes the work carried out in Botswana by David Norris, an architect, and Blair Hamilton, a passive solar design specialist, from February 13 to March 13, 1984. It includes a review of a passive solar design seminar conducted in early 1984; examination of the monitoring system for the non-solar reference house; and discussions on the project's solar office building. Appendices include a schedule for the passive design workshop and an evaluation of the BRET passive solar house.

S. Thermal Performance Analysis of the Tutume Health Center. Scott Matthews, Associates in Rural Development, Inc.,

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Burlington, VT, February 28, 1985, 30 pp., PNAAX906.

Results of a preliminary analysis of design options for improvement in the thermal performance of the Tutume Health Center are reported. The study focused on design alternatives to a central heating system to improve patients' comfort level. Cost-effectiveness is not considered. Capital and maintenance costs for heating a health center by a variety of heating systems/fuels (mostly conventional) are calculated.

T. New Chancery for Lusaka--Atrium Thermal Analysis. Scott Matthews, Associates in Rural Development, Inc., Burlington, VT, March 12, 1985, 20 pp., PNAAX907.

A design for a new chancery to be built by the Government of Botswana for the Botswana High Commission in Lusaka, Zambia, is analyzed to determine if the building will provide appropriate comfort levels. Thermal performance of the atrium glazing is examined, and selection of a suitable glass type is discussed. As it was determined that overheating would occur during the summer, an alternate roof concept for the atrium is presented. Recommendations for design modifications are included.

U. Technology Development for the BRET Project: A Consultancy Report. Ron Alward, Associates in Rural Development, Inc., Burlington, VT, November 1982, 33 pp., PDAAV999.

This report summarizes the activities of solar engineer Ron Alward during a consultancy conducted from October 21 through November 21, 1982. The passive solar designs for the Village Training Facilities (VTFs) are discussed. An overall technology assessment is furnished to assist in determining the project's future activities (next 6 to 12 months) in technology development and implementation.

V. Passive Solar Design Workbook. L. Blair Hamilton, David Norris, and Beth Sachs, Associates in Rural Development, Inc., Burlington, VT, May 2, 1984, 292 pp., PNAAX908.

This report consists of reference materials used in the two workshops on passive solar design held by the BRET project from February 27-March 9, 1984. The materials cover general passive solar design principles, such as site orientation, thermal design of the building envelope, ventilation design for passive cooling, etc. Specifics related to the Botswana context, such as how local climatic conditions affect design considerations, are covered. Appendices describe building design incorporating efficient wood-burning cookstoves, and water conservation possibilities for Botswana.

W. Performance Evaluation of the Botswana Technology Centre's Passive Solar Buildings. Blair Hamilton, Beth Sachs, and Gabaipone M. Masire, Associates in Rural Development, Inc., Burlington, VT, September 26, 1985, 111 pp., PNAAX910.

This analysis addresses the main office building and the library of the Botswana Technology Centre complex, designed and built by the BRET. Both buildings were to demonstrate the effects of passive solar and energy-conserving design on the two major institutional uses of energy: cooling and lighting. Monitoring and data collection, performance results, a qualitative performance evaluation by building occupants, a computer simulation modeling analysis, and an economic analysis are described. Appendices include notes on natural ventilation testing, and test measurements on ceiling fans and lighting levels. Graphs, charts, tables, and drawings are included.

X. Fenestration Design for Daylighting of Vocational Training Center Classrooms. Scott Matthews, Associates in Rural Development, Inc., Burlington, VT, January 29, 1985, 12 pp., PNAAX911.

This report summarizes the BRET's analysis and recommendations for the sizing and placement of windows for Vocational Training Center classrooms and workrooms.

Y. Ventilation Recommendations for MLGL/BHC Mid-Level Housing. Scott Matthews, Associates in Rural Development, Inc., Burlington, VT, January 16, 1985, 14 pp., PNAAX912.

This report examines the ventilation features of the standard plans being developed by the Botswana Housing Corporation for use in New Naledi. Modifications to improve ventilation are recommended.

Z. Production Training for BRET Metal Stoves. Eric N. Brunet, Judith A. Oki, and James Sentle, Associates in Rural Development, Inc., Burlington, VT, July 1984, 40 pp., PNAAX913.

BRET training of local tinsmiths to produce wood-conserving metal stoves is described. Appendices include a workshop schedule and an account of another stove workshop held in conjunction with Partnership for Productivity (PFP)/Gaborone.

AA. Development and Dissemination of Village Solar Water Heaters. Judith A. Oki, Associates in Rural Development,

Inc., Burlington, VT, August 30, 1985, 48 pp., PNAAX914.

This report describes comparative laboratory tests on seven prototype solar water heater designs, the process undertaken to narrow the selection to one model for pilot diffusion, the project's pilot diffusion experience, and an economic analysis of the solar technology. The simple batch solar water heaters are for use in village households. Appendices include drawings of the initial prototypes, test data sheets, and a user questionnaire.

BB. Training Needs Assessment for Renewable Energy Technologies. George Burrill, Associates in Rural Development, Inc., Burlington, VT, June 12, 1985, 52 pp., PNAAX915.

Assesses the skills, personnel, and training required for a number of Government of Botswana agencies and nongovernmental organizations to undertake R.E. activities within the next five years.

CC. The Thebe Pump--A Human Traction Pump for Botswana. Jack Shields and Richard McGowan, Associates in Rural Development, Inc., Burlington, VT, August 31, 1985, 30 pp., PNAAX916.

This report describes work performed by BRET and RIIC personnel on rebuilding two nonfunctional human traction "Thebe" pumps and on designing and constructing a third improved model human traction pump. Field pumping experience is presented. Economic and financial analyses and a summary of recurrent financial and economic costs for three standard hand pumps and a Thebe human traction pump are given. Appendices include a table of fabrication and installation costs for the RIIC-redesigned Thebe pump, a summary of RIIC design improvements, and a list of required installation tools.

DD. Test Report of the WTGS Windmill in Botswana. W. Nijhoff, TOOL Foundation-Technical Development with Developing Countries, Amsterdam, Netherlands, May 1986, 75 pp., PNAAX917.

A TOOL consultancy performed between February 8 and May 1, 1985, at the request of the WTGS is described. The consultancy received cooperation from the WTGS group, Momoso (the firm that manufactuered the WTGS windmill), BRET, and RIIC. The report describes in detail the WTGS Prototype II windmill, two of which were purchased by the BRET project; examines performance data of the WTGS prototype II windmill in Mochudi, a modified prototype I WTGS windmill in Shoshong, and the RIIC windmill in Mochudi; compares anemometer readings at the three sites

and discusses deviations from windtunnel calibration; compares costs for the RIIC and WTGS windmills; discusses testing results of the centrifugal clutch; and recommends improvements. Graphs and tables are included.

15. Evaluations/Major Findings:

A. Project Evaluation Summary: Botswana Renewable Energy Technology Project. February 3, 1984, PDAAP559 or PDBAQ858.

The evaluation calls for a conditional extension of the ARD technical assistance contract, dependent upon the improvement of project extension activities, report generation, and research design and implementation.

It is recommended that the GOB organize a Botswana Renewable Energy Activities Committee, composed of staff from the appropriate ministries and parastatal organizations; and that the GOB delineate the respective responsibilities of the BRET, which is a MMRWA project, and the Botswana Technology Centre, which is a parastatal organization. In total, forty recommendations are made, most of which are reflected in subsequent project activities.

The evaluators believed that for the project purpose to be realized, the projected outputs would have to focus more on developing a GOB capability to promote technologies and provide long-term encouragement to entrepreneurs. Consequently, recommended output changes are listed.

B. Project Evaluation Summary for Final Evaluation: Botswana Renewable Energy Technology Project. C.A. Pryor and Stafford Baker, May 29, 1985, PDAAR147 or PDBAV965.

It was felt that ARD would meet or surpass all outputs. Much improvement occurred after the hiring of an experienced engineer to test and evaluate the technical components. However, there was still some concern that ARD's methodology was too technology-driven.

The major finding was that there may be no simple village-level RETs suitable for Botswana; however, a number of RETs may be able to compete with diesel engines for water pumping in rural areas. Traditional cooking and washing habits were inhibiting dissemination of the retained heat cooker and low-cost solar water heaters; and, while there was widespread interest in the BRET metal stove, problems with production, marketing, and affordability remained unresolved and may be insurmountable.

There were many lessons learned: R.E. pilot projects should be designed more clearly around end uses and, if possible, incorporated within larger projects emphasizing that end use; the BRET project was too ambitious and based on a series of questionable concepts, which made meeting outputs impossible, although this was remedied considerably as a result of the mid-term evaluation; interagency conflicts, caused in large part by ambiguous responsibilities, are serious problems that cause considerable delays, duplication of work, and lack of cooperation; pilot projects should be given sufficient time, and donors should be willing to fund follow-on activities, although a pilot project should be redesigned to emphasize stand-alone outputs if follow-on becomes unlikely; and projects can and should be redesigned to reflect changing situations and results of analysis.

Six recommendations are made for close-out and follow-on activities: (1) BRET should prepare a memo on the need for MMRWA to continue an extension program; (2) BRET final reports should be focused on end uses and contain information useful to the GOB in policy making; (3) Technoserve and KENGO staff from Kenya should visit the BRET project to evaluate the BRET metal stove program and develop a plan for future activities; (4) BRET should request from AID/W S&T and WASH further assistance to continue the comparative pumping program; (5) MMRWA should plan for the disposal of the BRET assets; and (6) small working groups composed of the appropriate parties should discuss the takeover of BRET activities under the proposed GOB mini-projects.

16. Key Persons:

A. AID/Washington:

Karen Nurick, AFR/PD/SAP
2884 NS
647-8818

B. AID/Mission:

S. Baker, Field Project Officer
USAID Mission, P.O. Box 90, Gaborone, Botswana

C. Contractors:

Richard McGowan, Senior Engineer
Associates in Rural Development, Inc. (ARD)
72 Hungerford Terrace, Burlington, VT 05401
(802)658-3890

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D. Host Country:

Ministry of Mineral Resources and Water Affairs (MMRWA)

Department of Water Affairs (DWA)

Ministry of Local Government and Lands (MLGL)

Botswana Technology Centre (BTC)
Private Bag 0082, Gaborone, Botswana
Phone: 4161 or 2829
Telex: 2251 BD
Cable: DEVELOP

Rural Industries Innovation Centre (RIIC)
Private Bag 11, Kanye, Botswana

Gerrit Jacobs
Windmill Technology Group Serowe (WTGS)
Private Bag 10, Serowe, Botswana

17. Obligations by Fiscal Year (US$000):

USAID INPUTS

Year 1	725
Year 2	1,000
Year 3	1,579
TOTAL	3,304

(Source: Project Paper Amendment, 3/12/84, PDBAQ860)

18. Host Country Funding of R.E. Components (US$000): 1,178.3

(Source: Project Paper Amendment, 3/12/84, PDBAQ860)

19. Summary of R.E. Costs (US$000):

Technical assistance	1,293.415
Training	
U.S.	191.696
Local	91.600
Commodities	521.000
Research activities	227.448
Construction	266.000
Other	712.841
	3,304.000

(Source: Project Paper Amendment, 3/12/84, PDBAQ860)

20. R.E. Component Revisions:

A. Activities related to earthen stoves and simple, 15-liter solar water heaters reached the prototype development and testing stage before being dropped due to problems with cost, durability, and construction. Evaporative coolers, thatch insulation, and pedal-powered sorghum de-hullers were investigated initially but relegated to a lower priority.

(Source: Final Report, p. 10, 12/20/85, PDAAW030)

B. The original concept for R&D work and field testing of hand, solar, and wind water pumps, as identified in the Project Paper, was broadened to include animal-powered and biogas pumps through collaboration with the Rural Industries Innovation Centre (RIIC) and expanded into a comparative pumping assessment.

(Source: Final Report, p. 11, 12/20/85, PDAAW030)

C. The BRET project agreed to fund a local firm, Solar Power, Inc. of Gaborone, to develop and construct prototype low-cost solar water heaters which were to be tested subsequently by the University of Botswana. Solar Power, however, did not fulfill its obligations, developing sophisticated designs that required expensive, imported equipment to manufacture, and ignoring BRET technical suggestions. No prototypes were constructed. Consequently, all of the intended funds were not disbursed. Work on simple, batch institutional solar water heaters, contracted to the Rural Industries Innovation Centre, likewise was never conducted, due to staff vacancies and other problems with the solar section of RIIC.

(Source: Final Report, pp.60-63, 12/20/85, PDAAW030)

D. Project outputs were revised and expanded as a result of a recommendation of the mid-term evaluation.

(Source: PES, 5/29/85, PDAAR147)

E. The Comparative Water Pumping Technology Program was extended for an additional 15 months to strengthen the performance and cost data base, both in terms of longevity of monitoring and the number and types of systems tested. To complement the PV Jacuzzi and Mono pump systems, several Grundfos AC submersibles and a variety of other Mono pumps are being installed.

(Source: Solar Pump Field Tests in Botswana--Preliminary Technical and Cost Comparisons, 4/7/86, p. 5, PNAAX897)

F. The wind resource assessment activity, initiated by the BRET project, received funding from the Swedish International Development Agency (SIDA) for continuation of data gathering at 25 anemometer sites at the 10-meter level until early 1986.

(Source: Wind Pump Field Tests in Botswana--Preliminary Technical and Cost Comparisons, 3/24/86, p. 1, PNAAX898)

21. Follow-On Activities:

A. Various components of the BRET will be taken over by the Energy Unit of the Ministry of Mineral Resources and Water Affairs and by other GOB projects after its completion. The Appropriate Water Technology project will take over the water pumping comparison program. The Rural Domestic Renewable Energy Technologies and Extension Services Project will take over the village level technology and extension work. The Energy Technology Substitution project will follow up on PV electrification activities.

(Source: Project Implementation Report, 3/31/85, PDBAV964)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: March 1987 (jrl)
Revised May 1987 (jrl)

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---------- AID RENEWABLE ENERGY DATA BASE ----------

1. Project Number: 6490122 2. Geo: SOMALIA

3. Title: COOPERATION FOR DEVELOPMENT IN AFRICA (CDA) FORESTRY PHASE I--REFUGEE AREAS

4. Project Life/PACD: 1982-86 (extended to 1987)/September 30, 1987

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 6,000

   B. R.E. Components: Not specified

   (Source: Implementation Report, 3/31/85, PDBAV420)

7. Loan or Grant/Appropriation Category (US$000):

   G / FN / 6,000

   (Source: Implementation Report, 4/1/83, PDBAW052)

8. Project Purpose:

   To (1) Redress deforestation caused by presence of refugees; (2) Provide tree planting, fuel conservation, and work opportunities for refugee and neighboring Somali populations; and (3) Strengthen the institutional capability of the National Range Agency (NRA) at headquarters and in the field.

9. Renewable Energy (R.E.) Outputs:

   Trees planted in agroforestry projects, in fuelwood plantations, in shelterbelts, and for shade around public places; Expanded use of improved stoves; Trained NRA staff, NRA-sponsored workshops, land use survey, and other planning studies.

10. R.E. Inputs:

   NRA forestry officers; Technical assistance; Funds for equipment and supplies; Consultants; Training of local support staff.

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11. Summary of R.E. Components:

The CDA project is the first stage of a U.S. initiative to assist the Government of the Somali Democratic Republic (GSDR) to undertake a larger volume of forestry and fuelwood planting programs as part of its overall social and economic development efforts. The first phase consists of five components:

- NRA institution building, to provide training and technical assistance to NRA staff and support to the Afgoi forestry school;
- Reforestation and fuelwood production, to establish fuelwood plantations, windbreaks, and shelterbelts in and around refugee camps;
- Fuelwood conservation, to demonstrate and disseminate fuel-efficient stoves;
- Natural resources/land use survey, to complete a national natural resource and land use survey; and
- Fuelwood supply/demand assessment, to examine fuelwood supply and marketing systems.

The project contained the following reforestation and fuelwood production subprojects:

- The Africare/NRA subproject, aimed at expansion of existing NRA nurseries, dune control, fuelwood plantations, and agroforestry planting in Jalalaqsi.
- The NRA/CARE subproject, designed to redress deforestation in the vicinity of Belet Weyne caused by the presence of refugees, and to provide tree planting, fuel conservation, and work opportunities to refugees. The project had difficulty obtaining land for woodlots and shelterbelts, as much of the land around the camps was designated for agricultural use.
- The NRA/Save the Children Federation (SCF) subproject, established to plant trees on submarginal land, test and demonstrate agroforestry, and establish a nursery for seedling production in the Qorioley camp and environs. Although targets were met for the most part, outplanting success rate was not high.
- The Gedo Community Forestry subproject, implemented without a PVO partner. Planned as a response to environmental degradation in the Luug area, it was designed to establish a central nursery to supply seedlings to 18 cooperative village woodlots, to be

watered, tended, and protected by the villagers themselves. In addition, there were high rates of success with farm plantings and with multipurpose plantings around compounds. Seedling mortality rate, however, was quite high.

- The Overseas Education Fund (OEF) subproject, designed to work closely with the Somali Women's Democratic Organization, an indigenous non-governmental organization, in a combination of forestry and horticultural activities, including the writing of training manuals on the planting and care of seedlings. The cholera epidemic in Hargeisa and the subsequent quarantine of the Northwest Region disrupted project activity.

- The Volunteers in Technical Assistance (VITA) subproject, directed at implementing a program of testing and disseminating improved, more efficient versions of locally made cookstoves in four regions. An increase in the government tax on stoves from 2.5 to 53.5 shillings threatened production and price stabilization; VITA intervened to have this rescinded. Lack of a dependable supply of cast iron grates caused delays in the production of soapstone stoves.

An acute fossil fuel shortage negatively affected project implementation of all of the above subprojects by curtailing transportation and other vital project activities, such as irrigation.

As of 1985, the following were completed: 10 seedling nurseries were established, with output exceeding project objectives; 10 hectares of sand dunes were stabilized (with 48 ha. planned); 275 ha. of woodlots/plantations with approximately 4x4 spacing were planted (864 ha. planned); 14 NRA staff were on participant training in the United States and other countries; a detailed aerial and ground land-use survey of southern Somalia was completed showing plant and animal populations, human settlements, and ecological trends; energy-efficient kilns for stove production were constructed in Luug, Bur Dhubo, Merca, El Haji, and Brava; refugees who were trained in the construction of fuel-efficient stoves built 14 stoves for supplementary feeding centers in Luug and 3 at the orphanage in Mogadiscio; 2,013 ceramic stoves were produced, of which 95% were disseminated in Lower Shabelle, Gedo, and Hiran regions; and 5,385 improved soapstone stoves were produced, of which 4,315 were disseminated in Benadir, North West, Togdheer, Awdal, Gedn, Lower Shabelle, and Hiran.

12. R.E. Project Descriptors:

Firewood; Stoves; Charcoal; Kilns; Food preparation.

13. R.E. Technology Applications:

A. VITA conducted water boiling tests on 11 wood-burning stoves (the traditional three-stone fire and 10 traditional and improved metal and ceramic portable models) and on 8 charcoal-burning stoves (two traditional soapstone, two improved prototype soapstone, one traditional ceramic, one kerosene can, and on two variations of the Umeme).

The percent heat utilized (PHU) and gross specific consumption (GSC)--a variation of specific consumption measurement which does not subtract the energy content of the left-over charcoal (since Somali cooks do not typically recover this charcoal)--were calculated at both high and low power levels, and overall. Based on these and other tests, VITA selected one charcoal-burning soapstone stove and one wood-burning ceramic stove and disseminated them on a large scale through local retailers; fuel savings of 20-40% have been achieved.

(Source: Efficient Cookstove Development in Somalia: A Progress Report, VITA, 1984, PDAAU783)

B. VITA project also accomplished the following:

- Established a lab-testing facility for cookstoves at the National Foundry and Mechanical Workshop in Mogadiscio;
- Trained three Somalis in stove-testing procedures and data analysis according to international stove testing standards;
- Field tested two ceramic wood-burning stoves and one metal charcoal burning stove for pilot dissemination purposes;
- Field tested improved soapstone stoves in Mogadiscio;
- Trained potters in lower Shabelle in the use of templates and molds for producing improved ceramic stoves;
- Systematically tracked stove producers, retailers, and consumers for feedback purposes;
- Designed and tested inexpensive metal wood-burning stoves and a modified version of the Haraka (UNICEF) metal charcoal-burning stove that is being disseminated by CARE/Somalia and American Friends Service Committee in the Northwest and Awdal regions;

- Designed a cast iron grate for the improved charcoal-burning soapstone stoves after testing and finding sheet metal grates inappropriate for the purpose;

- Designed and constructed one inexpensive updraft kiln and simple circular kilns for potters so they can fire the ceramic stoves and other ceramic articles;

- Designed and constructed 17 community stoves in the supplementary feeding centers (14 stoves in Luug centers and 3 stoves at the orphanage in Mogadiscio);

- Conducted clay analysis in all six refugee camps around Belet Weyne for mud block and stove production purposes;

- Designed and constructed a waste-oil-burning stove in Afgoi Wildlife and Forestry Training Centers. Because of the nature of the waste oil resource and the difficulty in collection, it was redesigned and changed to a wood-burning stove; and

- Built stationary rammed earth stoves at Golweyn, Kurtun Warey, and Qorioley (Lower Shabelle Region). These stoves were not successful because (1) the clay was not suited for the purpose and (2) the local population prefers portable stoves.

(Source: VITA/NRA/USAID National Woodstove Program Final Report, 3/86, pp. 3-5, PDAAU782)

C. One objective of the Save the Children Federation subproject was the planting of 375,000 seedlings for future use as fuelwood. Of this total, more than 345,000 had been planted by November 1985. Species included Leuceana, Cassia, Parkinsonia, Melia, Eucalyptus, and Casuarina. These were planted in dry land plantations, irrigated plantations, and community woodlots. Total survival rate was approximately 57%. Over 100,000 of the seedlings were lost due to droughts during the first three planting seasons. Statistics by species and type of plantation are provided.

(Source: Qorioley Refugee Forestry Project Semi-Annual Report: 8/85-1/86, Table 1, PDAAV572)

D. SCF also assisted with directing research and demonstration of a practical nature, especially at the Land Resource Management Unit and the Arboretum, on the development of models for fuelwood plantations, agroforestry, controlled rangeland management, and fruit and nut trees. This resulted in over 40,000 fuelwood

trees planted in woodlots, and over 10,000 Leaucaena seedlings intercropped in one model with maize and sesame.

(Source: Qorioley Refugee Forestry Project Semi-Annual Report: 8/85-1/86, PDAAV572)

14. R.E. Technical Reports and Publications:

A. Wood Fuels Consumption and Cooking Practices in Selected Sites of Lower Shabelle, Banaadir, and Gedo Regions of Somalia. Melinda Smale, Michelle Savoie, et al., VITA, Inc., Arlington, VA, July 1984, 151 pp., PNAAW342.

Presents the findings from interviews of 280 families and various groups concerning fuel collection and purchase patterns, fuel types, cooking practices, and community perceptions and responses to fuel scarcity. The questionnaire is included.

B. Efficient Cookstove Development in Somalia: A Progress Report. Gautam S. Dutt and Mohamed Hassan, VITA, Inc., Arlington, VA, July 1984, 69 pp., PDAAU783.

Test results are given for gross specific consumption and percent heat utilized of 11 wood-burning and 8 charcoal-burning stoves, both traditional and improved. Stove descriptions are provided. Water boiling tests are discussed, as are household selection procedures for proposed kitchen performance tests.

C. Recommendations for the CARE Somalia/UNICEF Stove Component of the Village Forestry Project in Northwest Somalia. John S. Selker and Laurie Childers, UNICEF Technology Support Section, East Africa Regional Office, March 1985, 30 pp., PNAAW340.

Briefly reviews the groups working in cookstove development in Northwest Somalia and provides stove program and stove design recommendations for CARE's proposed stove activities in the area.

D. Activities, Accomplishments, and Recommendations: A Report for the Somalia National Woodstove Program. John S. Selker, VITA/UNICEF, March 1985, 30 pp., PNAAW341.

The author reviews the soapstone stove design, grate, and door, and recommends improvements. Brief observations on the program and on VITA stove testing are furnished. Calculation uncertainty in testing is discussed.

E. Somalia National Woodstove Program. Progress Report (Technical) January 5 to February 10, 1985. VITA, Inc., 10 pp., PDAAU787.

Reviews technical improvements discussed in PNAAW341, above. Drawings of simple kiln, stove template, molds, and ceramic stove making techniques are included.

F. Marketing Research and Strategy Development for Ceramic, Soapstone, and Metal Cookstoves in Somalia. Glenn W. Patterson and Hassan Noor Fahiye, September 9, 1984, 48 pp., PNAAW339.

This study describes a market research survey of producers and retailers of wood- and charcoal-burning stoves in Somalia. Questionnaires, survey results, and recommendations for the VITA wood stove program are included.

G. VITA/NRA/USAID National Woodstove Program Final Report. VITA, Inc., March 1986, 15 pp., PDAAU782.

Describes the woodstove subproject activities and accomplishments, problem areas and constraints, lessons learned, and recommendations for complementary activities. A financial analysis in included.

H. Qorioley Refugee Forestry Project Semi-Annual Report: August 1985 - January 1986. James Murdock, Save the Children Federation, Westport, Connecticut, undated, 17 pp., PDAAV572.

Status of the SCF subproject is reviewed. Statistics on trees planted, number survived, and percentage survival rate of seedlings for fuelwood, windbreaks and shelterbelts, and research and demonstration purposes, as well as establishment of a forest nursery system, are provided, based on a NRA survey conducted from December 11, 1985 to January 20, 1986. Many tables included. See 13 C. and D., above, for details on fuelwood plantings.

15. Evaluations/Major Findings:

A. Evaluation of VITA Subproject. C.A. Pryor, March 31, 1985, 7 pp., unpublished manuscript.

Because of problems with local acceptance and maintenance of high-mass stoves, VITA redirected its activities toward the production of improved soapstone and ceramic stoves using existing production and marketing networks. It is recommended, among other things, that (1) VITA continue to emphasize its improved soapstone and ceramic stoves, improve the Eel-Bur soapstone cooperative, begin

work on other major uses of woodfuel and charcoal through a subgrant of the PVO project, reduce its emphasis on refugee camps, and investigate links with the other PVOs involved in the CDA forestry activity; (2) USAID urge the other grantees to consider the type of interactive relationship that has developed between CARE and VITA; (3) USAID finance a detailed assessment of the social, economic, and institutional viability and acceptance of all of the subproject activities, including stoves, to be undertaken approximately 3 to 5 years after the PACD; and (4) USAID should strongly urge VITA not to curtail its support to the present stove activities if at all possible.

16. Key Persons:

A. AID/Washington:

Warren Weinstein
AFR/PD/EAP, 2450 NS, 647-8286

B. AID/Mission:

George T. McCloskey, Division Chief
Frank Catania, Project Management Coordinator
Rural Development/Refugee Affairs Office, USAID Mission to Somalia, Via Afgoi, Mogadiscio

C. Contractors:

Africare, 1601 Connecticut Avenue, N.W., Washington, D.C. 20009
(202) 462-3614

Michael W. Bourke, CARE Project Manager
CARE, 660 First Avenue, New York, NY 10016
(212) 686-3110

Save the Children Federation (SCF), 54 Wilton Road, Westport, CT 06880
(203) 226-7272

Resource Management and Research

Overseas Education Fund (OEF), 2101 L Street, N.W., Suite 916, Washington, D.C. 20037
(202) 466-3430

Lawrence Williams, Director, Africa Region
Volunteers in Technical Assistance (VITA), 1815 N. Lynn Street, Suite 200, Arlington, VA 22209
(703) 276-1800

D. Host Country:

Dr. Abdullahi Karani, General Manager
National Range Agency (NRA)

Mohamed Qabile
Mohamed Hassan Nur
Mohamed Ali Nor
VITA/NWP Technical Director, POB 3403, Mogadiscio, Somalia

17. Obligations by Fiscal Year (US$000):

Illustrative Financial Data
(entire project)

	FY1	FY2	FY3	TOTAL
AID	2,440	2,221	1,339	6,000
Non-AID GSDR				
P.L.-480 and others	150	385	395	930
Food-for-Work	250	375	353	978
PVOs	195	285	267	747
PROJECT TOTAL	3,035	3,266	2,354	8,655

(Source: Project Paper, p. 44, PDAAM078)

18. Host Country Funding of R.E. Components (US$000): 1,900*

*For entire project; R.E. costs not specified separately.

(Source: Implementation Report, undated, PDBAW994)

19. Summary of R.E. Costs (US$000):

A. Costs, by component:*

Institutional Support to NRA	645
Reforestation and Fuelwood subprojects	3,822
Fuelwood Conservation and Testing	539
Natural Resources and Land Use Survey	499
Fuelwood Assessment	0
Project Monitoring and Management	495
TOTAL	6,000

*For entire project; R.E. costs not specified separately.

(Source: Project Implementation Letter, 6/22/86, PDBBD016)

B. Cost breakdown by selected subprojects:*

	PVO Contribution
CARE subproject	990
Save the Children subproject	655.2
Gedo Community Forestry/NRA subproject	771
Africare subproject	808
Overseas Education Fund subproject	506
VITA stove subproject	539

*Does not account for entire LOP funding.

(Sources: Implementation Report, undated, PDBAY288; State Department telegram, 5/86, PDBBD013)

20. R. E. Component Revisions:

A. Funds for Fuelwood Supply/Demand Assessment ($200,000) were decommitted and shifted to Component I, Institutional Support to NRA, leaving a total of $15,000 earmarked for the maintenance of a documentation center at NRA.

(Source: Implementation Report, undated, p. 37, PDBAY288)

B. CDA PIL. 23 approved CARE amendment proposal to initiate a community agroforestry intervention into the Hiran project at no additional cost or time.

(Source: Implementation Report, undated, p. 41, PDBAY288)

C. The first amendment to the Africare agreement granted an additional $19,000, while a second amendment provided an additional $130,000 to the subproject.

(Source: Implementation Report, undated, p. 39, PDBAY288)

D. In a first contract amendment, VITA was granted permission to use $11,339 for pre-project design work. A second amendment approved $187,000 for increased extension and market activities for cookstoves and a three-month extension of the VITA subproject PACD until December 1985.

(Source: Cooperative Agreement, PDFAL510; Amendment I, 9/15/84, PDAAU679; Amendment No. 2, 12/2/84, PDAAU680)

E. The Save the Children Federation Project Forester and Coordinator resigned unexpectedly and were replaced.

(Source: Implementation Report, undated, PDBAY288)

F. Soon after its start-up, the VITA subproject ran into difficulties with acceptance and maintenance of high-mass stoves. In February 1984, the subproject was redesigned, emphasizing portable stoves that could be fabricated and marketed using existing networks. After considerable evaluation of various designs and the development of a stove testing and monitoring process, the subproject refined two designs: one, an improvement of a soapstone stove; the other, an improved ceramic stove. The December 1984 project amendment changed the target from disseminating 8,000 stoves to producing and disseminating 4,000 improved soapstone stoves and 2,000 improved ceramic stoves.

(Sources: Evaluation of VITA Subproject, 3/31/85, unpublished manuscript; VITA/NRA/USAID National Woodstove Program Final Report, 3/86, PDAAU782)

G. The PACD for the entire project was extended until March 31, 1987 (although certain components ended earlier).

(Source: Project Implementation Report, 3/31/85, PDBAV420)

H. The PACD was extended until September 30, 1987, to enable NRA to benefit from an additional year of service from the Forestry Technical Advisor and to carry out additional training for NRA staff.

(Source: Project Implementation Letter No. 27, 6/22/86, PDBBD016)

21. Follow-On Activities:

A. After the end of VITA's woodstove subproject in December 1985, NRA continued to support cookstove work, disseminating 2,000 soapstone and 1,580 ceramic stoves in the first four months of 1986. Traditional potters were trained in the use of kilns for ceramic stove production and introduced to more fuel-efficient stove designs, which they continue to produce.

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: June 1986 (jrl)
Revised February 1987 (jrl)

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1. Project Number: 6500041 2. Geo: SUDAN

3. Title: SUDAN RENEWABLE ENERGY PROJECT (SREP)

4. Project Life/PACD: 1981-86(extended to 87*/June 30, 1987*

   *A two-year follow-on, through 1989, has been authorized.

   (Source: Fifth Annual Work Plan, 4/87, PDAAW026)

5. Status: Terminated

6. LOP Funding (US$000):

   A. Entire Project: 5,600

   B. R.E. Components: 5,600

   (Source: Action Memorandum for the Assistant Administrator for Africa, 7/86, PDBBD050)

7. Loan or Grant/Appropriation Category (US$000):

   G / SD / 4,600*
   G / ARD / 1,000**

   (Sources: *DIS; **Action Memorandum for the Assistant Administrator for Africa, 7/86, PDBBD050)

8. Project Purpose:

   To assist the Government of Sudan (GOS) in developing an applied research and dissemination capability in renewable energy technology, with verification through extension services.

9. Renewable Energy (R.E.) Outputs:

   Cost/benefits, monitoring, evaluation, and policy analysis reports on R.E. technologies; Development, field testing, demonstration, and dissemination of feasible technologies-- including photovoltaic systems, an agricultural waste briquetter, charcoal kilns, and improved cookstoves-- to benefit the rural majority and urban poor; Training in R.E. technologies proven feasible by field tests.

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10. R.E. Inputs:

Technical assistance; Training; Commodities; Air charter; Information center; Renewable energy grants.

11. Summary of R.E. Components:

The Sudan Renewable Energy Project (SREP), working with the Renewable Energy Research Institute (RERI), is involved in the following activities:

- Preparation of energy use studies;
- Development, field testing, and dissemination of R.E. technologies;
- Training of Sudanese counterparts;
- Technology evaluation;
- Installation of R.E. technologies;
- Support and encouragement of private sector groups, government organizations, and PVO's active in R.E. technology dissemination;
- Establishment of an R.E. information center;
- Development of training materials; and
- Evaluation of dissemination channels for R.E. technologies.

The Energy Research Council is the local implementing agency. Georgia Institute of Technology is the prime contractor.

Progress during the project's first years was slow due to considerable emphasis on institutional development and conflicts between GOS and project staff over project design. By the end of 1984, however, the project had fielded staff, equipment, and funds (largely local currency) to small-scale R.E. activities through 24 Rural Energy Development Grants (REDGs). Priority technologies emerged in the following areas: (1) fuelwood/forestry; (2) charcoal-burning stoves; (3) charcoal production and mechanized farming; (4) briquetting of carbonized agricultural wastes; and (5) photovoltaics (PVs). The PV work was eventually incorporated into a water-pumping component.

Training for SREP staff was arranged at the Universities of Khartoum and New Mexico. The SREP staff, in turn, conducted

workshops on nursery techniques, forestry/agriculture integration at the design/planning stage, and production of charcoal-burning stoves.

12. R.E. Project Descriptors:

Firewood; Charcoal; Stoves; Photovoltaic energy; Biomass; Water pumps; Agricultural wastes; Briquettes; Cookstoves; Kilns; Carbonization; Cotton stalks.

13. R.E. Technology Applications:

A. Briquetting of Agricultural Wastes

The briquetting team designed, constructed, and lab-tested a complete briquetting system, consisting of a briquetter, mixer, mixing tank with ladder, circulating pump, compressor, and steel plate grinding mill. The briquetter could be manually operated or pneumatically driven using a compressor and air cylinder. A second prototype briquetter was designed, built, and tested. Six kilns, each with a 2.71 meter diameter, were designed and constructed for carbonizing cotton stalks in a private workshop in Fao City, Rahad Scheme. Briquettes were produced from varying proportions of charred cotton stalk fines, paper fiber binder, and other additives. Measurements were made to determine calorific value and moisture, volatiles, ash, and fixed carbon content of the briquettes.

The team completed field-testing of briquettes in villages of the Rahad Agricultural Scheme in late May of 1986. It was found that the overall cotton stalk carbonization process and the finished quality of the briquettes needed improvement. In late 1986, the team designed and built a new prototype hydraulic briquetter, which produced higher pressures and required less labor than the previous pneumatic machine. Lab testing of the new machine was completed, and field testing projected for March 15 to May 15, 1987.

The team tested waste starch, gum arabic, and molasses as binders for making briquettes from carbonized cotton stalks. Laboratory tests revealed that briquettes with starch binder were superior in strength and cohesion, produced less smoke, and had better combustion characteristics than briquettes using paper fiber, gum arabic, or molasses as binder. Although briquettes with starch binder burn cooler and slower than wood charcoal, they were found to be acceptable for general household cooking, except for cooking that requires high, quick heat, such as boiling water, frying eggs, etc.

(Sources: Sudan Renewable Energy Project: Fifth Annual Work Plan, 4/87, p. 17, PDAAW026; Sudan Renewable Energy Project: Fourth Annual Work Plan, 7/86, pp. 16-18, PDAAW025)

B. Analysis of Charcoal Production

Performed an initial investigation of the charcoal production industry in the Blue Nile Province, analyzing the quantity of wood required to produce one tonne of charcoal; weight and composition of the charcoal sacks; and incremental yields of the Acacia seyal resource base used for charcoal production. The study found that 6-9 cubic meters of stacked fuelwood was required per tonne of charcoal produced, contrasting sharply with 17-18 cubic meters found in other studies. Weight of the charcoal sack was measured at 35-43 kilograms, compared to 45-50 in a 1965 study. The mean annual increment of Acacia seyal in cubic meters/feddan was estimated at 1.0, in comparison to 0.5 estimated by the Sudan Forest Administration.

(Source: Charcoal Production in Blue Nile Province,p. 3, 11/84, PNAAX933; see also additional charcoal reports under 14., R.E. Technical Reports and Publications, below)

C. Stove Producer Workshops

Conducted two charcoal stove producer workshops in Khartoum and Omdurman, training 24 artisans in November 1984 in Canun El Duga production methods, with emphasis on use of templates and mass production techniques. Also, published trainers' and trainees' manuals for canun el duga production.

(Source: Monthly Report, 11/84, PDBAW101; see also additional stove reports under 14., R.E. Technical Reports and Publications, below)

D. Ceramic Liners for Stoves

The SREP Dissemination Unit conducted workshops for producers of ceramic liners and metal cladding for the el Jiko stove. A survey of clay workers and the ceramic firing process used was undertaken to identify potential producers of ceramic liners. Production of these stoves is increasing through SREP collaboration with CARE, which has introduced a specially-designed Kenyan molding machine to make the ceramic liners.

(Source: Sudan Renewable Energy Project: Fifth Annual Work Plan, 4/87, p. 13, PDAAW026; see additional stove reports under 14., R.E. Technical Reports and Publications, below)

E. National Stove Center

Established the National Stove Center, which has become nationally recognized for stove testing. The Center, in collaboration with the National Energy Administration and the UNDP, also developed and lab tested an all-metal stove designed especially to utilize groundnut shell briquettes.

(Source: Sudan Renewable Energy Project: Fifth Annual Work Plan, 4/87, p. 13, PDAAW026)

F. Wood Fuel Use in Khartoum Area Industries

Surveyed fuelwood consumption of traditional bakeries, brick kiln factories, restaurants, and soap, oil, and sweets industries in Khartoum Province. Although about 22 million Sudanese pounds had been spent on fuelwood in 1984, the owners of the industries generally had little incentives to increase energy efficiency or switch to alternative fuels, since the relative cost of fuelwood to total production cost in most of the industries was less than 10%. The brick kiln industry was the best candidate for technology development work, since the industry consumes 55.6% (100,980 tons) of total fuelwood consumption (181,610 tons), and the relative cost of fuelwood to total production cost averaged 17%.

(Source: Survey of Fuelwood Consumption in Khartoum Province Industries, 4/85, PNAAX929)

G. PV Lantern System

Installed four battery-operated lantern systems with centralized photovoltaic (PV) recharging in the Gezira and North Regions. Sixty-five self-contained PV recharging lanterns were distributed throughout Sudan. Seven PV sodium vapor lamps were installed primarily in the Rahad Scheme and in Gezira and Khartoum Provinces.

(Source: Sudan Renewable Energy Project: Fourth Annual Work Plan, 7/86, p. 18, PDAAW025)

H. PV Refrigerator

Installed PV refrigerator in Tokar.

(Source: Implementation Report, 3/31/85, PDBAZ603)

I. Fast-Growing Wood Species for Charcoal Production

Fast-growing wood species were investigated for suitability of charcoal production. One firing was made in a portable metal kiln of the traditional preferred charcoal species, Acacia seyal, and each of the following four fast-growing species: Prosopis chilensis, Eucalyptus microtheca, E. camaldulensis, and Conocarpus lancifolius. Physical and mechnical properties of the charcoal produced from each speicies were measured, and a chemical analysis was performed. The two eucalyptus species produced the best charcoal, followed by Conocarpus and A. seyal. Prosopis produced the poorest quality charcoal.

(Source: Report on Experimental Results of Charcoal Production from Five Wood Species Using a Portable Metal Kiln, undated, PNAAX935)

14. Technical R.E. Reports and Publications:

A. Sudan--The Economics of Wood Energy Production on Mechanised Farms. Derek E. Earl, Energy/Development International, Washington, D.C., April 1985, 115 pp., PNAAW781.

An historical review of mechanized farming in Sudan is presented, followed by a closer examination of three large farms with a combined gross area of 969,000 feddans (407,000 ha) in the Blue Nile Province. The author looks at the current practices of these farms, assesses the potential for reducing land clearance costs by producing and marketing charcoal from trees normally burnt during this operation, and estimates natural forest resources needed to cover the farms' fuel, shade, and shelter needs. Recommendations for the GOS are included.

B. Improved Charcoal Stoves (Canun El Duga) Trainer's Manual. Gaafar El Faki, Somaya Suliman, et al., Energy Research Council/Sudan Renewable Energy Project, November 1984, 73 pp., PNAAX927.

Step-by-step guides are presented for artisans to produce the open draft model and the controlled draft model of the Canun El Duga stove, both of which can utilize either large or small charcoal pieces for fuel. Drawings illustrate the tools needed and various stove components. Appendices provide instructions in Arabic.

C. Canun El Duga: Improved Charcoal Stoves for the Sudan. Gaafar El Faki Ali and Claudi H. Huff, Energy Research Council/Sudan Renewable Energy Project, December 1984, 24 pp., PNAAX928.

This report summarizes work on improved charcoal stoves begun in 1979 and picked up by the SREP. It describes the design of an open-draft and a controlled draft model of the stove, both of which utilize duga, or small pieces of charcoal; laboratory and field testing; production development through a stove contest; and dissemination activities.

D. Survey of Fuelwood Consumption in Khartoum Province Industries. Abdel Salaam Ahmed and El Sheikh Elmagzoub, National Energy Administration/Ministry of Energy and Mines, April 1985, 68 pp., PNAAX929.

Survey methodology and the results of a fuelwood consumption pattern survey for Khartoum Province industries--traditional bakeries, brick kilns, restaurants, and sweet, soap, and oil industries--are presented. The industries were surveyed also for their tendency to accept other alternative energy sources such as peanut shells. Data are analyzed in terms of relative cost of fuelwood to total industrial production cost. Forest area necessary to provide a sustained yield of fuelwood production is estimated. Questionnaires are included in the appendices.

E. Report on Charcoal Production. D.E. Earl, Energy Research Council/USAID, Khartoum, Sudan, February 1984, 57 pp., PNAAX930.

The charcoal industry in Sudan is described. Included are a cost breakdown for production and marketing for several charcoal entrepreneurs, an estimate of the size of the market for charcoal, estimates of present and future raw material supply, and description of the charcoal-making process used in Sudan (including photos). Fifteen recommendations are made for improvements in the industry.

F. Village Biomass Needs: Northern Kordofan Region. B.A. El Hassan, M.O. El Sammani, and M. Suliman, Khartoum, Sudan, July 1984, 48 pp., PNAAX931.

Three villages, Umm Inderaba, Shershar-El Gaa, and Ez Zariba, located in a semi-desert zone, are examined in order to selecting a site for a village forestry development project. The analysis covers ecological conditions, economic base, employment, infrastructure, and community institutions and leadership. Rough sketches of the village plans are included.

G. Seedling Demand for Khartoum Province. Khalafalla Sid Ahmed, Khartoum, Sudan, March 1985, 16 pp., PNAAX932.

This study discusses agricultural land under cultivation in the Khartoum Province, future tree planting in agricultural schemes necessary for a continuous supply of fuelwood, present nursery activities, and demand for seedlings. Contains numerous tables.

H. Dissemination Consultancy Report. Claudia H. Huff, Sudan Renewable Energy Project/Energy Research Council, December 12, 1984, 43 pp., PDAAW021.

This report reviews the accomplishments of a three-month consultancy to initiate technology dissemination activities at the newly established Technology Development and Dissemination Unit of the Renewable Energy Research Institute. Publications produced and workshops undertaken during the consultancy are described. The dissemination process in general is discussed, and strategies for dissemination of charcoal stoves and fuelwood production technologies are presented. Recommendations are made concerning future consultancies, staffing requirements, and activities related to technology dissemination.

I. Final Report of Information Center Consultancy, 1985-86. Carolyn Huskey, Energy Research Council-Khartoum/ TransCentury Corporation-Washington, DC, May 7, 1986, 45 pp., PDAAW022.

Activities concerning the organization, operation, and maintenance of the Renewable Energy Information Center (REIC), information dissemination, and the surveying of projects for renewable energy activities are described. Several recommendations are made. Appendices include REIC subject headings, a renewable energy project questionnaire, and a listing of purchases of books/ periodicals.

J. Charcoal Production in Blue Nile Province. Hassan Osman Abd El Nour and Kamal Satie, Khartoum, Sudan, November 1984, 61 pp., PNAAX933.

This report is the initial examination of the charcoal industry in the Blue Nile Province undertaken by the SREP. It investigates the quantity of wood required to produce one tonne of charcoal; weight and composition of charcoal sacks; and incremental yields of the Acacia seyal resource base used for charcoal production. Results, revealing much higher conversion efficiencies than previously reported, are provided. Data collection forms, conversion factors, and maps are appended.

K. Charcoal Marketing and Production Economics in Blue Nile. Gaafar El Faki Ali, August 1985, 58 pp., PNAAX934.

Marketing, production economics, and distribution of the charcoal industry in the Blue Nile are analyzed. The marketing section covers producers, traders, the marketing process, distribution channels, and institutional aspects. Production economics, prices, price development, investment characteristics such as profile, profitability (return on investment), and employment generation are covered under economic analysis. Production and marketing constraints are examined, and future prospects presented.

L. Report on Experimental Results of Charcoal Production from Five Wood Species Using a Portable Metal Kiln. Tageldin Hussein Nasroun, undated, 33 pp., PNAAX935.

This report examines the use of fast-growing species for charcoal production and the use of portable metal kilns for carbonization. Four fast-growing species--Eucalyptus microtheca, E. camaldulensis, Conocarpus lancifolius, and Prosopis chilensis--and the traditional species used for charcoal production--Acacia seyal--were investigated. Results are based on one firing for each species. Various properties of the wood and charcoal are analyzed.

M. How To Make "El Duga" Stove. Energy Research Council, Khartoum, Sudan, undated, 28 pp., PNAAX936.

This report illustrates by simplified drawings and step-by-step instructions in Arabic (with English translation) how to make the El Duga portable metal stove.

N. Project accomplishments and annual work plans are described in the following reports:

- Sudan Renewable Energy Project: Second Annual Work Plan, July 1984 - June 1985, 52 pp., PDAAW023.
- Sudan Renewable Energy Project: Third Annual Work Plan, 1985, 54 pp., PDAAW024.
- Sudan Renewable Energy Project: Fourth Annual Work Plan, July 1986, 44 pp., PDAAW025.
- Sudan Renewable Energy Project: Fifth Annual Work Plan, July 1987 through June 1988, 48 pp., PDAAW026.

15. Evaluations/Major Findings:

A. Evaluation of the Sudan Renewable Energy Project. September 1984, 37 pp., plus PES (dated 1/29/85), PDBAX404 or PDBAU878.

The evaluation team found that the project at mid-term had changed considerably from that envisioned by the Project Paper. This was attributed to changing external factors and a willingness on the part of USAID, the GOS, and the contractor to correct original design problems. The rural focus was dropped and urban areas included because of the high consumption of charcoal and the perceived greater opportunity for successful innovation and diffusion in those areas. Priority technologies evolved as follow: (1) fuelwood production; (2) charcoal-burning stoves; (3) charcoal production; (4) wood-burning stoves; and (5) PVs.

The team praised the action-oriented approach of the project. It recommended, however, that more effort be devoted to developing dissemination strategies, producing hypotheses, and documenting the rationale behind certain project activities. In all, the evaluators made 36 recommendations and observations.

B. An Evaluation of Fuelwood/Forestry Grants Awarded by Sudan Renewable Energy Project. M.H. El. Lakany, March 1986, 41 pp., PDAAW027.

This report evaluates the forestry technologies applied by the SREP in order to identify new areas of activity as well as new dissemination techniques for promoting fuelwood/forestry initiatives. It examines four categories of fuelwood/forestry Renewable Energy Development Grants (REDGs): (1) small private farms; (2) village woodlots-community forestry; (3) irrigated schemes; and (4) government agencies-state nurseries. Representative grantees were visited, individual projects were evaluated, and recommendations were made for improvements.

In general, the REDG program was regarded highly and thought to have contributed favorably to the promotion of fuelwood/forestry activities in the Sudan. Most recommendations are targeted toward specific projects. General recommendations are that further encouragement should be given to the growing of trees on private farms, especially those with potential for developing into large-scale, commercial plantations; community forestry should continue to receive support to benefit isolated population centers, with considerable emphasis given to technical assistance, extension, and dissemination of

information among communities; more projects dealing with irrigated schemes and incorporating agroforestry should be initiated following economic and social studies, since these projects offer the best chance of success to produce biomass and fuelwood; government nurseries should be supported in a limited manner with concentration on tree introduction and applied research; duplication of activities between SREP and other agencies should be avoided through continuous information exchange; training should be promoted at different levels; and research should be conducted on biological, technological, and socio-economic aspects of fuelwood/forestry.

16. Key Persons:

A. AID/Washington:

Tim Harris
Warren Weinstein
AFR/PD/EAP,2450 NS
645-8286

B. AID/Mission:

Richard A. Macken, Project Manager
Jay Carter, Project Manager

C. Contractors:

William Larson, Project Director and Acting Chief of Party
Don Peterson, Chief of Party (until 1/87)
Kenneth Maddox
Georgia Institute of Technology, Georgia Tech Research Institute, Atlanta, GA 30332

D. Host Country:

Dr. El Tayeb Idris Sisa, Director Energy Research Council and Coordinator, SREP (also Project Leader, Water Pumping Component)
Gaafar El Faki, Assistant Coordinator, SREP
Hamza Hamoudi, Project Leader, Fuelwood/Forestry and Mechanized Farming Component
Dr. El Sheikh El Magzoub, Project Leader, Briquetting
Sudan Renewable Energy Project
P.O. Box 4032
Cemetery Road and Street 59
Khartoum, Sudan

17. Obligations by Fiscal Year (US$000):

FY 82	1,500
FY 83	0
FY 84	1,000
FY 85	1,000
FY 86 (est)	500

(Source: Energy, Forestry and Natural Resources Activities in the Africa Region, USAID/Bureau for Africa, April 1986, p. 94, PNAAW771)

18. Host Country Funding of R.E. Components (US$000): 3,000

(Source: Project Paper, 8/81, p. 58, PDBAI841)

19. Summary of R.E. Costs (US$000):

A. Cost breakdown for original LOP funding:

Technical assistance	
Advisory services	2,920
Participant training	420
Procurement	260
Training	50
Commodities	300
Grants	250
Contingency	400

TOTAL	4,600

(Source: Implementation Letter No. 10, Attachment A, 7/21/85, PDBAY314)

B. Cost breakdown for additional $1 million grant:

Short-term consultancy	460
Training(long-term & short-term)	140
Procurement(vehicle & equipment)	140
R.E. Development Grants	160
Contingency	100

TOTAL	1,000

(Source: Action Memorandum for the Assistant Administrator for Africa, 7/86, PDBBD050)

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20. R.E. Component Revisions:

A. Original focus on rural energy was modified to include urban use in view of the overwhelming importance of charcoal consumption in urban areas; accordingly, the word "rural" was dropped from the project title.

(Source: PES, 1/29/85, PDBAU878 or PDBAX404)

B. Major technical priorities were reoriented toward (1) fuelwood production; (2) charcoal production; (3) charcoal stoves; (4) wood-stoves; and (5) PVs.

(Source: PES, 1/29/85, PDBAU878 or PDBAX404)

C. Original project purpose was reoriented toward emphasis on technology transfer process and replicability, rather than on quantity of objects produced.

(Source: PES, 1/29/85, PDBAU878 or PDBAX404)

D. PACD extended from September 30, 1986, to April 30, 1987, due to delays in contracting for an institution to provide technical services.

(Source: Implementation Letter No. 6, 10/20/82, PDBAI847)

E. PACD extended until June 30, 1987. A two-year follow-on, through 1989, has been authorized and is due to begin upon completion of the first phase.

(Source: Sudan Renewable Energy Project: Fifth Annual Work Plan, 4/87, p. 1, PDAAW026)

F. The Mission received approval to increase the LOP funding by $1 million and to add a new component to test various R.E. technologies for water pumping in a variety of circumstances.

(Source: Action Memorandum for the Assistant Administrator for Africa, 7/86, PDBBD050)

G. Photovoltaic applications was discontinued as a high priority technology area and incorporated into a new water pumping component.

(Source: Sudan Renewable Energy Project: Fifth Annual Work Plan, 4/87, p. 2, PDAAW026)

H. The Amercan staff of SREP was evacuated from Sudan in April 1986, and SREP activities continued in their absence under the direction and leadership of SREP Coordinator Dr. El Tayeb Idris Eisa and SREP Assistant

Coordinator Gaafar El Faki. Americans were allowed to return after the evacuation order was lifted on October 15, 1986. However, some continuity was lost. Peace Corps Volunteer participation ended in July 1986, with the last few months of work performed at Georgia Tech in Atlanta. The Chief of Party left the project in January 1987.

(Source: Sudan Renewable Energy Project: Fifth Annual Work Plan, 4/87, pp. 2, 3, PDAAW026)

I. Wood-burning stoves were dropped as a priority. Emphasis shifted toward (1) fuelwood combustion efficiency improvement in the brickmaking industry, which was terminated subsequently because of lack of technical assistance and funds for proper instrumentation, and (2) briquetting.

(Sources: SREP Second Annual Work Plan, 7/84-6/85, PDAAW023; SREP Third Annual Work Plan, 1985, PDAAW024; SREP Fourth Annual Work Plan, 7/86, PDAAW025)

21. Follow-On Activities:

A. The charcoal stove developed at the University of Khartoum and modified by Maxwell Kinyanjui and local producers has been well received by potential manufacturers as a result of a stove contest and artisanal training. There was good private sector participation in stove producer training workshops (emphasizing metal/ceramic stoves) in El Obeid. Consequently, there is good potential for follow-on stove activities by private stove manufacturers.

(Sources: Evaluation, 9/84, PDBAX404 or PDBAU878; Project Implementation Report, 3/31/85, PDBAZ603)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: June 1986 (jrl)
Revised February 1987 (jrl)
Revised June 1987 (jrl)

1. Project Number: 6500059 2. Geo: SUDAN

3. Title: ENERGY PLANNING AND MANAGEMENT (EPM)*

*Including the SUDAN ENERGY POLICY AND PLANNING PROJECT (SEPAP).

4. Project Life/PACD: EPM: 1982-87 (extended to 88)/April 30, 1988
SEPAP: 1980-84/March 1984

5. Status: Active

6. LOP Funding (US$000):*

A. Entire EPM Project: 8,450**

B. Entire SEPAP project: 1,535***

C. R.E. Components: Not specified

*Note: Includes overlap of EPM funding of SEPAP of $766,000.

(Sources: **Project Implementation Report, 9/30/85, PDBBA933; ***Evaluation of SEPAP, p. 2, 6/15/84, PDAAP875)

7. Loan or Grant/Appropriation Category (US$000):

G / SD / 8,150 (EPM)

(Source: Project Implementation Report, 9/30/85, PDBBA933)

8. Project Purpose:

To ease energy-related constraints to economic recovery while contributing toward a longer term goal of meeting Sudan's energy requirements for domestic, agricultural, and industrial uses in ways that are economical, efficient, and environmentally sound.

9. Renewable Energy (R.E.) Outputs:

National Energy Assessment completed; National Energy Plan developed; Energy studies conducted; Computerized data collection and analysis system established; Energy data compiled, updated, and energy forecasts made; National Energy Administration (NEA) organized as competent and effective primary source for information and analysis on energy policy, planning, and management issues; R.E. training courses conducted; Preliminary microeconomic analyses conducted for an ethanol from sugar molasses plant,

a water pumping windmill, improved charcal kilns, biogas production from water hyacinths, a gasifier, an active solar water heater, and briquetters of agricultural residues; Hot water needs of five major hotels and selected industries in Sudan identified.

10. R.E. Inputs:

Technical assistance; Commodities and equipment; Training; Management assistance.

11. Summary of R.E. Components:

The Energy Planning and Management (EPM) project has two major components: (1) To increase the short-term reliability of the Blue Nile electric power grid and improve the capability of the Public Electric and Water Corporation to generate, transmit, and distribute power; and (2) To improve the capability of the GOS energy agency to plan for the most efficient use of its energy resources through macroeconomic and financial analysis, manpower planning and training, and development of end-use education programs.

The EPM project provided partial funding to the Sudan Energy Policy and Planning Project (SEPAP), a subproject of the centrally funded Energy Policy and Planning Project (9365703). The two projects overlapped in time as well as scope, SEPAP beginning in 1980 and ending in March 1984. The EPM project carried on much of the work begun under the SEPAP project.

Although the project has no distinct R.E. component, it aims to improve the GOS capability to plan for the most efficient use of all energy resources, including renewable energy technologies where they are considered cost-effective. The project prepared the first National Energy Assessment, compiling data on energy supply and demand including wood, charcoal, crop residues, and other renewables. It conducted micro-economic analyses for a variety of biomass, wind, and solar technologies. It strengthened the Sudan National Energy Administration (NEA), barely existent prior to the project, and established it as a viable GOS energy planning and policy development unit concerned with renewables as well as conventional fuels. On-the-job training was provided to NEA staff, as was formal classroom training, including a number of workshops on renewable energy technologies. International Science and Technology, Inc. (ISTI) was the prime contractor, and Energy/Development International (E/DI) was subcontractor.

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12. R.E. Project Descriptors:

Hydroelectric power; Firewood; Charcoal; Water heating; Carbonization; Biogas; Solar energy; Water hyacinths; Cow dung; Briquetting; Biomass; Agricultural wastes; Ethanol; Molasses; Windmills; Wind energy; Kilns; Bananas; Energy planning; Energy policy.

13. R.E. Technology Applications:

A. National Energy Assessment

The following types of data were compiled for the Sudan National Energy Assessment:

Energy Use by Consumption Sector

Households: biomass resources
Industry: wood, crop residues
Commercial and Government: wood, charcoal.

Energy Supply by Resource

Wood fuel
Other renewables.

The initial baseline year was 1980. In support of the National Energy Plan, the baseline year was updated to 1982, and forecasts were made for 1995 and 2000. See source for summary of original baseline data.

(Source: Evaluation of SEPAP, 6/15/84, PDAAP875)

B. Training Courses

The following training courses were conducted in Sudan: 2.5 hour "Renewable Energy" training program in July 1981 for 16 participants; 12-hour "Renewable Energy Resources and Technology (Part 1)" program in November 1981 for 8 participants; and 13-hour "Renewable Energy Resources and Technology (Part 2)" program in February 1982 for 23 participants.

(Source: Evaluation of SEPAP, 6/15/84, PDAAP875)

C. Ethanol from Sugar Molasses

A preliminary micro-economic analysis was conducted for an ethanol from sugar molasses production plant. The design called for the production of 49,600,000 liters of ethanol, 1,680 tonnes of yeast, and 67,200,000,000 Kcal of methane, annually, consuming 160,000 tonnes of molasses per year. Capital costs were estimated in 1982

at $31.8 million, whereas operating and maintenance costs were estimated to be $10.4 million per year. Savings from ethanol, methane, and yeast were estimated at $16.6 million/year. The internal rate of return was calculated to be 34.3%. See source for details.

(Source: Renewable Energy Assessment for the Sudan, 9/82, PNAAX938)

D. Water-Pumping Windmill

A preliminary micro-economic analysis was conducted for a multi-bladed, "American type", horizontal-axis water pumping windmill which can be manufactured locally.

Total capital costs (1982), including manufacturing, erecting, and installing (with 260 cubic meter water storage tank), were estimated to be 7,200 Sudanese pounds (LS), whereas operating and maintenance costs were estimated to be LS 360/year. Total savings of diesel fuel for water pumping were calculated to be between LS 857.5/year and LS 1,715/year. Internal rate of return was calculated to be 12.05, or 28.9%. See source for details.

(Source: Renewable Energy Assessment for the Sudan, Table 5.3, p.39, 9/82, PNAAX938)

E. Improved Charcoal Kilns

A preliminary micro-economic analysis was conducted for a 25-30 cubic meter stationary masonry and a 6-7 cubic meter portable steel improved charcoal kiln. Annual charcoal production was estimated to be 104 tonnes from 416 tonnes of firewood with the masonry kiln, and 44 tonnes of charcoal per year from 220 tonnes of firewood with the portable kiln. Investment costs (1982) were estimated to be LS 3000 for the masonry kiln, and LS 6750 for the portable kiln. Operating and maintenance costs were estimated to be LS 5600 for the masonry kiln, and LS 9600 for the portable kiln. An internal rate of return (IRR) of 1,070.5% was calculated for the masonry kiln, and an IRR of 59.4% for the portable steel kiln. See source for details.

(Source: Renewable Energy Assessment for the Sudan, pp. 58, 59, 9/82, PNAAX938)

F. Charcoal Kiln to Carbonize Banana Residues

A preliminary micro-economic analysis was conducted for an improved 25-30 cubic meter masonry charcoal kiln that carbonizes banana residues. Cost, including material and

labor (1982), was estimated at LS 3,000 ($2,000, at $US 1 = LS 1.35, conversion discrepancy not explained). An internal rate of return (IRR) of 364.5% was calculated, assuming an annual production of 90 tonnes of charcoal per kiln from 10,642 tonnes/year of dried banana trunks using 36 kilns. See source for details.

(Source: Renewable Energy Assessment for the Sudan, Tables 5.6 & 5.7, p.42, 9/82, PNAAX938)

G. Biogas from Water Hyacinths and Cow Dung

A preliminary micro-economic analysis was conducted for biogas production from water hyacinths and cow dung, using a Chinese brick digester with 10 cubic meter total volume. Biogas production was assumed to be 3 cubic meters daily. Total capital costs (1982), including materials, labor, and gas utilization equipment, were estimated to be LS 1,000, whereas operating and maintenance costs were estimated to be LS 50/year. An internal rate of return (IRR) of 36.34% was calculated, assuming that charcoal was being displaced, and an IRR of 33.09%, assuming that kerosene was being displaced. See source for details.

(Source: Renewable Energy Assessment for the Sudan, 9/82, PNAAX938)

H. Briquetting of Agricultural Wastes

A preliminary micro-economic analysis was conducted for the briquetting of agricultural residues by means of both a large (1.6 tonnes/hour) and a small (0.05 tonnes/day) briquetting plant. Annual fuel briquette production was estimated at 10,000 tonnes by the large plant, and 17.3 tonnes by the small plant. Capital costs for the large plant were estimated at LS 202,500 for building, site preparation, and equipment, and LS 1,350 for small-scale equipment. An internal rate of return of 193.8% was calculated for the large plant, assuming displacement of fuel oil, and 109.4% for the small briquetting plant, assuming displacement of charcoal. See source for details.

(Source: Renewable Energy Assessment for the Sudan, 9/82, PNAAX938)

I. Gasification of Agricultural Wastes for Electricity Generation

A preliminary micro-economic analysis was conducted for electricity generation by means of a down draft, batch gasifier using agricultural wastes as feedstock. The

gasifier is to produce 50 cubic feet/minute of gas and be connected to a 37.5 kW generator. Estimates assume annual production of 262.8 MWh and annual consumption of 1,000 tonnes of agricultural residues. Total capital costs (1981), including equipment (LS 53,950) and installation (LS 4,000), building, structures, and transmission lines (LS 27,000) were estimated to be LS 65,000 (addition discrepancy not explained), whereas operating and maintenance costs were estimated at LS 25,510/year. An internal rate of return of 12.85% was calculated. See source for details.

(Source: Renewable Energy Assessment for the Sudan, 9/82, PNAAX938)

J. Solar Water Heating

A preliminary micro-economic analysis was conducted for a typical active solar water heater system which can be manufactured locally. Total capital costs were estimated to be LS 180/square meter (LS 120/sq m for the collector, and LS 60/sq m for the piping, support structure, and pump), whereas annual operating and maintenance costs were assumed to be LS 9/sq m. An Internal Rate of Return (IRR) of 8.85% was calculated assuming displacement of fuel oil (0.132 tonne of fuel oil/sq meter/yr), and an IRR of 28.61% assuming diesel displacement (0.128 tonne of diesel/sq meter/yr). See source for details.

(Source: Renewable Energy Assessment for the Sudan, 9/82, PNAAX938)

K. Hot Water Needs Analysis

Hot water needs for five major hotels and selected industries in Sudan were identified:

HOT WATER REQUIREMENTS OF MAJOR HOTELS IN KHARTOUM

HOTEL	# ROOMS	ANNUAL FUEL CONSUMPTION FOR WATER HEATING (tonnes/yr)	TYPE OF FUEL	HOT WATER UTILIZATION
Hilton	274	260.3	Fuel Oil	Rooms, Kitchen, Laundry, and Swimming pool
Friendship Palace	200	210.3	Diesel	Rooms, Kitchen, and Laundry

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Araak	181	113.7	Diesel	Rooms, Kitchen, and Laundry
Grand	145	276.1 MWh.yr*	Electric-ity	Rooms and Kitchen
Meridien	95	28.5	Diesel	Rooms, Kitchen, and Laundry

*Assumptions:

Average occupancy rate = 70%
Average inlet water temperature = 30 degrees C.
Average outlet water temperature = 65 degrees C.
Water consumption in rooms = 50 liters/day
Water consumption in kitchen = 500 liters/day
Efficiency of electric water heater = 30%

HOT WATER REQUIREMENTS OF SELECTED INDUSTRIES

INDUSTRY	HOT WATER NEEDS (tonnes/ day)	AV. HOT WATER TEMP. (0 degrees C)	ANNUAL FUEL CONSUMPTION FOR WATER HEATING (tonnes/year)	TYPE OF FUEL	HOT WATER UTILIZATION
Sudan Textile	1600	80	3501	Fuel oil	Washing, sizing & preparation of baths
Oasis Oil Company	160	85	385	Fuel oil	Neutralizing acid oil with caustic mixture
Karima Food Processing Factory	1728	62.5	2364	Fuel oil	Washing and pasteurizing
Babanoussa Karkade Factory	62.5	77.5	137	Fuel oil	Beverage production

(Source: Renewable Energy Assessment for the Sudan, pp. 55, 56, 9/82, PNAAX938)

14. R.E. Technical Reports and Publications:

A. The National Energy Plan: 1985-2000. National Energy Plan Committee, National Energy Administration, Khartoum, January 1985, 172 pp., PNAAW777; In Arabic, PNAAW778.

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This report provides on overview of the energy situation in Sudan from both a supply and demand viewpoint. Included are wood and charcoal demand projections for 1990 and 2000.

B. NEA Energy News. National Energy Administration, Khartoum, Vol. 1, No. 1, March 1984, 40 pp.; Vol. 1, No. 2, September 1984, 47 pp.; Vol. 2, No. 1, March 1985, 41 pp.; Vol. 2, No. 2, June 1985, 39 pp., available from VITA, P.O. Box 12438, Arlington, VA, 22209.

These reports provide information about the current energy situation in Sudan. Current and proposed energy-related project activities, issues, and statistics (mainly concerning conventional fuels) gathered by the NEA are covered.

C. Long-Range Electricity Futures for Sudan: Two Scenarios 1982-2000. Project Report No. 2. Shibu B. Dhar, International Science and Technology Institute, Inc. and Energy/Development International, Inc., Washington, D.C., September 1981, 119 pp, PNAAQ998.

This report critiques the long-range Nile Water Study carried out by British consultants. It considers two scenarios. The first, a "conventional outlook," looks at the consequences of following the recommendations of the Nile Water Study (which advocated slow expansion in hydro-electric power). The second, an "alternative resources outlook," advocates (1) more rapid adoption of hydro-electricity and cut back on oil use and (2) use of conservation, load management, and various R.E. resources, including small-scale hydro, solar, biomass, and cogeneration. Numerous charts, graphs, and tables illustrate peak and energy demands, by location and by period, and resource mix for various time periods for the two forecasts.

D. Reforestation and Community Development in the Sudan. Discussion Paper D-73M. Turi Hammer, Resources for the Future, Washington, D.C., September 1982, 84 pp., PNAAU236.

This report provides an historical account of forest management in the Sudan and reviews various projects aimed at controlling desert encroachment.

E. Sudan National Energy Assessment: Executive Summary. National Energy Administration/International Science and Technology Institute, Inc./Energy Development International, Khartoum, March 1983, 85 pp., PNAAQ989.

This report provides a general overview of the energy situation in Sudan and contains major issues and options presented by the project team. It also contains the base year (1980) energy supply and demand picture, which includes a Sudan energy flow system; total energy consumption in 1980 by sector for hydropower, wood, charcoal, other biomass, and vegetable oil, as well as fossil fuels; total household fuelwood consumption by provinces and sectors for 1980; industry energy consumption 1980 (by sub-sector) for such fuels as wood and crop residues; forestry resources in Sudan by province and region; household woodfuels balance by province and region; and projections of energy consumption by sector for 1985 and 1990.

F. Sudan National Energy Assessment: Forestry and Woodfuel Resources. NEA and Forestry Administration, Khartoum, September 1983, 18 pp., PNAAX937.

This report describes the strategy used to obtain rough estimates of Sudan's current forestry resources, relying on LANDSAT images supplemented by aerial photographs (mostly from the 1960s), numerous Forestry Administration studies and management plans, limited forestry studies, and limited ground surveying. The report discusses the various soil categories, climatic zones, topographic features, and vegetation of Sudan. Finally, it tabulates estimated forestry resources by province and region.

G. Renewable Energy Assessment for the Sudan. National Energy Administration/International Science & Technology Institute, Inc./Energy Development International, Khartoum, September 1982, 70 pp., PNAAX938.

This report reviews R.E. activities and assesses R.E. resources in Sudan. Resources include solar radiation, wind energy, and agricultural residues. Seven resource/technology combinations were selected as having the highest market and utilization potential: (1) ethanol production from molasses; (2) windmills for water pumping; (3) charcoal production from banana stalks; (4) briquetting of agricultural residues for household and industrial consumption; (5) biogas production using animal residues and water hyacinths as feedstock for rural cooking and lighting; (6) solar water heating for low-temperature commercial and industrial applications; and (7) improved charcoal kilns. These combinations are analyzed from a technical and cost viewpoint, resource availability, economics, and implementation issues. Finally, a recommended National Renewable Energy Program is outlined.

15. Evaluations/Major Findings:

A. Evaluation of Sudan Energy Policy and Planning Project (SEPAP). Arthur D. Little, Inc., Cambridge, MA; USAID, Bureau for Africa, Khartoum, Sudan; and USAID, Bureau for Science and Technology, Office of Energy, Washington, D.C.; June 15, 1984, 98 pp., PDAAP875.

The evaluation team viewed the SEPAP project as a resounding success. The project generally met its original objectives of developing an energy data base, identifying energy issues, recommending means to solve energy problems, and providing training and support for indigenous personnel and institutions. The contractor's performance was found to be good, performing admirably to cover all aspects of the broad scope of work.

Suggestions and recommendations are made for the follow-on Energy Planning and Management (EPM) project, including that the EPM project be more focused from a management viewpoint, that NEA staff development receive greater emphasis, and that energy library resources be augmented.

16. Key Persons:

A. AID/Washington:

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PPC/WID, 3725A NS, 647-3992

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Kawther Ahmed Medeni, Biomass Section
Abdel Salaam Ahmed A. Halim, Wind and Solar Section
Ekhlas Gasim Sheikh Mohd, Wind and Solar Section
Ahmed Osman Ahmed, Wind and Solar Section
Abdel Moneim Mohd A. Razig, Wind and Solar Section
National Energy Administration, Sudan

17. Obligations by Fiscal Year (US$000):

Illustrative Budget For Entire EPM Project*
(Fiscal Year Not Specified)

YR 1	996.7
YR 2	1,230.7
YR 3	2,033.8
YR 4	1,394.4
YR 5	942.8

TOTAL	6,598.4

*Does not reflect increase in LOP funding.

(Source: Project Paper, 8/82, PDBAI987)

18. Host Country Funding of R.E. Components (US$000): $6,500*
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*For entire EPM project; R.E. costs not specified separately.
**For entire SEPAP project; R.E. costs not specified separately.

(Source: Project Grant Agreement Amendment No. 3, 8/2/84, Annex 1, PDBAP833)

19. Summary of R.E. Costs (US$000):

Illustrative Financial Plan*

	AID	GOS
Technical Assistance	6,690	4,180
Training	700	395
Commodities	857	229
Local Consultancies and Studies	0	1,170
Project Evaluation	100	18
Contingency	103	508
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TOTAL	8,450	6,500

*For entire EPM project; R.E. costs not specified separately.

(Source: Project Grant Agreement Amendment No. 6, 8/12/86, Annex 1, PDBBD675)

20. R.E. Component Revisions:

A. EPM LOP funding increased from $6,600,000 to $8,450,000.

(Source: Quarterly Implementation Report, 9/27/83, PDBAP845; and Project Implementation Report, 9/30/85, PDBBA933)

B. EPM PACD extended from September 30, 1987, to March 30, 1988.

(Source: Project Grant Agreement Amendment No. 2, 12/5/83, PDBAP833)

C. EPM PACD extended from March 30, 1988, to April 30, 1988.

(Source: Project Implementation Letter No. 3, 2/29/84, PDBAR962)

D. The coup d'etat of April 6, 1985, which brought about replacement of the Minister of Energy and Mining (and all other Ministers), caused confusion which disrupted the project. Moreover, the long period without permanent Chief of Party (COP was terminated in early 1985 and replacement did not arrive until September 1985) slowed development of work plan.

(Source: Project Implementation Report, 9/30/85, p. 8, PDBBA933)

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E. SEPAP was originally conceived as an 18-month, 65 person-month effort funded by AID/W at $650,000. It began in 1980 and expanded over time, largely in response to GOS requests for additional services and support project activities. The contract was amended eight times. The project was terminated in March 1984 at a total cost of US $1,534,887 and LS 237,435 (local currency), which included a grant of US $766,107 provided by the EPM project, which succeeded it.

(Source: Evaluation of SEPAP, 6/15/84, pp. 14-15, PDAAP875)

C. The Limited Scope Grant Project Agreement of 8/30/80 (that governed the SEPAP project) between the Government of Sudan (GOS) and USAID called for a $89,000 contribution on the part of the GOS; an amendment to this on 9/30/81 increased the GOS contribution to SEPAP to $114,000.

(Source: Evaluation of SEPAP, 6/15/84, PDAAP875)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: June 1986 (jrl)
Revised February 1987 (jrl)

1. Project Number: 6500064 2. Geo: SUDAN

3. Title: EASTERN REFUGEE REFORESTATION PROJECT

4. Project Life/PACD: 1983-88/March 30, 1988

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 4,550

   B. R.E. Components: Not specified

   (Source: Project Implementation Report, 6/30/85, PDBBA936)

7. Loan or Grant/Appropriation Category (US$000):

   G / ES / 4,550

   (Source: DIS; Project Implementation Report, 6/30/85, PDBBA936)

8. Project Purpose:

   To enhance the quality of life for the refugees and Sudanese in the area through increased local fuelwood supply, income generation, soil productive capacity, and improvement in the institutional capacity of the Forestry Department.

9. Renewable Energy (R.E.) Outputs:

   1.8 million seedlings produced; 3,091 feddans (1 feddan = 4200 sq. m.) block plantations established; Over 230,000 man/days of employment provided; Over 250,000 trees distributed free in 14 villages/settlements; Over 500 improved charcoal stoves introduced in 13 villages/ settlements; Tin-smiths and potters trained to manufacture the improved stoves and market demonstrations held; Approximately 317 feddans of windbreaks and shelterbelts planted; Two nurseries established.

10. R.E. Inputs:

    Technical assistance; Host government commitments of seconded staff (borrowed from another agency) and land; Commodities; Training; Institutional support.

11. Summary of R.E. Components:

The Eastern Refugee Reforestation Project was funded by an OPG to CARE, the implementing agency. The project has four main components: large-scale fuelwood plantations, shelterbelt/agroforestry activities, extension, and tree nurseries to support the above three activities.

The project has established fuelwood plantations on 3,091 feddans of a 3,500 feddans target. The 1984 plantations were replanted or reseeded in 1985 in places where first year mortality exceeded 20%.

The equivalent of approximately 317 feddans of planted and direct seeded shelterbelts (total 93 km.) have been planted in mechanized farming areas.

Extension activities are reported to have resulted in 250,000 trees planted in household compounds mostly for shade and ornamental purposes. Survival is high (50-70%) and growth good (70-100 cm/yr). Most of the trees receive supplementary water and are fenced as a voluntary local contribution.

Nurseries, each with a capacity of 600,000 seedlings, were established in the villages of Showak and Abu Rakham. Total seedling production as of October 1985 is 1,800,000.

A recent improved stoves program, consisting of training and promotion, has resulted in the production and sale of over 500 improved charcoal stoves during the first nine months of activities.

12. R.E. Project Descriptors: Firewood; Charcoal; Stoves.

13. R.E. Technology Applications:

STAND CHARACTERISTICS
For One Feddan (4,200 square meters)
of Acacia Seyal*

	20 years	8-10 years estimated
1. Stand density, stem/fdn	60	675
2. Mean diameter at breast height, cm	14.5	n.a.
3. Spacing, m	8.4	2.5
4. Basal area, sq.m./fdn	1.0	n.a.
5. Standing volume, cu.m.	6.92	10.40
6. Charcoal produced, tons/fdn	1.48	1.55
7. Charcoal produced, sacks/fdn	55.5	57.0
8. Average weight per sack, kg	26.66	27.33

*Calculations based on measurements made in 1985 at Rawashda Central Forest Reserve.

Acacia seyal and Acacia senegal were the predominant species grown for plantations and shelterbelts. Sixteen species were grown for the extension program; the major ones were Acacia mellifera for living fences and Azadirachta indica, Leucaena leucocephala, and Eucalyptus camaldulensis for shade trees.

14. R.E. Technical Reports and Publications:

    A. The Social Context of Reforestation: Socioeconomic and Cultural Profile of Project Area with Recommendations for a Program of Forestry Extension. Cindi Katy, December 1983. (Report not available for review.)

    B. Forestry Law and Policy in Sudan. Simon H.J. Ripley. (Report not available for review.)

15. Evaluations/Major Findings:

    A. Mid-Term Evaluation for the Period October 15, 1985-November 12, 1985. Tim Resch, Abul Gasim Seif el Din, et al., USDA Office of International Cooperation and Development, and the USDA Forest Service, Forestry Support Program, 78 pp., PDAAU777.

    Major findings:

    - Refugees and rural Sudanese, even when lacking land and tree tenure, are willing to plant and maintain, often at great personal cost, trees that provide them early benefits such as shade, amenity, live fence, or food.

    - Plantation establishment techniques such as sub-soiling, cross-furrowing, micro-catchments, weed control, and mulching were successful in establishing trees in dry areas.

    - A number of tree species were tested under varying environmental conditions. New introductions that have done well in Sudan include Leucaena leucocephala, under irrigation and as a compound tree, and Parkinsonia aculeata, as a dryland plantation species and as a living fence.

    As a result of a request from the project staff to consider a consolidation and expansion of the extension program during the remaining two years, the mid-term evaluation team developed a two-year budget of approximately $400,000 for expanded extension activities. The team suggested that the project staff develop a proposal to submit to prospective donors. The team concurred with staff on: (1) Continued tree distribution

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activities; however, major activity should be concentrated during the rainy season; (2) Inclusion of extension responsibilities in the job descriptions of all senior project staff (to level of supervisors); (3) Gadaref nursery establishment; (4) Small-scale agroforestry appropriate to compounds and small (less than 25 feddans) agricultural plots; (5) Linkages with the improved wood and charcoal stoves program; (6) Sociological studies of tree and tenure and related needs of nomads, pastoralists, and women; (7) Private individual/family woodlots; and (8) Guarding and management of existing forest by a village organization.

The team also suggested that the program include the following elements: (1) Encouragement and support for small private nurseries (in lieu of school nurseries); (2) Production of native and exotic fruit trees in the two existing nurseries, the new Gadaref Nursery, and the proposed private nurseries; (3) Employment of refugees for the planting and care of trees in public areas in settlements and villages; (4) Employment of refugees for canal-side plantings and short-term protection; (5) Establishment of a cash value for fruit and other tree seedlings to the level the market could bear; and (6) Sociological studies of entities participating in mechanized farming activities.

16. Key Persons:

A. AID/Washington:

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AFR/PD/EAP

Tom Catterson, Forestry Advisor
AFR

B. AID/Mission:

Thomas Ivers, Project Manager

C. Contractors:

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Mohamed Majzoub, Stoves Coordinator
Fessaha Girma, Extension Monitor
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D. Host Country:

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Abdul Aziz A. Bashir, Chief Extension Coordinator at Gadaref, Assistant Conservator of Forests, Forest Department.

Adam Mohamed Babikar, Assistant Conservator of Forests at Showak, Assistant Conservator of Forests, Forest Department.

17. Obligations by Fiscal Year (US$000):

FY 83 - 4,550

(Source: Action Memorandum, 3/8/83, PDBAJ003)

18. Host Country Funding of R.E. Components (US$000): 241*

*For entire project; R.E. costs not specified separately.

(Source: Grant Agreement, 3/30/83, Attachment 2, p. 19A, PDBAJ004)

19. Summary of R.E. Costs (US$000):*

Technical assistance	1,037
Commodities	879
Local cost financing	2,634

TOTAL LOP	4,550

*For entire project; R.E. costs not specified separately.

(Source: Action Memorandum, 3/8/83, p.2, PDBAJ003)

20. R.E. Component Revisions:

A. Early in the project life, CARE, at the request of GOS, proposed that plantation targets be increased from 6,000 to 8,000 feddans and shelterbelt/agroforestry targets reduced from 4,000 to 2,000 feddans; this was approved by USAID. No budget changes were made.

(Source: Mid-Term Evaluation, p.1, 11/12/85)

21. Follow-On Activities:

See 15, above, for proposals made during mid-term evaluation.

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: June 1986 (jrl)

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1. Project Number: 6600114 2. Geo: ZAIRE

3. Title: SHABA REFUGEE HEALTH PROJECT (ISROS)

4. Project Life/PACD: 1985-91/March 31, 1991

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 2,500*

   B. R.E. Components: 800**

   (Sources: *Project Implementation Report, 9/30/86, PDBBE426; **Cooperative Agreement Grant No. 660-0114, Attachment 1, 3/19/85, PDBAX877)

7. Loan or Grant/Appropriation Category (US$000):

   G / DA (Health) / 2,500

   (Source: State Department telegram, 3/85, PDBAX879)

8. Project Purpose:

   To provide support to the United Methodist Church in its endeavor to rehabilitate and improve the health infrastructure of the Lualaba and Kolwezi subregions of Zaire.

9. Renewable Energy (R.E.) Outputs:

   PV systems procured and installed.

10. R.E. Inputs:

    Commodities; Technical assistance.

11. Summary of R.E. Components:

    The project focuses on improving the existing decentralized health care infrastructure, managed principally by religious groups, in the Lualaba and Kolwezi subregions. It includes the equipping of health centers with solar photovoltaic (PV) units to reduce operating costs or to extend electricity to remote areas in need of a low-maintenance, reliable energy source. The PV arrays will be used to provide lighting to rural dispensaries for night-time emergency and maternity

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work and to power refrigerators (for vaccine storage), single side-band radio equipment, water pumps, incubators, sterilizers, and water purifiers. The PV equipment was ordered during the fourth quarter of 1986, and delivery was projected for March 1987.

USAID established a Cooperative Agreement with the Southern Zaire Annual Conference of the United Methodist Church (UMC), which is responsible for the overall implementation of the project. Other PVOs participating in the project include the Roman Catholic Church and the Plymouth Brethen--Garenganze Church (Freres en Christ--Garenganze).

12. R.E. Project Descriptors:

Solar energy; Photovoltaic energy; Lighting; Electric power generation; Refrigerators; Radios; Water pumps; Incubators; Sterilizers; Water purifiers.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluaticns/Major Findings:

A. Start-Up Evaluation of Shaba Refugee Projects: 6600114 - Health; 6600115 - Roads; 6600116 - Water. Albert R. Baron, John Barton, and Lauren Greenberger, Kinshasa, September 10, 1986, 105 pp. plus 5-p. PES, PDBBE425 or PDAAU288.

This evaluation assesses the progress of three refugee projects in the Shaba Region. Little is stated concerning the R.E. component, except that access to solar refrigerators will be provided to all dispensaries.

Since the writing of the Project Paper, the needs and circumstances of certain health centers have changed (with some closed and others relocated). It was recommended that a needs assessment be performed, and a new implementation plan with accompanying budget be drawn up. The project currently has no maintenance and repair plan, and the establishment of such a program should be given priority for all equipment, including solar.

The evaluators called for closer cooperation between this project and a number of other projects and groups working in the same geographic area. They suggested, for example, that project personnel might attend training in solar equipment usage offered by ECZORT (Eglise du Christ au Zaire Organization for Rehabilitation through Training) in October 1986.

16. Key Persons:

A. AID/Washington:

L. Brown

B. AID/Mission:

Mr. Leon Skip Waskin, Field Project Officer

C. Contractors:

Dr. Jeffrey Hoover, Project Director

D. Host Country:

Southern Zaire Annual Conference of the United Methodist Church (UMC)

Plymouth Brethen--Garenganze Church (Freres en Christ--Garenganze).

Bishop Songasonga
Roman Catholic Diocese of Kolwezi

17. Obligations by Fiscal Year (US$000): Not specified

18. Host Country Funding of R.E. Components (US$000): 2,300*

*For entire project, R.E. costs not specified separately.

(Source: State Department telegram, 1/85, PDBAX879)

19. Summary of R.E. Costs (US$000):

ILLUSTRATIVE BUDGET FOR ENTIRE PROJECT

Construction/Renovation	250
Hospital Equipment	500
Electric Power Generation/Solar	800
Vehicles	500
Inflation/Contingency	450

TOTAL	2,500

(Source: Cooperative Agreement Grant No. 660-0114, Attachment 1, 3/19/85, PDBAX877)

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20. R.E. Component Revisions:

A. Funding for procurement of U.S. pharmaceutical supplies was eliminated after it was found that drugs could be purchased in Europe for half the price; these funds are to be reallocated to provide more equipment and construction.

(Source: Start-Up Evaluation, p. C-2, 9/10/86, PDBBE425 or PDAAU288)

B. At the time of the start-up evaluation in September 1986, Bishop Songasonga had thus far refused USAID assistance, and there was concern on the part of the evaluators if the Catholic-run health facilities would participate in the project.

(Source: Start-Up Evaluation, p. C-2, 9/10/86, PDBBE425 or PDAAU288)

C. A technical assistance component was added.

(Source: Start-Up Evaluation, p. C-2, 9/10/86, PDBBE425 or PDAAU288)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: April 1987 (jrl)

1. Project Number: 6640325 2. Geo: TUNISIA

3. Title: TUNISIA RENEWABLE ENERGY

4. Project Life/PACD: 1979-82(extended to 84)/December 31, 1984

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 1,548

   B. R.E. Components: 1,548

   (Source: Quarterly Project Implementation Status Report, 4/3/84, PDHAD450)

7. Loan or Grant/Appropriation Category (US$000):

   G / SD / 1,548

   (Source: DIS)

8. Project Purpose:

   To demonstrate the ability of alternative energy sources and technologies to meet the energy needs of a rural village; To provide information to Tunisian decisionmakers that will assist them in relating economic and social developments to energy availability.

9. Renewable Energy (R.E.) Outputs:

   Wind-electric generators purchased and installed; A wind-powered water pump installed; Photovoltaic (PV) drip irrigation systems installed; A stand-alone domestic PV system installed on a farmhouse; A central PV system installed for commercial, clinic, school, mosque, village water pumping, and public lighting uses; A PV vaccine refrigerator and a sterilizer installed in a clinic; A solar hot water heater installed at a clinic; Passive solar greenhouses constructed.

10. R.E. Inputs:

   Technical assistance; Commodities; Training.

500

11. Summary of R.E. Components:

The Tunisia Renewable Energy Project has two components: demonstration of R.E. technologies in a rural agricultural setting, and training of Government of Tunisia (GOT) officials to improve the GOT ability to harness R.E. sources.

In the pilot village of Hammam Biadha, the project installed photovoltaic (PV) drip irrigation systems, a stand alone domestic PV system, a central village PV system, passive solar greenhouses, and a wind-powered water pump. Near the end of the project, two wind electric generators were installed at Cap Bon. An evaluation of the Hammam Biadha project one year after completion revealed little interest by farmers in the PV drip irrigation systems and the passive solar greenhouses; acceptance of the central PV village system was positive, but economics were unfavorable, with operating costs (for salaries) far exceeding revenues.

Under the training component, seminars were conducted on desalting technology, housing and energy, and energy conservation and management in hotels.

The Solar Projects Office of NASA Lewis Research Center provided technical and management services for project implementation. AID/Washington retained responsibility for the training subproject, contracting with Human Resources Management, Inc., to conduct the training. SERI/Rocky Flats provided assistance with training and installation of the wind electric generators and was responsible for implementation of the demonstration subproject. Development Sciences, Inc., furnished professional and engineering services to NASA in the selection of suitable demonstration technologies. Peace Corps assigned two volunteers, primarily for agricultural extension. The Ministry of Industry, Mines and Energy (MIME) was the local implementing agency, delegating responsibility for project management to the Societe Tunisienne de l'Electricite et du Gaz (STEG).

12. R.E. Project Descriptors:

Wind energy; Electric power generation; Water pumps; Irrigation; Water pumping; Lighting; Refrigerators; Sterilization; Water heaters; Solar energy; Greenhouses; Photovoltaic energy.

13. R.E. Technology Applications:

A. PV Drip Irrigation System for Orchard, PV Electric System, and Passive Solar Greenhouse

Installed for Mr. Brahim Manai, a farmer, a 1.4 kWp battery-less PV drip irrigation system for an orchard; a

1.4 kWp PV electrical system, which contains storage batteries, 1.5 kW Abacus inverter, and monitoring equipment, on the farmhouse for domestic use; and a passive solar greenhouse. At the end of 1985/early 1986, the farmer reported that the PV pump/drip irrigation system was working, but upon inspection it was observed that the pipes and hoses of the drip system were disconnected and scattered about at the site, apparently not in use for some time. The solar greenhouse had not been used during the previous year due to rips in the plastic covering, except for a large crop of red chili peppers set out for drying. A problem with the inverter on the home power system required replacement by the U.S. supplier, causing a lengthy delay. Another inverter failure in 1984 shut down the system; it had not yet been repaired by early 1986.

(Source: Retrospective Analysis of Hammam Biadha Renewable Energy Project, 2/7/86, PDCAR710)

B. PV Drip Irrigation System for a Passive Solar Greenhouse

Installed a 1.4 kWp battery-less PV drip irrigation system on a private farm for use in a STEG-constructed passive solar greenhouse. Inspection by the evaluation team found that the pump was functioning but had been disconnected from the drip irrigation system and that the greenhouse was not being used.

(Source: Retrospective Analysis of Hammam Biadha Renewable Energy Project, 2/7/86, PDCAR710)

C. Passive Solar Greenhouse and Wind-Powered Water Pump

STEG constructed a passive solar greenhouse and a wind-powered water pump for a farmer. At the end of 1985/ early 1986, the windmill had been broken, fixed, and broken again. The farmer complained that the wind is lowest and most infrequent during the periods when water is needed most. The farmer had made a sufficient profit from growing crops in the solar greenhouse using the windpumper for irrigation to purchase a diesel pump, which he used in place of the windpumper. Two other water-pumping windmills were reportedly installed.

(Sources: Retrospective Analysis of Hammam Biadha Renewable Energy Project, 2/7/86, PDCAR710; Quarterly Project Implementation Status Report, 3/31/83, PDHAD450)

D. Central PV System

Installed a 28.6 kWp central PV system (containing storage batteries, Helionetics DECC inverter, and

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monitoring equipment) and distribution grid for residential, commercial, clinic, school, mosque, village well pump, and public lighting uses. Solar Power Corporation (part of Exxon, now defunct) and TriSolar Corp. (now Chronar TriSolar) supplied the PV equipment. There was a system down-time of 1.5 months during initial checkout operation, caused by inverter problems, but subsequent occasional electrical problems appeared easily correctable by the local STEG facility operator. Following is an account of electrical consumption from the system from start-up in February 1983:

ELECTRICAL CONSUMPTION THROUGH NOVEMBER 1985 (kWhs)

Household/commercial	15,421
Village facilities	2,400
Public lighting	1,409
STEG operations	765
TOTAL	19,995

The load was calculated as running, on average, about 31 percent of the system's projected output. Financial analysis revealed that annual operating expenditures, which included salaries for a STEG operator and three custodial/guard personnel, far exceeded the annual revenues, resulting in an annual operating deficit of about $13,000.

The PV village power system included installation of a vaccine refrigerator in a village clinic. The nurse reported no problems with its operation apart from a blown fuse. In October 1985, the Ministry of Health hooked an electric sterilizer to the PV system. STEG installed a solar hot water heater, which was little used, and a solar space heating system.

At the Hammam Biadha elementary school, PV-supplied electricity is used essentially for lighting. Other uses include operation of a table saw in a student wood shop and three sewing machines for girls' professional training classes.

At a cafe, PV electricity is used to power a refrigerator for soft drinks, lights, and a coffee pot. Lighting is also provided to a store and grain mill.

(Sources: Retrospective Analysis of Hammam Biadha Renewable Energy Project, 2/7/86, PDCAR710; Management Report: Tunisia Renewable Energy Project, 1/13/84, PDHAD446)

E. Wind Power Generation

Second Wind anemometry units were installed in September 1983 at Kerkenna and El Haquaria. A Bergey and a Jacobs wind generator, and a SERI/Rocky Flats data system, were installed with STEG support in October 1984. The Bergey machine was a three-bladed, upwind, BWC Excel wind turbine generator (WTG) with 10.0 kW rated capacity at 27 mph, with a 50 Hz, 220 VAC Power Sync inverter and an 80 foot tilt-up tower, and cost $25,187.00. The Jacobs machine was a three-bladed, upwind, variable pitch Model 23-12.5 Grid Intertie WTG with rated capacity of 12.5 kW at 27 mph, with a 50 Hz, 220 VAC, single-phase inverter and an 80 foot advanced "D" free standing tower, and cost $25,887.00. Problems occurred with equipment failures of both wind generators and data systems. An inspection in August 1986 by Bergey Windpower Co. concluded that lightning strikes were the major cause of the problems. Corrosion was found to be a minor problem.

(Sources: Letter of 11/22/85 from Warren S. Bollmeier II to Carolyn Coleman, 11/22/85, PDCAR707; Management Report: Tunisia Renewable Energy Project, 3/13/84, PDHAD446; Inspection Trip Report: S.T.E.G. El Haouaria Wind Energy Test Facility and Hammam Biadha Photovoltaic Demonstration Project, 9/26/86, PDAAV963)

14. R.E. Technical Reports and Publications:

A. Tunisia Renewable Energy Project Small Wind Energy Conversion System Subproject: Evaluation Report. NASA-Lewis Research Center, Cleveland, January 1983, 65 pp., PDHAD448.

This report presents the results of an examination of three potential sites for Small Wind Energy Conversion Systems (SWECS): Kerkenna Island and two sites at Sidi Mechrig. After concluding that Kerkenna Island would be an inappropriate site, the wind resources at the two remaining sites are reviewed and specifications given for testing one stand-alone SWECS/battery storage system and one stand-alone SWECS/diesel system at the sites. Cost estimates are provided. Included is a 49-page report prepared in December 1982 by D.L. Elliott of Pacific Northwest Laboratory which assesses the wind resource in Tunisia and evaluates sites for potential installation of SWECS, including Kerkenna Island and Sidi Mechrig; a table of commercial small wind machines of 25 kW rated capacity or smaller is provided.

B. Inspection Trip Report: S.T.E.G. El Haouaria Wind Energy Test Facility and Hammam Biadha Photovoltaic Demonstration Project. Bergey Windpower Co., Inc., Norman, Oklahoma, September 26, 1986, 24 pp., PDAAV963.

Describes an inspection of the project's two wind electric generators by Mike Bergey of Bergey Windpower Co. (BWC), and Alan Cowan, consultant to BWC, August 18-25, 1986. (This consultancy was funded under AID project 6640328.16.) Details cover the condition of the wind generators, repairs and upgrades performed, and recommendations for future actions. The report also describes the condition of the central PV system in Hamman Biadha.

15. Evaluations/Major Findings:

A. Retrospective Analysis of Hammam Biadha Renewable Energy Project (Huddleston/Roberts Trip Report). Allen Roberts and Jack Huddleston, Resource Management Associates of Madison, Inc. (RMA), Madison, Wisconsin, February 7, 1986, 93 pp., PDCAR710.

This report is a socio-economic evaluation of the Hammam Biadha PV system. It is based on a consultancy performed by two RMA consultants from December 30, 1985, to January 7, 1986, in collaboration with the Societe de la Maitrise de l'Energie, with funding by the Energy Planning Project 6640326. It supplants the social impact analysis called for by the project but which STEG refused to complete.

Conclusions and lessons learned include the following: (1) The project was successful in providing electricity to a rural area and developing PV technical expertise among STEG personnel; however, none of the agricultural applications were adopted successfully and little demonstration effects or information on them developed. (2) Although the project was not viewed as an integrated rural development project, in reality it was, and sustained commitment by the various agencies involved was not achieved; this experience supports the trend toward small sectoral development projects rather than large complex projects. (3) The local administrative agency, STEG, performed well in its traditional role, that of delivering electricity, but the agricultural applications were never developed, illustrating the need to distinguish between ends and means in the selection of project roles and responsibilities. (4) Lack of documentation and information precludes the judging of appropriateness of R.E. in agricultural applications. Although R.E. has been relegated to a low priority by AID/Tunisia, such technologies should be considered in other types of

projects as an appropriate means of accomplishing a specified end (such as better health care through vaccination made possible by a PCV vaccine refrigerator). (5) Efforts should be made to assist host country nationals with social impact assessments, since these are part of American social science theory and method, but are alien to social scientists of other cultural backgrounds. (6) The PV central village system is difficult to replicate elsewhere, due to costs far exceeding revenues. (7) GOT may wish to investigate other methods of electrifying the village of Hammam Biadha, due to the high operating costs of the PV sytem. (8) More detailed research needs to be undertaken on the technology applications, and it should be conducted in a controlled and monitored research or experimental environment.

16. Key Persons:

A. AID/Washington:

Carolyn Coleman
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303 SA-18
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(202) 235-9020

B. AID/Mission:

Richard Stevenson, formerly Science and Technology Officer, USAID/Tunis, now with USAID/Manila, Philippines

C. Contractors:

James Martz
Larry R. Scudder, Project Manager for Tunisia Renewable Energy Project
Anthony Ratajczak
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David Tyler
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Washington, DC 20007

D. Host Country:

Khereddine Guellouz, Director of R&D, STEG
Mr. Mokdad Maksoudi, former STEG Project Manager
Mr. Bouhchicha, STEG Project Manager
Nasri Habib, STEG Wind Program Manager
Mr. Yahoubi, Station Manager, STEG-Hammam Biadha
Heidi Turki
Societe Tunisienne de l'Electricite et du Gaz (STEG)
38 Rue Kemal Ataturk
1001 Tunis Republique
Tunisia C-83358-D

17. Obligations by Fiscal Year (US$000):

FY 79	1,000
FY 80	548

(Source: AID LOP Authorization/Requests by Component, chart attached to 8/31/79 Grant Agreement, undated, PDHAD428)

18. Host Country Funding of R.E. Components (US$000): 516

(Source: Quarterly Project Implementation Status Report, 4/3/84, PDHAD450)

19. Summary of R.E. Costs (US$000):

USAID COSTS FOR HAMMAM BIADHA COMPONENT

	Village PV System	Farm-House PV System	Drip Irrigation Systems	Total Reported Expenditures
NASA administration	123.617	17.659	19.265	160.541
PV equipment	681.888	97.413	106.268	885.569
Project studies	45.624	6.518	7.110	59.252
Equipment transport	33.275	4.753	5.186	43.214
Spare parts	24.196	3.457	3.771	31.424
Misc.	15.400	2.200	2.400	20.000
TOTAL USAID	924.000	132.000	144.000	1,200.000

(Source: Extracted from Table III-1, p. 22, Retrospective Analysis of Hammam Biadha Renewable Energy Project, 2/7/86, PDCAR710)

20. R.E. Component Revisions:

A. The location and technology selection changed considerably from the early conceptualization stages in 1979 to the project's final realization in 1983. Hassi El Frid was the original project site; subsequently, the GOT selected Hammam Biadha for the pilot village.

(Source: Retrospective Analysis of Hammam Biadha Renewable Energy Project, 2/7/86, PDCAR710)

B. LOP funding was increased from $1 million to $1,548,000 to provide additional funds for training and increased costs of hardware.

(Sources: First Amendment to Project Authorization, 8/28/80, PDHAD426; Project Data Sheet, undated, PDHAD424)

C. The PACD was extended several times. First, due to unforeseen implementation delays, USAID approved extension from March 31, 1982, to March 31, 1983. The Near East Bureau extended it to September 30, 1984, to allow for the demonstration of wind electric generating systems. A final three-month extension was granted to December 31, 1984, to allow for installation of the wind electric generators and training.

(Sources: Action Memorandum to the Director, NE/TECH, 9/28/84, PDHAD431; Project Implementation Letter No. 5, undated, PDHAD436)

21. Follow-On Activities:

A. $100,000 was provided by project 6640328 to finance technical assistance for STEG technicians in charge of the Hammam Biadha PV system and the El Haouaria (Cape Bon) SWECS system, equipment and spare parts, and also the purchase of a time limited systems warranty if needed. A contract was given to Bergey Windpower Co. (BWC). An initial site inspection was performed in August 1986, and repairs and upgrades of the two wind electric generators initiated. Bergey Windpower Co. also visited briefly the Hammam Biadha PV system, and subsequent to the inspection visit undertook work to upgrade that facility. It was decided that training of STEG personnel in operation and maintenance would be preferable to the purchase of a warranty contract; BWC provided training in the U.S. for STEG personnel in January/February 1986. Another visit to Tunisia by BWC is planned for June 1987.

(Sources: State Department Incoming Telegram, 4/86, PDCAR708; Inspection Trip Report: S.T.E.G. El Haouaria Wind Energy Test Facility and Hammam Biadha Photovoltaic Demonstration Project, 9/26/86, PDAAV963; phone conversation of 5/8/87 with Mike Bergey of Bergey Windpower Co.)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: May 1987 (jrl)

1. Project Number: 6830205.01 2. Geo: NIGER

3. Title: NIAMEY DEPARTMENT DEVELOPMENT

4. Project Life/PACD: 1978-80(extended to 81)/July 30, 1981

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 4,698

   B. R.E. Components: Not specified

   (Source: End of Tour Report, 7/10/81, PDAAN108)

7. Loan or Grant/Appropriation Category (US$000):

   G / FN / 2,673
   G / SH / 2,025

   (Source: DIS)

8. Project Purpose:

   To start a process of rural development by (1) Providing the initial motivation and organizational requirements among the rural population for economic and social development, and (2) Creating an institutional, physical, and technical capability within the government services of the Niamey Department to begin implementation of a comprehensive rural development plan.

9. Renewable Energy (R.E.) Outputs:

   Increased use of animal traction; Woodlots established.

10. R.E. Inputs:

    Technical assistance; Commodities; Training.

11. Summary of R.E. Components:

    This three-year project, Phase I, was designed to initiate and test development activities to promote rural development in the Niamey Department, a vast project zone in western Niger. It consisted of ten diverse activities, two of which had renewable energy components: a village-level land use and soil conservation/forestry activity, including the

establishment of village woodlots; and agricultural extension and provision of agricultural inputs, including an animal traction element.

Regarding village woodlots, it was felt that the Eaux et Forets, the Government of Niger (GON) implementing agency for this component, was incapable of successfully carrying out a tree planting activity of any significant scale. Concerning animal traction, it was found that few of the farmers utilized the agricultural techniques learned at the training centers.

(Sources: End of Tour Report, 7/10/81, p. 21, PDAAN108; Inspector General Audit Report No. 7-683-83-2, 2/10/83, PDAAM358; First Annual Evaluation Synthesis Report, 5/79, PDAAP509)

12. R.E. Project Descriptors: Animal traction; Firewood.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings:

A. Project Evaluation Summary for the Period 1/78 - 1/79. Tridib Mukherjee, Steve Reyna, Gaoh Oumarou, and Kaka Gado, USAID, 4 pp., PDAAT051.

Quantitatively, this three-year project attained 56% of its end of project (EOP) targets during its initial year, indicating that the project was exceptionally well-managed and very likely to achieve most, if not all, EOP targets. However, a number of exogenous problems were identified, including a shortage of qualified GON personnel; an unreliable delivery system for agricultural inputs and credit; unresolved questions concerning the economic and technical soundness of the agricultural production packages; and climatic vagaries and unfavorable market conditions.

After learning that the quantity of agricultural inputs depended upon GON funds available to subsidize inputs sold to the farmer, the evaluation team expressed the need for the GON to provide more precise details on its subsidy programs so that the project could better anticipate availability of project inputs. Since the project covered such a broad geographic area as well as number of activities, it was suggested that future projects of this nature first concentrate on small-priority areas and reach a successful implementation stage before expanding. Moreover, extension services

must first prove the economic and technical viability of the technical packages before disseminating them.

B. Niamey Department Development Project First Annual Evaluation: Synthesis Report. Tridib Mukherjee, Steve Reyna, Gaoh Oumarou, and Kaka Gado, USAID, May 1979, 24 pp., PDAAP509.

This report apparently is related to the above evaluation summary, and may be the basis for it. Consequently, in addition to that mentioned above, the team concluded that the project may be trying to undertake too much, too soon, and recommended that the project:

- Upgrade its data collection capabilities to better test the soundness of its interventions;
- Concentrate on the different interventions necessary for improving agricultural production and productivity; and
- Concentrate its activities in specific, restricted zones to assist in coordination and to reduce geographic over-extension.

The report also describes problems in specific project components and furnishes general recommendations to resolve these problems. For example, the tree planting operations were plagued with high mortality, high costs, and lack of village involvement, and it was recommended that local participation be encouraged in future endeavors.

C. The Niamey Department Development Project in Niger Audit Report No. 7-683-83-2. Regional Inspector General for Audit, USAID, Abidjan, February 10, 1983, 58 pp., PDAAM358.

This report examines the progress of the Niamey Department Development Project as of early 1983. It covers both Phase I (6830205) and the beginning of Phase II (6830240).

The Phase I project objectives proved to be too optimistic and overly ambitious. Inadequacies in GON technical services caused the forestry sector component to be dropped from Phase II activities.

It was found that few farmers used the agricultural techniques learned at the training centers. Nothing was being done to learn why the farmers were not adopting the new agricultural packages, and the team stated that the project must determine the reasons for non-use. Different beliefs existed in the minimum area of farmland

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needed for animal traction to be profitable. Six recommendations were made, including evaluating the training provided at the centers, providing use of a vehicle to follow-up the training graduates, and developing a training program for the follow-up agents.

16. Key Persons:

    A. AID/Washington: Not specified

    B. AID/Mission:

    Mark Wentling, Project Officer

    C. Contractors: Not specified

    D. Host Country:

    Saley Moussa, GON Project Director
    Niamey Department Development Project, Direction de Foret et Faune (formerly Eaux et Forets under the Ministere de Developpement Rural), Ministere de l'Hydraulique et de l'Environnement, Niamey, Niger

17. Obligations by Fiscal Year (US$000): Not specified

18. Host Country Funding of R.E. Components: 40,511,240 CFA*

    *For entire project, in local currency; R.E. costs not specified separately.

    (Source: End of Tour Report, 7/10/81, PDAAN108)

19. Summary of R.E. Costs (US$000): Not specified

20. R.E. Component Revisions:

    The PACD was extended until July 30, 1981.

    (Source: End of Tour Report, 7/10/81, Annex C, PDAAN108)

21. Follow-On Activities:

    This project was followed by a five-year (1981-85) Phase II project, 6830240, by the same name. AID signed the grant agreement in June 1981, providing $13.6 million. Phase I was designed to initiate and test development activities in the project zone. Phase II was to take those activities found to be viable and implement them on a broader basis.

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: August 1986 (jrl)

1. Project Number: 6830230 2. Geo: NIGER

3. Title: FORESTRY AND LAND-USE PLANNING (FLUP)

4. Project Life/PACD: 1980-84(extended to 87)/December 31, 1987

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 4,089

   B. R.E. Components: Not specified

   (Source: Phone conversation of 8/27/86 with George Jones, AID/Niger Project Desk Office)

7. Loan or Grant/Appropriation Category (US$000):

   G / SH / 4,089

   (Source: Phone conversation of 8/27/86 with George Jones, AID/Niger Project Desk Office)

8. Project Purpose:

   To establish a planning and managerial capability within Niger's Forestry Service; To produce a long-term perspective plan for the rehabilitation and protection of Niger's soil and vegetative resources; To increase the awareness of Niger's rural population and government service personnel on the need for resource conservation actions.

9. Renewable Energy (R.E.) Outputs:

   Establishment of a Resources Planning Unit, the BTF, and preparation of a rehabilitation and protection plan; Establishment of a natural resource inventory and data base; Establishment of model sites; Training of Forest Service managers and agents; Mobilization of human resources toward environmental concerns and actions.

10. R.E. Inputs:

    Technical assistance; Commodities; Operational costs; Training.

11. Summary of R.E. Components:

The project had four major components: 1) the creation and support of a technical planning unit called the Bureau Technique Forestier (BTF) to develop and analyze project proposals, engage in long-term planning and technical monitoring of conservation-related projects, provide a data bank on renewable natural resources, and provide technical advice to other services of the Government of Niger (GON) engaged in project activities that impact on Niger's natural resource base; 2) the establishment of model sites for forestry and conservation experimentation and testing activities; 3) the compilation of a natural resource inventory to provide basic data to the BTF as well as to provide technical training in more sophisticated techniques of resource survey and management; and 4) development of an awareness campaign aimed at the rural population and the GON to strengthen environmental concern and action and to reinforce the management and extension skills of field personnel.

Renewable energy activities centered around forestry and fuelwood-related surveys. The BTF conducted a study on the fuelwood supplies reaching Niamey. It began a fuelwood inventory for the Maradi region and completed an urban fuelwood inventory for Zinder. It centered the model sites/forest management work on the productive potentials of natural forests and woodlands. In the Guesselbodi model site, for example, cutting experiments yielded valuable data on dry weight fuelwood yields for various typical brush wood forest types. This will help guide the Forest Service's permit system for fuelwood cutters and lead to refined cutting cycles in native brush forest so that sustained yield production can be planned. The BTF also participated in and provided limited support to a survey and evaluation study of the National Women's Organization/Church World Service improved stoves project.

12. R.E. Project Descriptors:

Firewood; Stoves.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings:

A. Niger Forestry and Land Use Planning Project - Report of the Mid-Term Evaluation. Thomas Catterson et al., USAID/Niger, June 1983, 99 pp., PDAAN806.

The Evaluation team found that the project design was overly ambitious. The assumption that the GON could provide an adequate number of trained counterparts was unrealistic. Even had this been possible, an overly ambitious plan would have prevented full project implementation. Lack of continuity in personnel in USAID project management led to neglect of the project by the Mission. Moreover, there was the false assumption that creation of the BTF would automatically lead to institutionalization of forestry planning in Niger. Nonetheless, the project made significant contributions to forestry sector development in Niger through studies, surveys, and model site development, and it was innovative in addressing the question of natural forest management.

Recommendations included:

- Eliminating the overly ambitious 20-year national resource management and use plan;
- Giving priority to resolving the institutionalization problems of the BTF;
- Scaling down of the model sites component, the national-level natural resource inventory, and the national-level social survey;
- Extending the PACD one year to 12/31/85; and
- Defining each of the project components better and limiting each component to a reasonable level of effort aimed at addressing present day needs for information and data required by the Forest Service.

16. Key Persons:

A. AID/Washington:

Nancy McKay, Project Development Officer
647-6321

B. AID/Mission:

Dennis Panther, Field Project Officer
USAID, B.P. 11201, Niamey, Niger

C. Contractors:

John G. Heermans, Model Sites Advisor
R.D. 2, West Mountain Road, Glen Falls, NY 12801,
(518) 793-1918

D. Host Country:

Mr. Ibrahim Nagada, Conseiller Technique Forestier
Ministry of Water Resources and the Environment (MWR/E) - Ministere de l'Hydraulique et de l'Environnement, Niamey, Niger

Mr. Amoul Kinni, Directeur
Direction de Foret et Faune, Ministere de l'Hydraulique et de L'Environnement, Niamey, Niger

Mr. Mamadou Mamane, Director
Forestry and Land-Use Planning Project

17. Obligations by Fiscal Year (US$000):

FY 82	1,684	
FY 33	800	
FY 84	1,355	
FY 85	0	
FY 86	384	(estimated)

(Source: Energy, Forestry, and Natural Resources Activities in the Africa Region, Bureau for Africa/AID, April 1986, p. 70, PNAAW771)

18. Host Country Funding of R.E. Components (US$000): 1,332*

*For entire project; R.E. costs not specified separately.

(Source: Energy, Forestry, and Natural Resourcs Activities in the Africa Region, Bureau for Africa/AID, April 1986, p. 70, PNAAW771)

19. Summary of R.E. Costs (US$000):

PROJECTED COMPONENT COSTS*

Technical assistance	2,029
Training	564
Commodities	489
Other costs	1,007
TOTAL	4,089

*For entire project; R.E. costs not specified separately.

(Source: Amendment No. 5 to the Project Grant Agreement, 8/86, PDBBD791)

20. R.E. Component Revisions:

A. Although the BTF was effective in making important contributions to improvement in the forestry sector during the first half of the project, it was not acknowledged as a functional planning unit for the forestry service. Its role within the Water and Forest Service (Eaux et Forets - EFS) of the Ministry of Rural Development and within the project itself were unclear. In 1983, following the Mid-Term Evaluation, the EFS was renamed the Forest and Wildlife Department (Direction de Foret et Faune) and transferred, along with authority over the FLUP and the BTF, to the Ministry of Water Resources and Environment.

(Sources: Mid-Term Evaluation, 6/83, PDAAN806; Incoming Telegram, 10/83, PDBAP131)

B. Several extensions were made to the PACD, the latest extending the project to December 31, 1987.

(Source: Project Implementation Report, 4/19/85, PDBAX122)

21. Follow-On Activities:

A committee, with representation by all major donors to Niger (including Italy, Canada, Germany, and IBRD) was created to formulate a viable natural resources development and rehabilitation strategy. Most donors have indicated their intentions to replicate the project's forest management activities in different areas of Niger, and many on-going forestry projects are modifying their objectives to address the land rehabilitation problem.

(Source: Incoming Telegram, 3/86, PDBBB566)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: August 1986 (jrl);
Revised February 1987 (jrl)

1. Project Number: 6830235 2. Geo: NIGER

3. Title: NIGER SOLAR ENERGY DEVELOPMENT

4. Project Life/PACD: 1978-80 (extended to 82)/PACD not specified

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 500

   B. R.E. Components: 500

   (Source: DIS)

7. Loan or Grant/Appropriation Category (US$000):

   G / SH / 500

   (Source: DIS)

8. Project Purpose:

   To assist Niger's Office of Solar Energy (ONERSOL) to develop, test, and apply solar energy technologies, especially for the benefit of Niger's rural poor.

   (Source: Project Evaluation Summary, p. 9, 10/20/82, PDAAL677)

9. Renewable Energy (R.E.) Outputs:

   ONERSOL building incorporating passive air conditioning systems; Equipped laboratory and research units; Doctoral degree for ONERSOL deputy director; Installation and trial of solar pumps.

10. R.E. Inputs:

    Commodities; Training; Technical assistance.

11. Summary of R.E. Components:

    The project design consisted of five components: architectural design and construction supervisory services for the new ONERSOL building which incorporated passive air conditioning systems; provision of laboratory instruments and equipment; lab and field testing of solar thermal and photo-

voltaic water pumps for irrigation, livestock watering, and domestic water supply; U.S. training for two ONERSOL personnel; and consultative visits by U.S. experts.

The ONERSOL building was completed. Laboratory equipment and instruments were supplied. The deputy director of ONERSOL received a master's degree in mechanical engineering in the United States. None of the other objectives was achieved, however, due in part to lack of qualified technical personnel at ONERSOL.

Sources: Project Grant Agreement, 9/30/78, PDBAL862; PES, PDAAL677 or PDBAL869)

12. R.E. Project Descriptors:

Solar energy; Solar cooling; Photovoltaic energy; Water pumps.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings:

A. Niger Solar Energy Development Project Evaluation Summary for the Period 10/78 - 9/82. Clarence F. Koci, USAID, October 20, 1982, 19 pp., PDAAL677 or PDBAL869.

The evaluator found that the implicit goal of providing solar water pumping to rural Niger was not met. ONERSOL had benefitted from architechtural and supervisory services for the new ONERSOL building, from equipment and instruments supplied by the project, and from the training of the Deputy Director in the United States. However, the project furnished little technical assistance, and did not achieve a trained, capable team at ONERSOL engaged in solar water pump development and adaption. Difficulties with procurement, price, and waivers prevented ordering of a solar pump. ONERSOL lacked technical personnel to undertake project activities, and USAID failed to discover this. Absence of trained technical personnel at ONERSOL was assumed to be caused by a very low pay scale and absence of appropriate academic training facilities in Niger. Neither a planned mid-term evaluation in 1979 nor a final evaluation in 1980 was performed. The importance of early evaluations to plan corrective measures was stressed.

The evaluator recommended that the project be terminated, and that unused funds, estimated at approximately $260,000, be deobligated. Before doing so, however, he

recommended the purchase of (1) miscellaneous equipment, needed to make operational the already purchased instruments, (2) library materials, and (3) a PV water pump. It was also recommended that AID undertake with other funds a thorough study of technical engineering and scientific training and personnel in Niger so that the country's apparent lack of technical expertise can be addressed.

16. Key Persons:

A. AID/Washington: Not specified

B. AID/Mission:

Winfield Collins, Mission Engineer and Project Manager
Roy Harrell, Program Officer
USAID/Niamey, B.P. 11201, Niamey, Niger

Sidney Bliss, former Project Officer, now USAID/Togo, c/o American Embassy, Rue Pelletier Caventou et Rue Vouban, B.P. 852, Lome, Togo

C. Contractors: Not specified

D. Host Country:

Dr. Abdou Moumouni, Director
Albert Wright, Deputy Director
ONERSOL, P.O.B. 621, Niamey, Niger, Telephone: 72-30-83

Abdousalaam Ba, former ONERSOL engineer/scientist, now Director, CRES, B.P. 1872, Bamako, Mali

17. Obligations by Fiscal Year (US$000):

A. Projection of Expenditures:

	AID	GON	TOTAL
FY 78	0	0	0
FY 79	366.9	533.2	900.1
FY 80	133.1	433.3	566.4
FY 81	0	433.3	433.3
TOTAL	500.0	1,399.8	1,899.8

(Source: Project Paper, 9/28/78, p. 10, PDBAF718)

B. Funding Obligation:

FY 78 500

(Source: Energy, Forestry and Natural Resources Activities in the Africa Region, AID/Bureau for Africa, July 1982, p. 59., PNAAL224)

18. Host Country Funding of R.E. Components (US$000): 1,399.8

(Source: Project Paper, 9/28/78, p. 10, PDBAF718)

19. Summary of R.E. Costs (US$000):

Projected Summary Cost Estimate

	AID			GON	TOTAL
Source	FX	LC	Total AID	LC	All Sources
Architectural/ Construction Supervisory Services	10	60	70	0	70
Construction	0	0	0	1,300	1,300
Equipment/Instruments	164.4	21.5	185.9	31.8	217.7
Water Pumps	58.5	6.5	65	50	115
Technical Assistance	56	0	56	0	56
Participant Training	63	0	63	18	81
Inflation and Contingency	60.1	0	60.1	0	60.1
TOTAL	412	88	500	1,399.8	1,899.8

(Source: Project Paper, 9/28/78, p. 11, PDBAF718)

20. R.E. Component Revisions:

The 1982 evaluation revealed that most project activities were not being undertaken, due in part to an absence of qualified technical personnel at ONERSOL, and recommended that the project be terminated as of September 30, 1982, and the remaining $260,000 be deobligated. No further information is available to indicate whether these actions were taken.

(Source: PES, 10/20/82, PDAAL677 or PDBAL869)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: August 1986 (jrl)

1. Project Number: 6830240 2. Geo: NIGER

3. Title: NIAMEY DEPARTMENT DEVELOPMENT II

4. Project Life/PACD: 1981-86(extended to 87*)/December 31, 1987*

*A draft Congressional Notification proposes to extend the PACD until December 1988.

(Source: State Department telegram, 6/86, PDBBD274)

5. Status: Active

6. LOP Funding (US$000):

A. Entire Project: 13,582*

B. R.E. Components: Not specified

*A draft Congressional Notification proposes to increase LOP funding by $1.262 million to $14.844 million.

(Source: Project Implementation Report, 4/85, PDBAX131; State Department telegram, 6/86, PDBBD274)

7. Loan or Grant/Appropriation Category (US$000):

G / SH / 13,582

(Source: DIS)

8. Project Purpose:

To institutionalize a process of rural development through the establishment of self-managed village organizations capable of assisting farm families with increased food production on a self-sustaining basis.

9. Renewable Energy (R.E.) Outputs:

Farmer couple training centers completed and operational; Farmers trained in animal traction practices; Animal traction incorporated into farming practices; Blacksmiths trained and equipped to produce farm implements, including animal traction equipment.

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10. R.E. Inputs:

Commodities; Construction; Technical assistance; Training.

11. Summary of R.E. Components:

This project, Phase II, continues the work begun under Project 6830205 of the same name. It is a long-range program of integrated rural development aimed at providing needed inputs, such as credit, technical training, and a delivery system for a variety of agricultural inputs (for example, fertilizer, implements, and oxen for animal traction), to increase agricultural production and productivity in the Niamey Department of western Niger. There is also a component aimed at increasing women's access to development activities, which includes training in the construction of improved cookstoves.

The Ministry of Rural Development has overall authority for organizing and managing the project. Project implementation has been delegated to the Niamey Department Prefect. An eight-person technical assistance team has been furnished to the project through a contract with Development Alternatives, Inc.

Technical training and extension are provided through Farmer Couple Training Centers (Centres de Perfectionnement Technique - CPTs), working with village cooperatives. The organization of cooperatives and the supply of imported inputs is carried out by the National Cooperatives Service Agency (Union Nigerienne de Credit et Cooperation - UNCC), and credit management by the UNCC and the National Agricultural Credit Bank (Caisse Nationale de Credit Agricole - CNCA).

As of 1985, results indicate that the extension system based on CPT training is not working and the animal traction package has not been particularly successful.

12. R.E. Project Descriptors:

Animal traction; Stoves; Food preparation.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications:

A. New Approaches to Animal Traction in Niger. Roger Poulin, David Gow, and Edward Scott, Development Alternatives, Inc., Washington, D.C., February 1984, 75 pp., PNAAT187.

This report discusses the need for animal traction equipment in the Niamey Department, blacksmithing services available to meet those needs, and the benefits and costs of using animal traction in Niamey. It also compares and contrasts animal traction usage with other areas of Africa. Information is based largely on a number of studies prepared for AID during the early 1980s. This analysis was made to determine if the Farm Equipment Enterprises Development (FEED) Project conceived by USAID/Niger was economically feasible; it was found not to be feasible under present conditions in Niger.

B. General project progress is discussed in the following reports:

In French:

Rapport Trimestriel Janvier a Juin 1985, 31 pp., PNAAV563.

Rapport Trimestriel d'Activite Cellule Appui aux Organisations Locales, 4eme trimestre 1985 - octobre a decembre 1985, H. Magagi Abdou & Hossein Naficy, 14 pp., PNAAV564.

Rapport Trimestriel No. 2 85/86, periode du 1 janvier au 31 mars 1986, Roman Imboden et al., Cellule de l'Artisanat Rural et du Machinisme Agricole, 9 pp., PNAAV566 (available only in paper).

Rapport Trimestriel d'Activites Cellule Appui aux Organisations Locales et Villageoises, 3eme trimestre 1986: avril-mai-juin, Hossein Naficy, 7/86, 9 pp., PNAAV567.

Rapport sur les Ex-Stagiaires et les Postulants Pour l'Annee 1985, Charles Routt, December 10, 1985, 25 pp., PDAAV568 (available only in paper).

Cellule de l'Artisanat Rural et du Machinisme Agricole: Rapport Annuel 1985, 21 pp., PDAAV565.

Rapport sur le Seminaire de Formation des C.V.D. du 12 au 15 mai 1986, Cellule Appui aux Organisations Locales et Villageoises, 6 pp., PDAAW991.

ARMA, N'Dounga: Atelier de Developpement de Prototypes, brochure, circa 1986, 8 pp., PDAAW990.

Etude sur les Organisations Locales Dans le Departement de Niamey: Rapport Final. Pr Hamidou A. Sidikou and Robert B. Charlick, Development Alternatives, Inc., Washington, D.C., October 1985, 174 pp., PDAAV569.

In English:

Quarterly Report, January - June 1986, Development Alternatives, Inc. (DAI), 8 pp., PDAAV561.

1985 Annual Report, DAI, 57 pp., PDAAV562.

15. Evaluations/Major Findings:

A. Niamey Department Development (NDD II): First Interim Evaluation. Richard Roberts, Theresa Ware, and Douglas Barnett, USAID, Bureau for Africa, Niamey, Niger, February 12, 1983, 194 pp., PDAAM817; PES, 17 pp., PDBAR687.

The evaluation team found that there is no conclusive evidence to prove that the technical package was the best set of practices for each of the agro-ecological zones within the Niamey Department. Rather, there was circumstantial evidence indicating that it was not appropriate for certain zones and, even where appropriate, it appeared to be profitable only during periods of normal rainfall. Even then, it appears marginally acceptable only when non-agronomic factors are considered, such as cartage and oxen resale.

Carts were found to be a popular element of the credit program. Ox and donkey carts were the widely adopted items in the technical package, used year-round for household purposes and as a source of revenue in non-agricultural uses, such as providing hauling fees and sales from commodities such as firewood, water, and hay. Animal traction was not highly regarded by the evaluation team. It was suggested that experiments be conducted (1) with animal traction using other than two oxen and (2) with manual labor only. Fifty-five recommendations are provided, including that special attention be given under the training and extension components to the benefits of the technical package exclusive of animal traction.

B. Niamey Department Development Project: Second Interim Evaluation. Roger J. Poulin, David Harmon, Thomas Painter, and Douglas Barnett, Development Alternatives, Inc., Washington, D.C., February 1985, 103 pp., PDBAX913 or PDBAV457.

The evaluation reports that the project emphasis has shifted from quantitative targets to institutional development, with some notable successes in the latter area (particularly in credit management and CPT training design improvement).

The evaluation contains an analysis by the project's agricultural economist on the progress made in adapting the animal traction technical package to the different climatic zones of Niamey Department. Due to time constraints, project personnel changes, and the 1984 drought, various studies were incomplete and the findings represent only preliminary results. Yield impact analysis for fields using animal traction versus those using only manual labor was not possible. Adoption rate of animal traction was low. The highest acceptance was in the Say arrondissement; however, the sample size was the smallest (22 parcels). The project engaged the services of a renowned animal traction specialist who suggested minor equipment modifications, directed two blacksmith training seminars, and will shortly make recommendations for improving the animal traction industry. The evaluation recommended that the first key issue that must be addressed is the technical package, making it appropriate and affordable. Furthermore, it recommended that the project define a farming systems research program to more systematically perform on-farm research for more productive methods of raising crops.

C. Development Management in Africa: The Case of the Niamey Department Project in Niger. AID Evaluation Special Study No. 36. Thomas M. Painter, Roger J. Poulin, David Harmon, and Douglas Barnett, USAID, December 1985, 91 pp., PNAAL069.

This study provides a thorough analysis of the project from an organizational and management perspective. In addition to many findings that have appeared in previous evaluations, the report notes that

- After years of using the same technical package with very limited results, the project is beginning to experiment with alternative agricultural techniques;
- NDD policy is shifting from a national rural development focus to one emphasizing village-level active participation; and
- Strengthening of local organizations, rather than the creation of new structures, may mean reduced effectiveness of implementation.

D. The Niamey Department Development Project in Niger Audit Report No. 7-683-83-2. Regional Inspector General for Audit, USAID, Abidjan, February 10, 1983, 58 pp., PDAAM358.

This report examines the progress of the Niamey Department Development Project as of early 1983. It covers both Phase I (6830205) and the first 18 months of Phase II (6830240).

Phase II was found to be experiencing serious implementation problems. CPT training still seemed inadequate to achieve farmer adoption of the technical package on their fields. Over 50% of the CPT graduates were found to be using less than 15% of the technical package. The accounting system was poorly designed, and, as a result, USAID/Niger suspended the credit fund at the recommendation of the Auditor General's office. The auditor stated the need for an evaluation to determine where the project was heading and what modifications were needed to achieve overall objectives. The report contains 20 recommendations.

E. 1985 Annual Report, Development Alternatives, Inc., Washington, DC, 57 pp., PDAAV562.

Although this can best be classified as a progress report, it includes a chapter on issues and problems facing the project, and another on the efforts on the part of DAI to fulfill the terms of the contract with the Government of Niger.

An extensive study was undertaken in 1985 by the monitoring and evaluation unit to measure the impact of the project, particularly relating to literacy and use of technical themes adopted by couples who had attended a CPT.

Concerning equipment, the study found that

- Ox carts, used for transporting baggage, wood, and other material, far exceeded the use of other equipment on a regular basis;
- A small percentage of the equipment is used on a regular basis, but 40% of the equipment needed some type of repair; and
- No regular repair service existed for the equipment.

As regards the animals:

- Care and feeding of the animals was highly dependent on climatic conditions; ex-trainees often could not afford to feed them or pay for needed veterinary services; and
- Two oxen were often desired.

As regards the technical package:

- Ex-trainees (84%) could generally explain the technical themes, but few (29%) actually applied some of them on a regular basis;
- Average cultivated area per ex-trainee was less than 3 hectares;
- A major reason given for non-use of the technical package was the lack of inputs, either due to unavailability or lack of resources to purchase them; and
- Regular technical follow-up by the agricultural field agents was found to be infrequent and superficial.

The study supported the contention that an extension system based on the CPT training concept is not working.

16. Key Persons:

A. AID/Washington:

Nancy McKay, Project Development Officer
(202) 647-6321

B. AID/Mission:

Kevin Mullally, Field Project Officer

C. Contractors:

Development Alternatives Inc.
624 Ninth Street, N.W., Washington, D.C. 20001, (202) 783-9110

D. Host Country:

Baoua Assoumane, Project Director
Niamey Department Development II

Ministere de Developpement Rural/Prefecture de Niamey
(project implementing agency)

17. Obligations by Fiscal Year (US$000):

FY 82	6,036
FY 83	2,500
FY 84	2,500
FY 85	5,092
FY 86	2,000

TOTAL	18,128*

*Total does not match LOP funding cited under No. 6, above.

(Source: Energy, Forestry, and Natural Resources Activities in the Africa Region, April 1986, PNAAW771)

18. Host Country Funding of R.E. Components (US$000): Not specified.

19. Summary of R.E. Costs (US$000):

ILLUSTRATIVE BUDGET PROPOSED IN DRAFT CONGRESSIONAL NOTIFICATION

Technical Assistance	5,468
Training	500
Construction	1,729
Commodities	4,362
Local Expenses	2,785

TOTAL	14,844

(Source: State Department telegram, 6/86, PDBBD274)

20. R.E. Component Revisions:

A. Following the 1982 national seminar on rural development strategies held in Zinder, Niger, which emphasized the need for rural populations to take more active responsibility for their development, the NDD policy shifted more toward village-level interventions. The outcome of this shift was unclear as of early 1986.

(Sources: Second Interim Evaluation, 2/85, PDBAV457; and AID Evaluation Special Study No. 36, 12/85, PNAAL069)

B. Because of poor adoption of the technological package, experimentation on variation of techniques and prototype animal traction equipment was begun to determine a more

appropriate package to meet the different climatic conditions found in the project site.

(Sources: Second Interim Evaluation, 2/85, PDBAV457; and AID Evaluation Special Study No. 36, 12/85, PNAAL069)

C. USAID/Niger suspended funding of the NDD project credit fund in October 1982 as a result of the U.S. Auditor General's report which found it impossible to determine the flow of inputs provided by the project to farmers on credit. Considerable improvements in the credit component were subsequently achieved.

(Sources: Second Interim Evaluation, 2/85, PDBAV457; and AID Evaluation Special Study No. 36, 12/85, PNAAL069)

D. PACD extended to December 31, 1987.

(Source: Phone conversation of 9/10/86 with George Jones, AID Niger desk office.)

E. A draft Congressional Notification proposes to extend the PACD until December 1988 to permit consolidation of the work undertaken under NDD I and II projects and to complete work on adaptation of technical packages, to affirm sustainability of the extension system, and to confirm that the cooperative system is self-supporting.

(Source: State Department telegram, 6/86, PDBBD274)

F. A draft Congressional Notification proposes to increase LOP funding by $1.262 million to $14,844 million.

(Source: State Department telegram, 6/86, PDBBD274)

G. An animal traction and rural artisan cell (ARMA-Artisanat Rural et Machinisme Agricole) was incorporated in the project to undertake R&D on development and adaptation of new animal traction equipment, training of rural artisans, and testing of prototype equipment. In 1986 ARMA made more than 200 yokes for the CPT training centers and the CVF village training centers. Many of the personnel and material resources that DAI expected for this unit were either reduced or eliminated, however, limiting implementation by the unit.

(Source: 1985 Annual Report, DAI, PDAAV562; ARMA, N'Dounga: N'Dounga: Atelier de Developpement de Prototypes brochure - in French, circa 1986, PNAAW990)

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21. Follow-On Activities:

    A. A follow-on Phase III has been planned, and an RFP issued.

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: September 1986 (jrl)
    Revised February 1987 (jrl)

1. Project Number: 6850201 2. Geo: SENEGAL

3. Title: SENEGAL CEREALS PRODUCTION PROJECT

4. Project Life/PACD: 1975-78(extended to 79)/December 31, 1979

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 6,746*
   4,750**

   B. R.E. Components: Not specified

   (Sources: *DIS; **Audit Report No. 0-685-81-50 by the U.S. Inspector General, 3/6/81, p.5, PDAAH457; and Amendment No. 6, 11/29/79, PDBAG389)

7. Loan or Grant/Appropriation Category (US$000):

   G / DR / 3,847
   G / FN / 2,000
   G / SH / 899

   (Source: DIS)

8. Project Purpose:

   To assist the Government of Senegal (GOS) achieve a higher, self-sustaining level of productivity in the agricultural sector; To support efforts of the Senegalese implementing agency, SODEVA, to diversify and intensify productivity in the West Central Region of Senegal's Groundnut Basin.

9. Renewable Energy (R.E.) Outputs:

   Artisans trained in building implements; Animal traction implements built; Oxen trained; Farmers trained in animal traction techniques.

10. R.E. Inputs:

   Salaries; Technical assistance; Training; Commodities.

11. Summary of R.E. Components:

The aim of the project was to increase agricultural production/productivity by promoting the use of improved seed varieties, farming methods, and higher levels of technology. The lowest technology level (TL - Themes Legers) included use of improved light implements for donkey and horse traction, plus light fertilizer. The intermediate package (TB - Traction Bovine) included the introduction of oxen traction with heavier implements, plus heavier fertilizer applications. The highest technology level (TBFF - Traction Bovine et Fumure Forte) contained the most extensive use of oxen traction, a large array of equipment, and heavy fertilizer application.

The Societe d'Assistance Technique et de Cooperation (SODEVA), a semi-autonomous agricultural development and extension organization, and the Centre National de Recherches Agricoles (CNRA) - a division of the Institut Senegalais de Recherches Agricoles (ISRA) - were the principal GOS implementing agencies. The Office National de Cooperation et d'Assistance au Developpement (ONCAD) was responsible for providing many of the inputs to farmers, such as implements and fertilizers.

12. R.E. Project Descriptors:

Animal traction.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings:

A. Evaluation of the Senegal Cereals Project. Fran J. LeBeau, February 11, 1978, 22 pp., PDAAC150E1.

The evaluator found that "More success has been achieved with the TL (lowest level of technology package) levels." However, it is stated that it was too early to ascertain effects on production as data on yields were not yet available.

It was observed that the number of oxen in use exceeded the amount of heavy equipment available. Moreover, the average pair of oxen plowed only .75 hectares, as oxen were being used with light equipment, yielding less than effective results.

B. Programme de Vulgarisation Agricole et de Production Cereales au Senegal, Rapport d'Evaluation Campagne 1975-76 Perspectives 1976-77 (in French). SODEVA, Dakar, Senegal, April 1976, 76 pp., PDBAG397.

For the 1975/76 campaign, the number of agricultural concerns using the three traction packages was 57% more than the goal (10,381 opposed to 6,610). However, only 56% and 96% were attained for the intermediate (TB) and highest (TBFF) technology packages, respectively, while the simplest (TL) technical package reached 178% of its goal.

The start-up of oxen traction had serious delays. 1,340 oxen teams, 89% of the goal, were trained by the end of the 1975/76 campaign. Goals would have been reached, had there not been considerable losses, 90% of which were due to sales for slaughtering. Consequently, the number of heifers, which have the advantages of giving milk, bearing calves, etc., will be increased, hopefully encouraging farmers to retain them. Although the number of oxen in use was fairly satisfactory, the actual utilization of the oxen pairs was poor.

C. Evaluation Economique du Projet Cerealier Moyen Terme Sahel (in French). SODEVA, Dakar, Senegal, August 1978, 49 pp., PDBAG398.

This study presents the results of an economic analysis of the revenues generated from farm operations using the three different technology packages for the Thies, Bambey, and Diourbel departments during the 1975/76, 1976/77, and 1977/78 campaigns. Income from sales of peanuts and millet accounted for total revenues. The simplest technology package (TL) was considered equal to traditional farming practices, since both were nearly identical in use of fertilizer, equipment, crop yields, and revenues. Revenues per hectare increased with the use of successively higher technology packages, although the increases were slight in the 1977/78 season.

D. Etude des Rendements et des Revenus Moyens Par Exploitation Pour le Mil et l'Arachide (in French). SODEVA, Dakar, Senegal, January 1979, 34 pp., PDBAG603.

A statistical analysis showed that for 1977 there was no difference in average yield for peanuts among farms using the three technology packages, TL, TB, and TBFF. They all suffered the ill effects of the drought. General average yield was 140 kg/hectare. As for average millet yield, TBFF farms averaged 390 kg/hectare; TB farms, 280 kg/ha; and TL farms, 270 kg/ha. The superior yield for TBFF farms, however, was not statistically significant because of the high coefficient of variation.

E. Senegal Cereals Production Project Evaluation Report. W.H.M. Morris, Robert L. McDill, and W. Davis, March-April 1977, 107 pp., PDAAT685.

The evaluation indicates that a limited supply of inputs, particularly plows, double hitches, tool frames, and fertilizer, made it difficult or impossible for farmers to adopt the whole technical package. Selling oxen for butchery became very profitable over the 2-3 year period preceding the evaluation. Farmers who had oxen were using them with horse equipment due to unavailability of oxen equipment. A study in the Bambey department in 1975 reported that 6% of the farmers had oxen; there was less than 1 cart per 6 pair of oxen; only one pair of oxen in 12 were on a farm with a plow; only one pair in 10 were on a farm with a double hitch (used to pull 2 or 3 seeder units); and only about one pair in 13 were on a farm with a multipurpose tool frame. The liaison group revealed that farmers using oxen in this less-than-optimal fashion did not receive higher income from crop production on a per worker or a per hectare basis. The survey also indicated that there was an average of almost 1 horse and 0.5 donkey per farm in the Bambey department; that one farm in four had a horse cart; and that 70% of the farmers used fertilizer. The evaluation team noted that a total of 1,011 pair of oxen were trained in 1975-76, and 1,860 pair during the 1976-77 period.

16. Key Persons:

A. AID/Washington:

Dennis Baker, AFR/CWR

B. AID/Mission:

Robert L. McDill

C. Contractors: Not specified

D. Host Country:

Societe d'Assistance Technique et de Cooperation (SODEVA)
92 Rue Blanchet, Dakar, Senegal

Chief of the Liason Unit
National Center for Agriculture Research - Centre
National de Recherches Agricoles (CNRA)

Office National de Cooperation et d'Assistance au
Developpement (ONCAD)

17. Obligations by Fiscal Year (US$000):

Projected Cost Summary For Entire Project*

1974	1975	1976	1977	TOTAL
506.4	1,030.6	1,334.6	1,128.3	4,000

*Does not reflect adjustments to LOP funding.

(Source: Noncapital Project Paper, Exhibit A, PDAAC149 or PDBAG388)

18. Host Country Funding of R.E. Components (US$000): 2,100*

*For entire project; R.E. costs not specified separately.

(Source: Noncapital Project Paper, PDAAC149 or PDBAG388)

19. Summary of R.E. Costs (US$000):

Projected Cost Summary*

Construction	427.3
Equipment	47.4
Material/supplies for demonstration and training	55.6
Personnel	1,438.6
Operating costs	420.9
Training program	203.1
Special projects	243.3
Contingencies and/or possible expansion in other districts	562.6
Applied research activities	552.2
Other contingencies	48.8
TOTAL	3,999.8**

*For entire project; R.E. costs not specified separately.
**Does not reflect adjustments to LOP funding.

(Source: Noncapital Project Paper, Exhibit A, PDAAC149 or PDBAG388).

20. R.E. Component Revisions:

A. Due to technical questions that had to be resolved, uncertain funding levels for all Sahel projects, and the considerable amount of coordination and discussion needed for a project of this magnitude, six months elapsed between the submission of the Noncapital Project Paper (PROP) and project funding approval. During this time, some revisions took place. Consequently, although the PROP stated $4 million as total AID contribution, $3,815,000 was actually authorized. $3,358,000 was to be obligated in FY75, while the remaining $457,000 was to be obligated in FY78. The project life was extended from 3-1/2 to 4 years.

(Source: Action Memorandum for the Administrator, 12/20/74, PDBAG388 or PDAAC149)

B. In September 1975, AID authorized an additional $500,000 for a "Promotion Humaine" component. This component had three parts, one of which was training rural artisans in the production of simple farm equipment, such as ox-yokes and metal plows.

(Source: Project Paper Facesheet, Addition one, 9/29/75, PDAAC150)

C. LOP funding increased by $300,000.

(Source: Amendment No. 2 to the Grant Agreement, 6/78, PDBAG389)

D. LOP funding increased by $598,500.

(Source: Amendment No. 5 to the Grant Agreement, 8/23/79, PDBAG389)

E. PACD extended to November 30, 1979, and then to December 31, 1979.

(Source: Amendment No. 5 to the Grant Agreement, 8/23/79, PDBAG389; Amendment No. 6 to the Grant Agreement, 11/29/79, PDBAG389)

21. Follow-On Activities:

On December 18, 1979 AID authorized $7.7 million for a phase II Senegal Cereals Production Project (No. 6850235). It provides for the continuation of support for expanded extension service in the departments of Thies, Bambey, and Diourbel as well as expansion of activities into the adjacent departments of Tivaouane and M'Backe.

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: August 1986 (jrl);
Revised February 1987 (jrl)

---------- AID RENEWABLE ENERGY DATA BASE ----------

1. Project Number: 6850208 2. Geo: SENEGAL

3. Title: BAKEL SMALL IRRIGATED PERIMETERS PROJECT

4. Project Life/PACD: 1977-80(extended to 85)/December 31, 1985

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 8,574

   (Source: DIS)

   B. R.E. Components: 700*

   *Represents solar pump component only.

   (Source: Project Paper Amendment, 2/23/78, p. 14, PDAAP437)

7. Loan or Grant/Appropriation Category (US$000):

   G / FN / 4,200
   G / SH / 4,374

   (Source: DIS)

8. Project Purpose:

   To introduce the technologies of irrrigated agriculture in the Bakel area of Eastern Senegal and demonstrate the feasibility, both technically and economically, of irrigation in the area; To test the feasibility of using a solar pumping system in a rural area of a developing country.

9. Renewable Energy (R.E.) Outputs:

   Data on the technical field performance, reliability, ease of maintenance, social implications, and cost-effectiveness of a 30 kW solar thermal water pumping system.

10. R.E. Inputs:

    Commodities (specifically, a 30 kW solar thermal water pump); Technical assistance; Sociological survey.

11. Summary of R.E. Components:

This project was concerned with the introduction of small-scale irrigated agriculture in villages along the Senegal River near Bakel, with improved practices for traditional dryland crops, and with expanded health services. Animal traction was a small component.

A solar pump component was added in February 1978 as a result of discussions in 1977 among various parties in Senegal, France, and the U.S., including the National Society for the Development and Exploitation of the Senegal and Faleme River Basins (SAED), the project's Senegalese implementing agency. SOFRETES, a French firm that had developed a solar thermal water pump, and Thermo Electron Corporation (TECO), an American firm specializing in heat transfer technologies, prepared a proposal for jointly manufacturing the pump and incorporating it into the Bakel project. They submitted the proposal to the Government of Senegal, which turned to USAID and the French Government's counterpart, FAC, for funding.

SOFRETES was responsible for all aspects of the solar plant project management. TECO was responsible for producing and testing certain pump components. The Senegalese National Industrial Company for Solar Energy Applications (SINAES) was a local subcontractor.

Total cost for the solar pump project was to be $1,495,000, with AID and the FAC each providing $625,000 for provision of the pump, AID furnishing an additional $75,000 for studies of social and financial impacts, and Thermo Electron cost-sharing of $170,000. However, serious delays and cost overruns plagued the project.

Although the pump was designed to provide enough water to irrigate 200 hectares, by 1982 it was conceded that it was only capable of irrigating 32 hectares when operating at top efficiency. Furthermore, top efficiency could only be achieved if the glass covers of the solar collectors, situated on the roof of the project headquarters, were kept dust free, an impossible task for that location on the edge of the Sahara. In addition, due to enormous amounts of material needed to construct the large solar collector array, it was admitted that projected cost reductions could not be realized. Three options were presented to complete the unfinished pump, all requiring more than half a million dollars in additional funding. It was decided in early 1983 that all work would cease on the pump.

(Sources: AID Evaluation Special Study No. 34, pp. A-9 and A-10, PNAAL067; Project Paper Amendment, 2/23/78, PDAAP437; Outgoing Telegram, 5/82, PDBAL589; Memo of 12/13/82 from Clarence Kooi, "Comments on Future Prospects for the Bakel

Solar Pump," PDBAL590; and Project Status Report and Proposal for Completion with Reduced Work Scope, TECO, 4/27/82, PDBAL607)

12. R.E. Project Descriptors:

Irrigation; Solar energy; Water pumps; Animal traction; Solar collectors; Solar thermal energy.

13. R.E. Technology Applications:

A. Designed and began installation of a 30 kW solar thermal water pump, consisting of a 1,868 cu. m. (20,100 sq. ft.) flat-plate collector, a Freon-driven Rankine-cycle heat engine, a small electrical generator, a water pump, and a hot water storage system. The original design called for a direct mechanical linkage pump-driving mechanism; SOFRETES changed this to an electrical generator/motor unit with electric water pump, with an estimated associated 30% loss in pumping capacity. The pump was designed initially to produce 287 kWh/day net, enough power to pump a daily average of 1.7 million gallons (6,400 cu. m.) of water and 4.7 kWh of electricity for system use and for power needs at SAED headquarters. SOFRETES decided to (1) add a second electric pump to assist system start-up and (2) drop electrical energy supply to SAED. Later recalculations determined that the pumping facility would be capable of pumping only 3,460 cu. meters per day.

(Sources: Trip Report, Glen Brandvold, 10/79, PDBAL604; Memo of 2/25/82 from John McMahon, "Bakel Solar Pump - Objectives and Commitments of AID," PDBAE819; Memo of 12/13/82 from Clarence Kooi, "Comments on Future Prospects for the Bakel Solar Pump," PDBAL590; and Project Paper Amendment, 2/23/78, PDAAP437)

B. An analysis performed by Sandia Laboratories of the initial design being developed by SOFRETES identified the following nominal characteristics (based on average values) of the solar thermal engine pumping system:

Turbine Inlet: 187 degrees F., 86 psia
Condenser Outlet: 97 degrees F., 8.1 psia
Heat Input (R11-the working fluid-data): 1.31 x 1,000,000 Btu/hr (383 kW-therm)
Heat Input (Water data): 1.50 x 1,000,000 Btu/hr (439 kW-therm)
Gross Turbine Gearbox Output: 39.7 kW-mech
Engine Mechanical Parasitics (estimated if turbine driven):
R11 Boiler Feed Pump: 1.8 kW-mech
Hot Water Circulating Pump: 2.7 kW-mech

(does not include collector hot water circulating pump)
Cold Water Circulating Pump: 4.1 kW-mech
Engine Electrical Parasitics: Negligible
Gross Engine Efficiency: 9.0% (based on water data)
Net Engine Efficiency: 7.0% (based on water data)

(Source: Letter of 11/29/79 from J.P. Abbin to G.E. Brandvold, both of Sandia Laboratories, PNAAW779)

14. R.E. Technical Reports and Publications:

A. "Analysis of Test Data on Bakel Pump System", letter of November 29, 1979 from J.P. Abbin to G.E. Brandvold, both of Sandia Laboratories, PNAAW779.

This one-page letter with additional one-page schematic attachment describes the characteristics of the original design of the solar thermal water pump being developed by SOFRETES; a summary of the test data and analyses is based on average values. See 13 B. above for actual data.

15. Evaluations/Major Findings:

A. Development Management in Africa: The Case of the Bakel Small Irrigated Perimeters Project in Senegal, AID Evaluation Special Study No. 34. Matt Seymour, Laura McPherson, and David Harmon, AID, Washington, DC, December 1985, 112 pp., PNAAL067.

The solar thermal water pump took up management time, accounted for approximately 10% of project costs, and ultimately proved to be unoperational. See last paragraph of summary, Number 11, above, for evaluation findings.

B. Memo: "Bakel Solar Pump - Objectives and Commitments of AID", John McMahon, AID Agricultural Development Office, Washington, DC, 2/25/82, 9 pp., PDBAE819.

Although not an evaluation, this report provides an excellent review of the correspondence, reports, and evaluations concerning the solar water pump project component, its objectives, and USAID commitments as of early 1982.

The author felt that, in view of the present stage of development, no significant savings could be achieved from termination of the project, while diversion of equipment could result in additional costs. It was acknowledged that differing opinions on the appropriateness of this technology abounded, and

this divergence could be resolved only by careful monitoring and documentation of both the advantages and the disadvantages of the technology; AID was committed to that effort.

C. Project Review For Bakel Small Irrigated Perimeters. Jack Keller et al., Water Management Synthesis Project/Utah State University, Logan, Utah, January 1982, WMS Report 9, 167 pp., PDBAE879.

The evaluation team concluded that the solar pump facility required extensive use of imported materials, a high level of technical expertise to operate, and considerable maintenance, which precluded it from ever being economically viable. The solar pump was considered for (1) the value of the electric power it could produce and (2) its water pumping cost compared with diesel water pumping. It was estimated that the entire potential energy output from the solar plant could be produced by a diesel-powered unit for a current capital plus operating cost of not more than $15,000/year. The evaluation team recommended that the solar pump project be terminated as soon as politically feasible.

16. Key Persons:

A. AID/Washington:

Cameron Pippitt
AFR/PD/SWAP, 2733A NS, 647-8242

Henderson Patrick
AFR/PD/SWAP

Rose Marie Depp

B. AID/Mission:

Mamadou Ndaw, Project Field Manager
Joseph Salvo, former Project Field Manager
John McMahon, former Project Manager
USAID/SENEGAL, B.P. 49, Dakar, Senegal

C. Contractors:

Dr. Ravi Sakhuja, Manager for Bakel Project
Dr. Walter J. Bornhorst, Manager-Solar Sytems
Dr. Arthur Ruggles
Thermo Electron Corporation, P.O. Box 9046, Waltham, MA 02254-9046
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Mr. Jean-Pierre Girardier, President
Mr. Marc Verget, Manager
Societe Francaise d'Etudes Thermiques et d'Energie Solaire (SOFRETES), Zone Industrielle d'Amilly, B.P. 163, 45203 Montargis, France

Glen E. Brandvold, Manager, Solar Energy Projects
(Served as AID's technical consultant throughout project)
Sandia National Laboratories, P.O. Box 5800, Albuquerque, NM 87185 (505) 844-5875

D. Host Country:

Mr. Djibril Sene
Senegalese Government Organization for Scientific & Technical Research (DGRST - Delegation Generale de la Recherche Scientifique et Technique)

Mohamed Ali Toure, Director
Senegalese National Industrial Company for Solar Energy Applications (SINAES - Societe Industrielle des Applications de l'Energie Solaire)

Mr. Jean Jacques
Mr. Pierre Diouf
The National Society for the Development and Exploitation of the Senegal and Faleme River Basins (SAED - Societe Nationale d'Amenagement et d'Exploitation des Terres du Fleuve Senegal et des Vallees du Fleuve Senegal et de la Faleme)

17. Obligations by Fiscal Year (US$000):

Projected Expenditures For Entire Project*

	FY1	FY2	FY3	FY4	TOTAL
AID	3,458	1,238	1,002	161	5,859
GOS	366	476	607	683	2,132

*Does not reflect adjustments to original LOP authorization.

(Source: Project Paper, 5/15/77, PDBAE814 or PDBAU427)

18. Host Country Funding of R.E. Components (US$000): 2,400*

*For entire project; R.E. costs not specified separately.

(Source: AID Evaluation Special Study No. 34, 12/85, p. viii, PNAAL067)

19. Summary of R.E. Costs (US$000):

Solar pump components:		
$ costs	520	
Local costs	105	
SUBTOTAL		625
Studies and evaluation:		
Social impact study	60	
Financial and cost-benefit analyses	15	
SUBTOTAL		75

TOTAL		700

(Source: Project Paper Amendment, 2/23/78, p. 15, PDAAP437)

20. R.E. Component Revisions:

A. The original title, "Bakel Crop Production Project," was changed, as was the project purpose. The solar pumping system component was incorporated into the project purpose in July 1978.

(Source: AID Evaluation Special Study No. 34, 12/85, p. viii, PNAAL067)

B. $700,000 was added in March 1978 to the original LOP grant authorization of $5,859,000 in order to finance the solar pump component. LOP funding was further increased to $8,199,000. (This differs from the DIS, which indicates $8,574,000.)

(Sources: Action Memorandum to the Assistant Administrator, undated, PDBAL587; Implementation Report, 9/30/85, PDBBB009)

C. PACD extended to December 31, 1981, to December 31, 1982, to December 31, 1983, to June 30, 1984, and finally to December 31, 1985.

(Sources: Action Memorandum for the Acting Mission Director, 6/23/83, PDBAL587; Amendment No. 10 to the Grant Agreement, 8/8/84, PDBAT418)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: August 1986 (jrl)
Revised February 1987 (jrl)

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1. Project Number: 6850219 2. Geo: SENEGAL

3. Title: SENEGAL FUELWOOD PRODUCTION - PHASE I

4. Project Life/PACD: 1979-83(extended to 84)/December 31,1984

5. Status: Terminated

6. LOP Funding (US$000):

   A. Entire Project: 3,434

   B. R.E. Components: 3,434

   (Source: Project Evaluation Summary, 5/10/83, PDAAN330)

7. Loan or Grant/Appropriation Category (US$000):

   G /SH / 3,434

   (Source: DIS)

8. Project Purpose:

   To improve efficiency of firewood production for Dakar/Thies and help stabilize seasonal fluctuations in supply and price; To provide employment, improve general environment and revenues for Thies region local timbercutters and villagers; To reduce pressure on upcountry forest cutting.

9. Renewable Energy (R.E.) Outputs:

   Production of fast-growing tree species; Stabilization of charcoal supply and price in urban areas of Thies and Dakar; Development of Senegalese expertise in the management of fuelwood projects; Development of an extendable fuelwood production system; Some local forestry development at the village level.

10. R.E. Inputs:

    Technical assistance; Commodities; Training; Research; Soil surveys; Labor.

11. Summary of R.E. Components:

    The original project envisioned the planting of 3,000 hectares of fast-growing tree species over a four-year period. Decree No. 006236 of June 21, 1982, of the State

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Secretariat for Inland Fisheries and Forests (SEEF) placed management of the project in the hands of the Projet Autonome pour le Reboisement de la Foret de Bandia (PARFOB), except for research. Research was conducted by the National Forestry Research Center (CNRF), as established in a formal agreement between the Direction Generale des Eaux et Forets (DGEF) and the Institut Senegalais de Recherches Agricoles (ISRA), CNRF's parent institution. There was a training component for advanced degrees in forestry in the U.S. and elsewhere in Africa as well as in-country training. A detailed soils survey was performed by the USDA Soil Conservation Service under a Participating Agency Service Agreement. Moreover, PARFOB collaborated with the Societe de Developpement et de Vulgarisation Agricole (SODEVA) to provide seedlings and assistance to help establish village woodlots.

The project succeeded in planting only 1,850 hectares by the PACD. It was plagued with many problems concerning AID financing, GOS financing, contracting of services, procurement of imported and local equipment and goods, short-term technical assistance, and inadequate maintenance of the heavy equipment. The cost was high, averaging $808 per hectare established and maintained at the end of the project's third year, not including depreciation costs of approximately $1 million worth of equipment and installations. An expected negative internal rate of return on the project's direct costs indicated the infeasibility of investing resources in fuelwood plantations in this limited rainfall regime. An energy input/output analysis revealed that the money spent in fuel alone for the plantation operation could purchase 84% of the butane equivalent of the plantation's energy production. Consequently, plantation operations were stopped at the end of 1983, and funds were allocated to continue research and plantation maintenance.

(Sources: Third Year Evaluation, 4/83, PDAAN330 or PDBAN121; End of Project Completion Report, 8/6/85, PDBAX511)

12. R.E. Project Descriptors: Firewood.

13. R.E. Technology Applications:

During the period 1980-1982, the following number of hectares of tree species were planted in the Bandia Forest:

Eucalyptus camaldulensis	1,359
Prosopis juliflora	126
Azadirachta indica (Neem)	30
Cassia siamea (in association with eucalyptus)	33
Melaleuca leucadendron (Niaouli)	7

(Source: Third Year Evaluation, 4/83, p. 3, PDAAN330 or PDBAN121)

14. R.E. Technical Reports and Publications:

A. Reforestation in the Republic of Senegal: Framework, Description and Analysis. Chun K. Lai, New Haven, Connecticut, May 1984, 152 pp., PNAAW775.

The Senegal National Reforestation Program is reviewed, and 20 current reforestation projects described and analyzed. This study, underwritten by a Fulbright Grant, is based on original field data collected in Senegal from October 1982 to August 1983 and on complementary research undertaken at the Yale School of Forestry and Environmental Studies.

Among the 20 projects described are the following AID-funded projects: Senegal Fuelwood Production - Phase I (No. 6850219); Africare Reforestation OPG (No. 6850243); and Village Woodlot Firewood Production (No. 6850247).

15. Evaluations/Major Findings:

A. Third Year Evaluation of the Senegal Fuelwood Production Project 685-0219. Peter Freeman et al., April 1983, 241 pp., PDAAN330 or PDBAN121.

Organizational, management, and logistical requirements for the project were underestimated by the project design document, and this caused delays during the project's first year (1981). Moreover, growth rate was extremely overestimated. Actual measurements amounted to only 1.5 cu. m. per hectare per year, as compared to the 10 cu. m. per hectare per year projected. This was due to a combination of reasons including lower than anticipated rainfall (320 - 445 mm annual for 1980-82 compared to 500 - 700 mm assumed), less tree plantation density than planned, and seedling mortality. Costs were also higher than expected. Project growth rates and cutting trials corroborate the recent consensus among Sahelian foresters that it is not worthwhile to grow Eucalyptus below 800 mm. of rainfall.

Recommendations were made, including that AID not finance a Phase II, since rainfall was insufficient in the project zone; that plantation work continue through the 1983 season; and that AID provide financial support at a reduced level for plantation maintenance, for continuation of ongoing research on various aspects of plantation establishment and maintenance, and for an economic and management study of the plantation.

16. Key Persons:

A. AID/Washington:

Cameron Pippitt
AFR/PD/SWAP, 2733A NS, 647-8242

B. AID/Mission:

Daby Diallo, Field Project Officer
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C. Contractors:

Roger Jones, Project Manager
P.O. Box 1864, Window Rock, Arizona 86515

David Campbell Gibson, PARFOB Co-Director
1860 Bay Road, No. 106, Vero Beach, Florida

Peter Freeman, former part-time PARFOB Co-Director,
consultant at AID/S&T/Forestry, 235-2245

D. Host Country:

Mr. Sidibe, Director
Mr. Idrissa Mbaye, Assistant Director
Projet Autonome de Reboisement de la Foret de Bandia
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Centre National de Recherches Forestieres (CNRF)
Hann-Dakar, Senegal

Mr. El Hadj Sene, Director
Direction Generale des Eaux et Forets (DGEF)
Parc National de Hann
B.P. 1831
Hann-Dakar, Senegal

Inspection Regionale des Eaux et Forets
B.P. 146
Thies, Senegal

Abdoulaye Kane, former Chef de Reboisement at DGEF now
"conseiller technique" at the Secretariat D'Etat aux Eaux
et Forets

17. Obligations by Fiscal Year (US$000):

Fiscal Year	Amount
1979-80	2,104
1981	730
1982	600

TOTAL	3,434

(Sources: Amendment No. 3 to the Grant Agreement, Annex A, 9/27/82, PDBAN118; Amendment No. 2 to the Grant Agreement, Annex A, 12/18/80, PDBAN118)

18. Host Country Funding of R.E. Components (US$000): 779*

*For entire project; R.E. costs not specified separately.

(Source: Project Paper, 2/5/79, PDAAG149 or PDBAE882)

19. Summary of R.E. Costs (US$000):

ITEM	EARMARKINGS
Commodities	896.274
Contracts	620.499
Participant Training	198.025
Direct Reimbursement	83.511
OP. Account/Local	1,502.050
Joint Projects Costs	69.475
Other	6.949
TOTAL EARMARKINGS	3,376.783
TOTAL OBLIGATIONS	3,434.000 - 57.217 de-obligated

(Source: End of Project Completion Report, 8/6/85, PDBAX511)

20. R.E. Component Revisions:

A. PACD extended to December 31,1984.

(Source: End of Project Completion Report, 8/6/85, PDBAX511)

B. $57,216.99 was deobligated.

(Source: End of Project Completion Report, 8/6/85, PDBAX511)

C. The project's financial problems, lack of rainfall, and unrealistic planting projections resulted in the ruling out of Phase II. After the third year evaluation, personnel was reduced, and operations were adjusted downward. A maintenance budget was established, pending dispersal of Title III funds, to cover the protection and management of existing plantations.

(Sources: End of Project Completion Report, 8/6/85, PDBAX511; Implementation Letter No. 12, 6/1/84, PDBAT426)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: August 1986 (jrl)
Revised February 1987 (jrl)

1. Project Number: 6850243 2. Geo: SENEGAL

3. Title: AFRICARE REFORESTATION OPG

4. Project Life/PACD: 1980-81/December 31, 1981

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 126.23

   B. R.E. Components: 126.23

   (Source: Grant Agreement, 5/28/80, PDAAG828)

7. Loan or Grant/Appropriation Category (US$000):

   G / SH / 126.23

   (Sources: Grant Agreement, 5/28/80, PDAAG828; and DIS)

8. Project Purpose:

   AFRICARE will assist the Government of Senegal and inhabitants of rural areas to establish individual woodlots of approximately 20 hectares in each of five participating villages.

9. Renewable Energy (R.E.) Outputs:

   Establishment of village woodlots.

10. R.E. Inputs:

    Commodities; Administrative support; Technical support.

11. Summary of R.E. Components:

    An Operational Program Grant was provided to Africare to assist the Forest Service of the Government of Senegal with a two-year project in establishing individual woodlots of 20 hectares in each of five participating villages in the Regions of Thies and Kaolack. The major purpose was to produce firewood, while at the same time contribute to the improvement of soil quality, the alleviation of soil erosion, and protection against drought. Village nurseries were to be

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established, and free, voluntary labor was to be provided by the villagers for the planting, maintenance, and protection of the seedlings.

Since the agreement was signed just before the 1980 planting season, the Forest Service decided to forego the establishment of village nurseries and instead use seedlings from regional nurseries in order to begin planting immediately. The Forest Service, local administrative agents, and the local population represented by Rural Community Councils, all aware of a possible impending project, cooperated admirably to plant 70 hectares in the Kaolack region and 10 in Thies in only a six-week period. Government equipment (tractors, trucks, etc.) were supplied when needed to break bottlenecks that occurred in this well-orchestrated self-help effort. Subsequent tree maintenance was excellent. Survival rate exceeded 90%. An additional 110 hectares were planted the following year, resulting in nearly 200% of the projected area planted. Some of the two-year old trees were over 2 meters tall at the end-of-project evaluation. Eucalyptus camaldulensis was the major species planted, while Anacardium occidentale was planted in some villages as windbreaks.

12. R.E. Project Descriptors: Firewood.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications:

    A. Reforestation in the Republic of Senegal: Framework, Description and Analysis. Chun K. Lai, New Haven, Connecticut, May 1984, 152 pp., PNAAW775.

    The Senegal National Reforestation Program is reviewed, and 20 current reforestation projects described and analyzed. This study, underwritten by a Fulbright Grant, is based on original field data collected in Senegal from October 1982 to August 1983 and on complementary research undertaken at the Yale School of Forestry and Environmental Studies.

    Among the 20 projects described are the following AID-funded projects: Senegal Fuelwood Production - Phase I (No. 6850219); Africare Reforestation OPG (No. 6850243); and Village Woodlot Firewood Production (No. 6850247).

15. Evaluations/Major Findings:

End of Project Evaluation: Africare Reforestation in Five Rural Villages. Fred R. Weber, December 8, 1981, 17 pp., PDAAN118.

The project was found to be a major success. 190 hectares of trees were planted, some 90% more than the production goal. Survival rate exceeded 90%. Cost per hectare for USAID and Forest Service inputs was estimated at $770 (not counting a $150/hectare estimated value of the free self-help villager labor), considerably lower than for most large industrial plantation projects. Possibility for replicability elsewhere was rated as very good.

However, none of the participants viewed firewood production or woodlot establishment as the goal. They viewed the trees as a source of income generation (sale for construction, poles, pickets, etc.) to directly benefit the rural community. Distribution of benefits remained undefined at the end of the project, and the outcome would have to await the first harvesting.

16. Key Persons:

A. AID/Washington:

Joel Schlesinger, Program Manager

B. AID/Mission:

John Balis, Project Officer
Carol Ulinski, Contract Project Officer, USAID Project Manager

C. Contractors:

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Dakar, Senegal

D. Host Country:

Service of Waters and Forests (SWF - Service Eaux et Forets)

17. Obligations by Fiscal Year (US$000):

Projected Budget By Year
(FY not stated)

YR 1	YR 2	TOTAL
87.179	39.051	126.23

(Source: OPG Grant Agreement, 5/28/80, PDAAG828)

18. Host Country Funding of R.E. Components (US$000): approx. 38*

*Estimated for entire project funding.

(Source: End of Project Evaluation, 12/8/81, p. 3, PDAAN118)

19. Summary of R.E. Costs (US$000):

Projected Summary of Costs

Salaries (Local)	
Laborers	10.584
Guardians	32.960
Forestry Agent Per Diem	7.718
Agricultural Supplies	30.090
Nursery Construction	15.899
Other Direct Costs	2.535
Overhead	26.444

TOTAL	126.230

(Source: OPG Grant Agreement, 5/28/80, PDAAG828)

20. R.E. Component Revisions: Not specified

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: August 1986 (jrl)
Revised February 1987 (jrl)

1. Project Number: 6850247 2. Geo: SENEGAL

3. Title: VILLAGE WOODLOT FIREWOOD PRODUCTION

4. Project Life/PACD: 1980-82(extended to 83)/December 31, 1983

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: 211

   B. R.E. Components: Not specified

   (Source: Quarterly Implementation Report, 9/30/83, PDBAR508)

7. Loan or Grant/Appropriation Category (US$000):

   G / SH / 211

   (Source: Requests For Allotments, 9/9/80, PDBAF190)

8. Project Purpose:

   To undertake community forestry activities (woodlots, agro-forestry, windbreaks, and fruit trees) in 40 participating villages in the Diourbel Region of Senegal.

9. Renewable Energy (R.E.) Outputs:

   Village firewood woodlots and nurseries established; Development and testing of a formula for establishing small, inexpensive village woodlots using voluntary, self-help village labor.

10. R.E. Inputs:

    Commodities (fencing materials, tools, watering cans, seeds, etc.); Technical assistance; Financial management.

11. Summary of R.E. Components:

    The project was designed to assist the Senegalese Forest Service in developing a formula for government-local collaboration in addressing basic village-level forestry and conservation needs and issues using voluntary, self-help village labor. The local implementing agency was the Service of Waters and Forests (SWF). Administrative and technical personnel were provided by the Government of Senegal. An OPG

was given to Africare to develop the project management format and serve as primary administrator, manager of AID financial assistance, and coordinator of activities of SWF and Peace Corps volunteers (nine of which had been assigned by mid-1983).

The original concept consisted of the establishment of "large" nine-hectare fuelwood woodlots in the Diourbel Region, with considerable emphasis placed on Eucalyptus camaldulensis plantations. It also involved intercropping to replace lost tree resources, improve cultivated soil, and produce fodder for livestock. The choice of E. camaldulensis was de-emphasized because of insufficient groundwater. Activities were extended into the Bambey area. Tree species were diversified and the scope broadened to include production of fruit and shade trees for family compounds, village public places, and small (less than one hectare) unused plots.

Eight villages were selected to participate in the project during the first year, 12 more in 1982, and a final 17 added in 1983, for a total of 37 villages.

12. R.E. Project Descriptors:

Firewood.

13. R.E. Technology Applications:

A. The Bambey nurseries broadened species diversity by experimenting with the following indigenous trees (listed in decreasing order of production): Prosopis juliflora; Acacia albida; Eucalyptus camaldulensis; Azadirachta indica (neem); Acacia holocericea; citrus ("agrumes"); Khaya senegalensis; Casuarina equisetifolia; Ziziphus mauritiana; Carica papaya; Balanites aegyptiaca; Mangifera indica; Celtis integrifolia; Poinciana regia; Acacia tortilis; Leucaena leucocephala; Detarium microcarpum; "sap-sap"; "gaic"; Anacardium occidentale; and Annona muricata.

(Source: Evaluation Report, 7/31/83, pp. vii and 15, PDAAP205)

B. Eucalyptus camaldulensis was found to be unsuitable for many of the project sites because of insufficient water (rainfall less than 500 mm. and deep water table).

(Source: Evaluation Report, 7/31/83, pp. 24-27, PDAAP205)

C. As of mid-83, Prosopis juliflora was found to be the species most resistant to drought, termites, and water salinity. It had a survival rate of 56% in 1980 on the

"tanns" soils of the National Center for Forestry Research (CNRF) Keur Makhar Station, a rate surpassed only by Melaleuca spp. and Acacia laeta.

(Source: Evaluation Report, 7/31/83, p. 27, PDAAP205)

14. R.E. Technical Reports and Publications:

A. Reforestation in the Republic of Senegal: Framework, Description and Analysis. Chun K. Lai, New Haven, Connecticut, May 1984, 152 pp., PNAAW775.

The Senegal National Reforestation Program is reviewed, and 20 current reforestation projects described and analyzed. This study, underwritten by a Fulbright Grant, is based on original field data collected in Senegal from October 1982 to August 1983, and on complementary research undertaken at the Yale School of Forestry and Environmental Studies.

Descriptions are included of the following AID-funded projects: Senegal Fuelwood Production - Phase I (No. 6850219); Africare Reforestation OPG (No. 6850243); and Village Woodlot Firewood Production (No. 6850247).

15. Evaluations/Major Findings:

A. Joint Africare/AID/PC Evaluation Mid-Project Review: Village Woodlot Firewood Production. Fred R. Weber, Africare, Washington, DC, October 27, 1981, 33 pp., PDBAF196.

Delays in project starting caused certain important activities to be rushed or eliminated, despite valiant efforts, resulting in low first-year survival rate (estimated at 30% by the Forest Service, and 15% by Peace Corps volunteers). Nonetheless, less than 12 months after the initial agreements were signed, the project was well under way. Neither firewood nor woodlots for individual villages were found to be foremost in the minds of the villagers or the Forest Service. Most concern centered on shade trees, trees for food and fruit, and conservation measures, and it was recommended that the project scope be broadened to include those elements. Eight recommendations were made, including that the previous year's planting efforts be redone, taking all precautions to achieve better nursery outputs, better timing of operations, and adequate planting and subsequent protection.

Solid steps had been made toward establishing an implementation structure involving local voluntary labor. Villagers and the Forest Service were highly optimistic.

The project management mechanism -- PVO/PC and Forest Service collaboration -- though requiring further refinements, had been basically successful. Ultimate success of the model would depend on the ability to perform next year's planting in a timely manner, avoiding the previous year's delays.

A final recommendation called for another evaluation after the 1982 planting season; and, if sufficient positive results were achieved, the project should be extended another two years at a slightly higher funding level.

B. Evaluation Report: Diourbel Village Reforestation Project. Chun K. Lai, Ely J. Sambou, and Issa Faye, Office of Agricultural Development/USAID, Dakar, July 31, 1983, 69 pp., PDAAP205.

The number of participating villages increased to 20 in the 1982 season, and to 35 in the 1983 campaign. The survival rate in the 1982 season was 34%, an improvement over the previous year. In response to mid-project evaluation recommendations (see above reference), small woodlots (less than one hectare) were established near the villages, and tree species diversified for use in family compounds (fruit trees) and village public places (shade trees). The Acacia albida component was extended to the Bambey Department.

The evaluation recommended allocation of Title III Program funds and a two-year extension, with SWF assuming project management and administration from Africare, which would no longer be needed, and Peace Corps continuing and adding the dissemination of "Ban ak suuf" improved wood-burning cookstoves. Other recommendations included strengthening the project's training component; seeking greater use of indigenous fencing and protective materials; re-evaluating the priority of Acacia albida, for which demand far outstripped supply; and restricting the use of Eucalyptus camaldulensis to sites where adequate water is available.

C. "Case Study - The Diourbel Village Woodlot Project." In Community-Level Forestry Development: Options and Guidelines for Collaboration in PL 480 Programs. Steven Joyce and Bruce Burwell/Graduate School - USDA, Peace Corps, Washington, D.C., January 1985, pp. 75-79., PNAAS056.

Although not an evaluation, this case study reviews the project and indicates problems it encountered. The most serious problem identified was the drought and severe climatic conditions under which the project operated.

Another problem was land scarcity. Other problems concerned an unclear role definition from the project's start among the collaborating entities; a cumbersome management structure relating to consultation and decision-making during the first two years under Africare administration; and unclear definition of benefits to the community participants.

16. Key Persons:

A. AID/Washington:

Henderson Patrick
Rose Marie Depp

B. AID/Mission:

Daby Diallo, AID Project Manager
Carol Ulinski, Contract Project Officer and former Project Manager

C. Contractors:

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Chris Kopp and Ken Barber, PC Project Managers
Peace Corps, 806 Connecticut Ave., NW, Washington, D.C., 20526, (202) 254-6886

D. Host Country:

Amadou NDiaye, Project Director (Dakar)
Abdoulaye Sene, Chief Inspector (Diourbel)
Service of Waters and Forests (SWF - Service Eaux et Forets)

17. Obligations by Fiscal Year (US$000):

Projected Costs For Entire Project

FY81 (9/1/80-8/31/81)	FY82 (9/1/81)-8/31/82)	TOTAL
88.234	123.110	211.344

(Source: OPG Grant Agreement, 8/29/80, PDBAL723 or PDBAF190)

18. Host Country Funding of R.E. Components (US$000): Not specified

19. Summary of R.E. Costs (US$000):

PROJECTED COSTS*

Consultants	12.600
Travel	9.030
Allowances	27.600
Commodities	67.680
Other direct costs	50.160
Overhead	44.274

TOTAL	211.344

*For entire project; R.E. costs not specified separately.

(Source: OPG Grant Agreement, 8/29/80, PDBAL723 or PDBAF190)

20. R.E. Component Revisions:

A. PACD extended from December 31, 1982, to December 31, 1983.

(Source: Evaluation Report, 7/31/83, PDAAP205)

B. Following villager participants' interest in small clumps of trees in small unused places for shading, forage, and food/fruit, the project was modified to include planting of the above trees on small (less than one hectare) plots near or within villages.

(Source: Evaluation Report, 7/31/83, PDAAP205)

C. The use of Eucalyptus camaldulensis was de-emphasized because of the low water table.

(Source: Mid-Project Review, 10/27/81, PDBAF196)

21. Follow-On Activities:

A. The final year evaluation recommended that Title III Program funds be allocated to allow the project to operate an additional two years with a modified administrative structure. In 1984, PL 480 Title III counterpart funds were provided to replace the Africare OPG, and funding for two years was approved. Africare's participation ceased with the end of the OPG.

(Source: Evaluation Report, 7/31/83, PDAAP205; Community-Level Forestry Development: Options and Guidelines for Collaboration in PL 480 Programs, 1/85, PNAAS056)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: August 1986 (jrl)
Revised February 1987 (jrl)

1. Project Number: 6880217 2. Geo: MALI

3. Title: MALI RENEWABLE ENERGY PROJECT

4. Project Life/PACD: 1978-83 (extended to 85)/November 15, 1985

5. Status: Terminated

6. LOP Funding (US$000):

   A. Entire Project: 4,517

   B. R.E. Components: 4,517

   (Source: Project Implementation Report, 11/9/83, PDBAW399)

7. Loan or Grant/Appropriation Category (US$000):

   G / SDP / 4,517

   (Source: Project Implementation Report, 11/9/83, PDBAW399)

8. Project Purpose:

   To identify appropriate sources and applications of renewable energy and develop processes for their introduction in rural communities; To develop the capacity of the Solar Energy Lab to provide continuing R&D efforts to adapt renewable energy technologies for Malian use.

9. Renewable Energy (R.E.) Outputs:

   R.E. library established; R.E. units including improved stoves, windmills, biogas digesters, photovoltaic water pumps, and solar dryers installed, field tested, and modified; New passive-cooled Solar Energy Lab (LESO) and offices built; LESO staff trained; Portable metal stoves manufactured and field tested; Domestic hot water systems manufactured and installed.

10. R.E. Inputs:

    Technical assistance; Training; Commodities; Construction.

11. Summary of R.E. Components:

    The project was conceived with four phases. Phase I consisted of the strengthening of the existing (established in 1964) Malian Solar Energy Laboratory (LESO), training of

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LESO staff, plans for construction of a new LESO building, ordering of equipment, and readying LESO to develop and/or test R.E. equipment to meet local needs, as identified under Phase II. The second phase consisted of a socio-economic survey in 25 representative villages to determine energy needs and usage, energy resource availability, and village-level capabilities to operate and repair potential R.E. technologies. Prototype development would also commence under Phase II. Under Phase III, prototypes would be installed in survey villages, and use and maintenance by villagers trained in their operation and service monitored. Phase IV was designed to determine which R.E. technologies had the most favorable economic and financial benefits, based on analysis of the field records.

R.E. technologies developed and/or installed by LESO included solar dryers (Taos and tent models), solar water heaters, solar stills, PV lighting, PV water pumps, PV refrigerators, remote weather stations, biogas digesters, windpumps, and improved stoves. Critical electrical supplies for the new LESO laboratory were lost in a train accident and had to be reordered, preventing completion of the building until after the PACD.

The U.S. Department of Energy, through the Solar Energy Research Institute (SERI), was the initial implementing agent under Phases I and II under a Participating Agency Service Agreement (PASA). Volunteers In Technical Assistance and Intermediate Technology Power, Ltd., provided technical assistance. Following termination of the PASA on July 30, 1982, DOE abolished the International Division at SERI and decided not to renew its contractual relationship with USAID on the project. Under the final two phases, the U.S. Small Business Administration became the prime contractor, subcontracting to Sheladia Associates, Inc. The Department of Anthropology of American University provided assistance to the energy use survey design and implementation. The Technical Studies Division of the Institut d'Economie Rurale (IER) undertook the survey component with assistance from Peace Corps volunteers. LESO, under the Ministry of Industrial Development and Tourism, was the local implementing agent.

12. R.E. Project Descriptors:

Solar energy; Crop driers; Water heaters; Solar heating; Solar stills; Photovoltaic energy; Lighting; Water pumps; Refrigerators; Biogas digesters; Wind energy; Stoves; Fish; Mangos; Electric power generation; Battery chargers; Wind measurement; Solar radiation measurement; Passive solar designs.

13. R.E. Technology Applications:

A. Thermosiphon Solar Water Heating System Testing

In August 1981, the LESO Confusol-Mali thermosiphon solar water heating system was lab-tested and its efficiency calculated. This solar water heater consists of a 150-liter, soldered galvanized sheet steel cylinder set inside a larger painted steel cylinder, with approximately 5 cm of glass wool or styrofoam bead insulation separating the two tanks. There are two collector panels (1.3 sq meter each) each made of a single glass cover; an absorber plate painted with common flat black paint mounted about 3 cm from the glass cover and consisting of 20 mm galvanized water pipe risers and 25 mm header pipes clamped to a steel sheet with metal U-shaped clamps; about 5 cm of glass wool insulation; and a painted steel enclosure. Insulated 25 mm galvanized pipes connect the two parallel collectors to the tank.

In a typical installation, a series of valves controls water entering the house through insulated galvanized pipes. Water entering the collectors is drawn from the tank bottom and returns to the tank about 1/4 to 1/3 of the way up the tank height. Water is likewise drawn from the tank bottom for point of use. Testing revealed little stratification in the tank.

Mean daytime efficiency was around 35% in August 1981, with efficiency around 20% for a 24-hour period due to night heat losses. Early morning temperatures were typically around 40-50 degrees C. with the tank inlet valve closed; temperatures would drop to around 30-40 degrees C. if the inlet valve was left open over night. Consequently, from a thermal standpoint, the solar water heaters worked reasonably well. However, corrosion was a serious problem. Users also complained of lack of understanding or unwillingness to use the valves properly to maximize tank temperatures. In 1981, the unit was reported to sell for approximately MF 250,000 (US$450).

(Source: Wind and Solar Energy Prototype Development at the Laboratoire d'Energie Solaire, 12/81, PDBAG120; see also other solar reports under 14., R.E. Technical Reports and Publications, below)

B. Solar Water Heater Manufacture and Installation

At the end of 1984, LESO had been manufacturing a solar water heater for several years. It consists of locally available materials and requires simple equipment for fabrication. Approximately 150 units had been installed in the Bamako area on dwellings and, in a few instances,

in institutional settings. Solar water heaters were also installed in rural health care facilities and, in one case, a village.

(Source: Terms of Reference, Phase IV: Renewable Energy Project, 11/29/84, PDBAU264; see also other solar reports under 14., R.E. Technical Reports and Publications, below)

C. Solar Dryers at Fish Co-ops

One tent and two Taos-type solar dryers were constructed and donated to a fish cooperative in Djidara. A forced-air solar dryer was donated to a fish co-op in Mopti, and two tent-type dryers and two Taos units were given to Bozo fishermen.

(Sources: Terms of Reference, Phase IV: Renewable Energy Project, 11/29/84, PDBAU264; see also other solar reports under 14., R.E. Technical Reports and Publications, below)

D. Combination Wood/Solar Dryer/Smoker

A combination wood/solar dryer/smoker was developed and built by LESO. It was made mainly from banco (clay and sand mixture).

(Source: Wind and Solar Energy Prototype Development at the Laboratoire d'Energie Solaire, 12/81, PDBAG120; Les Sechoirs Solaires a Convection Naturelle, 3/82, PNAAX940; see also other solar reports under 14., R.E. Technical Reports and Publications, below)

E. Solar Dryer for Mangos

A Taos-type dryer was constructed for a local firm wishing to improve the drying of mangos (traditionally dried by the open air method) for export. Mango drying was evaluated using four methods: open air drying; using the Taos dryer; using the banco dryer/smoker in the dryer mode only; and using an indirect sheet metal dryer. Results were being prepared at the time of report preparation.

(Source: Wind and Solar Energy Prototype Development at the Laboratoire d'Energie Solaire, 12/81, PDBAG120; Terms of Reference, Phase IV: Renewable Energy Project, 11/29/84, PDBAU264; see also other solar reports under 14., R.E. Technical Reports and Publications, below)

F. Solar Still

A solar still was distributed to each zone, with two to Gao, for the production of distilled water for vehicle batteries.

The following economic analysis was performed on the LESO prototype:

Production capacity	20,000 liters/year
Size of prototype	25 square meters
Construction cost/sq m	135,000 MF*
Life expectancy	10 years
Annual interest rate	15%
Amortization factor	0.199
Cost per liter (annual cost production capacity)	104 MF*

*The conversion rate for the Malian franc (MF) at the time of the mid-term evaluation varied between 595-615 MF to the dollar.

(Sources Terms of Reference, Phase IV: Renewable Energy Project, 11/29/84, PDBAU264; Mid-Project Evaluation Report, 7/14/82, p. 27, PDAAL385)

G. Passive Solar Designs

The project promoted passive solar energy designs for heating, cooling, and daylighting needs in Mali. This included an assessment of heating and cooling needs for various living and working environments in Bamako; review of current and planned building designs, both traditional and modern, from a passive solar viewpoint, and recommendations for improved energy efficiency; a model cost-benefit analysis for various passive solar techniques; and review of the architectural plans for the new LESO facilities and suggestions for modifications. Passive solar features to be incorporated into the new LESO building included the addition of a double roof with interlayer infrared reflective and ventilation passages; south, east, and west shading for apertures and directly exposed walls; a passive air extractor at the roof ridge; cross ventilation and shade louvres; and solid filled cement block walls.

(Sources: Quarterly Report No. 4, 10/83-12/83, PDBAY600; Implementation Letter No. 10, 2/7/85, PDBAU715)

H. PV Lighting Systems

PV lighting systems were installed in schools, literacy centers, maternity clinics, dispensaries, hospitals, and night nurses' rooms. Early systems were provided by ARCO Solar and Solarex, and consisted of 8-watt "fixed neons" and in one case a rechargeable portable lamp. The portable lamp contained gel-cell batteries, ill-adapted for long-term use under Malian conditions. Twenty-watt fluorescent lighting systems were incorporated into PV refrigeration systems at health centers; the replacement tubes were not available locally and had to be ordered specially. Regulator reliability was a major problem. Later, high-quality DC fluorescent lamps were imported, to be direct coupled to a 12-volt battery sized to match the PV array, eliminating the charge controller.

(Source: Terms of Reference, Phase IV: Renewable Energy Project, 11/29/84, PDBAU264)

I. PV Refrigerators

Three PV refrigerators were procured and installed. Long-term monitoring data are available for one system; the other two failed frequently due to technical defects, primarily electronic problems with the voltage regulator circuit or compressor controller circuits. The PV modules were 100% reliable. In many cases the batteries failed prematurely. Two later-generation PV refrigerators were procured. LESO also participated in the NASA-Lewis worldwide program of refrigeration testing, outfitting one unit and monitoring it on a regular basis.

(Source: Terms of Reference, Phase IV: Renewable Energy Project, 11/29/84, PDBAU264)

J. Zeolyte Refrigeration Systems

Four zeolyte refrigeration systems were procured. Lab testing revealed that they were not capable of producing sufficient refrigeration under Malian climatic conditions.

(Source: Terms of Reference, Phase IV: Renewable Energy Project, 11/29/84, PDBAU264)

K. PV to Power Grain Mill

The project procured from NASA-Lewis a DC-powered grain mill, sized to operate about 3.75 hours daily with a 2.5 kWp PV array and battery bank, for installation in Tonfa. The design had a simplified control circuitry compared with the NASA-Lewis Tangaye, Burkina Faso design. The PV

array was mounted on the millhouse roof, with module supports allowing adjustable tilting along an east-west axis. The system was planned to be operational during the Phase IV assessment.

(Source: Terms of Reference, Phase IV: Renewable Energy Project, 11/29/84, PDBAU264)

L. PV Nickel-Cadmium Battery Chargers

The project developed several prototype PV nickel-cadmium battery ("C" and "D" cells) chargers. One can recharge up to 40 batteries at once, while a smaller model charges 5. The larger charger is modular, accepting charge modules in increments of 5 batteries. Each modular unit contains independent electronic charge circuits for each battery, guaranteeing a charge rate that is a function of the battery's state of discharge.

(Source: Terms of Reference, Phase IV: Renewable Energy Project, 11/29/84, PDBAU264)

M. Guinard PV Water Pumps

Four demonstration PV water pumping systems were installed with Guinard pumps. Project personnel also collaborated on other installations. Four later-generation pumps were procured.

(Source: Terms of Reference, Phase IV: Renewable Energy Project, 11/29/84, PDBAU264; see also Evaluating the Technical and Economic Performance of Photovoltaic Pumping Systems [draft report], 2/85, document number pending)

N. SEI PV Water Pump

The project tested the daily pumping performance of an early generation SEI-15 Sun Pump, which consisted of eight ARCO Solar 16-2000 PV modules wired in series delivering 250 watts peak at 117 volts; an electronic controller which transforms the array output to a nominal 65 VDC and matches the pump load to available array power; a 1/3 hp permanent magnet, brushless, DC motor and a plastic centrifugal KSB (West German) pump. Water was pumped from a static head of 4 meters. Orientation was true north, at 7 degree tilt. Average output for 11 days operation in the month of August 1981 was 20.2 cubic meters per day, while the average insolation level for the same period was 17.8 MJ/sq meter/day.

(Source: Wind and Solar Energy Prototype Development at the Laboratoire d'Energie Solaire, 12/81, PDBAG120; see

also Evaluating the Technical and Economic Performance of Photovoltaic Pumping Systems [draft report], 2/85, document number pending.)

O. Sahores Wind Water Pumps

LESO evaluated Sahores multiblade water-pumping wind machines, built primarily of local materials and installed by groups in Mali, especially Pere Plasteig of the Catholic Mission in Segou and Peace Corps/Mali. A typical Sahores windmill system consists of a plywood disk rotor with 16 bamboo blade spars and galvanized sheet metal blades clamped to the spars, with a bamboo pole extending upwind; a head consisting of a plywood frame encasing either hardwood bearings or ball bearings and supporting the tail; a tail made of two 5-meter bamboo poles bolted to the plywood head at one end and lashed to two vertical bamboo poles forming a square, which has a galvanized sheet clamped to it and a rope extending from the square for turning out of the wind; a transmission system with a crank welded to the shaft on one side and fixed to the connecting rod at the other; a simple pole tower; a piston pump; and a ferrocement water storage tank. A simple system of strings and elastic rubber loops controls feathering; two loops of cable connecting all blades assure that they feather in unison. See PDBAG120 for more details and drawings. The cost of the machine was estimated at 310,000 Malian Francs ($690), with an additional 260,000 MF ($580) for the reservoir, assuming that all materials are purchased, which need not be the case. Various recordings were made on one field site, and values calculated for volume per stroke, pump volumetric efficiency, and net power produced (power to pump water). Numerous repairs were needed for the machines.

(Source: Wind and Solar Energy Prototype Development at the Laboratoire d'Energie Solaire, 12/81, PDBAG120; Construction, Test et Adaptation au Pompage d'Eoliennes de Type "Sahores," 12/81, PNAAX944; see also Summary Report: Wind Power Consultant Mission, 8/84, PDAAW028)

P. Sahores Windpump for Low Wind Speed Locations

A Sahores wind machine was constructed at LESO and tested near the village of Moribabougou, about 15 km east of Bamako. Results showed high rotor performance. The no-load (maximum) tip speed ratio (TSR) was 1.9 to 2.0, and TSR for max power was around 1.0, both fairly normal. The power coefficient, however, at 0.4, was quite high, as was the torque coefficient.

The Sahores windpump was designed by consultant William Wright for low wind speed locations. It had a cam driven pump rod lifter to reduce speed and load on the delivery cycle and enable a fast return. It had a 6-blade rotor, 5 meters in diameter. Cost estimates performed by a Peace Corps volunteer amounted to about $450 for rotor, transmission, tower, and pump, excluding a storage tank or maintenance hand tools.

(Sources: Wind and Solar Energy Prototype Development at the Laboratoire d'Energie Solaire, 12/81, PDBAG120; Mid-Project Evaluation Report, 7/14/82, pp. 21-22, PDAAL385; Construction, Test et Adaptation au Pompage d'Eoliennes de Type "Sahores," 12/81, PNAAX944; see also Summary Report: Wind Power Consultant Mission, 8/84, PDAAW028)

Q. Weather Measurement Stations

Installed a Hollis Data Point 21 System in each of the survey zones: Bamako, Nioro, Gao, San, and Bougouni. These instruments measure total insolation, wind speed and direction, precipitation, dry bulb temperature, and humidity. Malfunctions were frequent, and poor accuracy was reported.

At the laboratory, there were two Eppley pyranometers, one with a shadow band for diffuse insolation measurement, the other for total insolation measurement, and an Eppley pyroheliometer for direct insolation measurement. These instruments are connected to a Leeds and Northrop multipoint recorder for continuous daily recordings. Records have been kept since early 1982. Frequent city power failures have spoiled the quality of records and necessitate battery back-up.

(Source: Mid-Project Evaluation Report, 7/14/82, p. 18, PDAAL385)

R. Wood-Burning Metal Stoves

LESO lab-tested and field-tested a series of prototype improved wood-burning stoves. Emphasis was on metal stoves designed partially by LESO and fabricated in the LESO shop. Price was about 4,000 FM, or a little more than $8.00. LESO conducted a village wood consumption survey in each zone, and subsequently conducted a stoves survey to ascertain the extent of fuelwood savings realized by introduction of the improved stoves.

(Source: Terms of Reference, Phase IV: Renewable Energy Project, 11/29/84, PDBAU264)

S. High Mass Banco Stoves

Early project stove work centered on construction of high mass banco stoves. Lorena Hybrid I and II stoves were installed in consenting survey households in the San zone during January-February 1982. An unannounced LESO inspection in early March 1982 revealed that only 39% of the stoves were in regular use. Problems included quality of construction, which varied widely from builder to builder; durability; poor placement of the stoves due to insistence of the lab personnel that they be placed in the kitchens, which were often dark and hot, or poorly placed chimney outlets facing the prevailing winds; and need of tailoring of design to fit the cooking habits or cooking pots of the users. A preliminary examination revealed a 20% reduction in wood consumption and a 30% reduction in cooking time with the improved stoves. In mid 1984, LESO was building two models of improved stoves in the Nioro zone villages: one a parallel stove with two chimneys, allowing the user to block one chimney to halt cooking at one pot hole; and a series stove with a second pot hole raised above the front hole. A preliminary economic analysis for high mass stoves is provided in the source.

(Source: Mid-Project Evaluation Report, 7/14/82, pp. 23-27, 29-31, PDAAL385; see also Contraintes a la Diffusion du Foyer Ameliore en Milieu Urbain: Proposition d'Amelioration, 11/82, PNAAM694)

T. Biogas Digesters

The project constructed low-technology digesters at LESO and a Chinese-type digester in the field. In addition, a digester was built next to a maternity clinic and dispensary in Keleya, about 100 meters from a school. Cow dung was the major feedstock, to be supplied by the school children. Biogas was to be used to light the school and maternity clinic and facilitate water-heating and cooking. Compost was to be made available to the school children. Management problems plagued the unit, especially concerning manure collection and availability. Small technical problems, such as the use of lamp mantles, also arose. The mid-term evaluation team observed two biogas digesters, both apparently operating properly but without measurement equipment. The team reported that the biogas component was successful, and the engineers appeared to be competent in construction, operation, and analysis of the digesters. A preliminary economic analysis is included in the mid-term evaluation.

(Sources: Terms of Reference, Phase IV: Renewable Energy Project, 11/29/84, PDBAU264; Mid-Project

Evaluation Report, 7/14/82, pp. 23, 31-33, PDAAL385; see also additional biogas reports in French and English under 14., R.E. Technical Reports and Publications, below)

14. R.E. Technical Reports and Publications:

A. Wind and Solar Energy Prototype Development at the Laboratoire d'Energie Solaire. Alan Wyatt, Volunteers in Technical Assistance, Arlington, VA, December 1981, 141 pp., PDBAG120.

Chapter 1 provides a table of baseline solar radiation data for Mali and compares different radiation measuring instruments, pointing out some significant discrepancies between instruments. Chapter 2 outlines day-long performance testing of an SEI Model 15 PV water pump. Chapter 3 outlines thermal testing on the LESO-developed Confusol-Mali thermosiphon water heater. Chapter 4 presents a technical evaluation of the Sahores windpump. The final chapter compares tests on four solar drying systems for mangos. Included are 10 appendixes, including an "Instruction Manual for the 'Confusol-Mali' Solar Water Heating System" in French.

B. Conception, Realisation et Test d'un Systeme Combine de Sechoir Solaire a Circulation Naturelle (in French). Amadou Doumbia, Cheickna Traore, Modibo Dicko, Cheick O. Traore, and Terence Hart, Laboratoire de l'Energie Solaire, Bamako, Mali, April 1982, 21 pp., PNAAX939.

This report describes the testing of a combination direct/indirect natural convection solar dryer with chimney, developed at LESO. A drawing and list of construction materials and their costs are provided. Calculations are made on the thermosiphon air speed. Data are given for empty dryer tests conducted during four days in March 1982.

C. Les Sechoirs Solaires a Convection Naturelle (in French). Sekou Oumar Traore, Cheickna Traore, Modibo Dicko, and Terence Hart, Laboratoire de l'Energie Solaire, Bamako, Mali, March 1982, 28 pp., PNAAX940.

Descriptions, costs, and results from limited testing are provided for six prototype dryers: (1) an indirect solar dryer with chimney; (2) a combination indirect solar dryer/wood-burning stove smoker made of banco for drying and smoking of fish; (3) a conical solar dryer with hexagonal base and central chimney; (4) a greenhouse-type direct solar dryer; (5) a direct Taos solar dryer; (6) A combination direct/indirect solar dryer with chimney.

D. Rapport sur le Digesteur "Gobar": 1ere et 2eme Series de Tests (in French). Hamata Ag Hantafaye, Yaya Sidibe, Andre Longmire, Cheickna Traore, Modibo Dicko, and Terence Hart, Laboratoire de l'Energie Solaire, Bamako, Mali, March 1982, 13 pp., PNAAX941.

Results are presented from two series of tests on the operation of a 3-cubic-meter concrete digester with a 1-cubic-meter metal gas holder using cow manure as the feedstock. The volume of biogas produced is approximated.

E. Realisation et Experimentation d'un Digesteur Type Chinois (in French). Yaya Sidibe, Hamata Hantafaye, Andre Longmire, Cheickna Traore, Modibo Dicko, and Terence Hart, Laboratoire de l'Energie Solaire, Bamako, Mali, April 1982, 17 pp., PNAAX942.

The construction costs, operation, and economic analysis of a Chinese digester are described. Drawings included.

F. Realisation et Test d'un Digesteur Experimental (in French). N'to Diarra and Cheickna Traore, Laboratoire de l'Energie Solaire, Bamako, Mali, circa January 1981, 10 pp., PNAAX943.

Briefly describes a slightly modified Gobar biogas digester, its construction, and gas production. A list of materials (and their costs) is provided. Energy production costs are calculated.

G. Construction, Test et Adaptation au Pompage d'Eoliennes de Type "Sahores" (in French). Mahamane b. Toure, Fatogoma Dembele, Alan Wyatt, Modibo Dicko, and Cheickna Traore, Laboratoire d'Energie Solaire, Bamako, Mali, December 1981, 23 pp., PNAAX944.

Two types of Sahores water-pumping windmills are described. One was constructed at LESO and installed at the village of Moribabougou. Data on its performance with no load, with a Prony brake, and hooked to a Vergnet hydro-pump, held vertically at the edge of the Niger River, are given. The second windpump was constructed at Segou by Father Plasteque and installed at a well in a vegetable garden in Sama. Data is presented on its performance hooked to a piston pump. Graphs and tables included.

H. Contraintes a la Diffusion du Foyer Ameliore en Milieu Urbain: Proposition d'Amelioration (in French). Association d'Etudes de Technologies Appliquees et d'Amenagement en Afrique (AETA), B.P. 2031, Bamako, Mali, November 1982, 72 pp., PNAAM694.

This report is based on an AID-funded study aimed at (1) assessing the extent of improved high-mass mud cookstoves disseminated throughout Bamako, advantages and inconveniences of using these stoves, and degree of satisfaction of the users; (2) surveying stove builders, including where they learned their skills; and (3) making recommendations for increasing stove dissemination. In addition to surveys of stove builders and stove owners, interviews were also conducted with various Malian government, foreign government, and non-governmental organizations providing assistance to Mali, and with the National Union of Malian Women, all of which are involved in improved stoves work in Mali. Although this study appears to have been undertaken independently of the Mali R.E. project, LESO was one of the groups it contacted; moreover, findings revealed that 27% of the stove builders learned their stove-building skills at LESO.

I. Summary Report: Wind Power Consultant Mission. William L. Schmidt, Sheladia Associates Inc., Riverdale, MD, August 1984, 177 pp., PDAAW028.

Findings and conclusions of the author during a six-week consultancy mission with the wind power group (Group Energie Eolienne [GEE]) of LESO are summarized. The bulk of the report consists of appendices which include a comparative analysis of horizontal- and vertical-axis wind machines for water pumping; a description of a technique to provide standard Weibull function wind predictions for local Malian wind regimes based on average wind speeds; a report on using computer modeling techniques for wind turbine rotor design analysis; a discussion of windmill control and braking systems; an evaluation of wind-powered system performance; computer printouts of the contents of existing programs for the Apple computer available at LESO; a list of Fortran and Wordstar programs prepared for GEE during the consultancy; findings by the Kenya Industrial Estates on work with the 12PU500 windmill; and an IT Power report on the future development of the LESO MK I windpump.

J. Chinese Dome Biodigester Construction and Technology Transfer. M & E Pacific, Inc., Honolulu, Hawaii, April 1982, 99 pp., PNAAX945.

Report describes the selection and construction of a Chinese biogas digester of approximately 7.75 cubic meters; results of analysis of substrate, bacteriological seed, and biogas production; a seminar on biogas technology transfer; and a three-phase biogas research program for the LESO. Photos of biodigester construction and components are included in appendices.

K. Evaluating the Technical and Economic Performance of Photovoltaic Pumping Systems (Draft Report). Jeffrey Kenna, Bernard McNelis et al., IT Power Inc., Washington, DC, February 1985, 78 pp., document number pending.

A methodology is defined to determine the technical and economic viability of photovoltaic water pumping. It consists of three performance tests, a PV rating test, a short-term performance test, a long-term performance and durability test, and a procedure to calculate cost effectiveness. The instruments, procedures, and data analysis for each test are described. Results of PV rating and short-term performance tests for five pumps in Mali are presented.

15. Evaluations/Major Findings:

A. Mali Renewable Energy: A Mid-Project Evaluation Report for USAID, Bamako. Djibril Fall, Richard A. Graham, Clarence Kooi, and Frances Stier, July 14, 1982, 186 pp., PDAAL385.

The project had a difficult start-up, and seemed doomed to failure in mid-1980. Little was accomplished during the first two years. SERI's assistance was considered unsatisfactory until mid-1980, when a new project manager was appointed. The Afro-American Purchasing Company was considered an ineffective procurement agent for USAID. A lack of communication, cooperation, and collaboration between LESO's management and the USAID/Mali project officer was a continuing problem. Largely due to the hire of a broadly competent engineer, the project turned around in late 1980. Consequently, the evaluation was positive, recommending continuation into Phases III and IV and construction and equipping of the new lab facilities.

The team recommended that LESO place primary emphasis on photovoltaics, secondary emphasis on wind and biogas, and drop solar thermo-dynamic engine work. High priority needs were water pumping, grain drying and agricultural work. The survey of energy needs and usage is discussed at length.

Many recommendations regarding staffing, short-term assistance, training, data analysis, and contractors are included. Regarding R.E. technologies, it is recommended that the lab begin PV development work as opposed to simply installing off-the-shelf components; that human-powered devices be given some attention; that engines

fueled by biogas from the LESO digester be tested; and that windmill development work continue along present lines.

16. Key Persons:

A. AID/Washington:

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2733A NS, 647-8242

B. AID/Mission:

Leslie Koski, GDO/ENGR, Field Project Officer

C. Contractors:

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Department of Energy, SERI Site Office, 1617 Cole Blvd., Golden, Colorado 80401

Dolores Koenig
Department of Anthropology, The American University, Washington, DC

Volunteers In Technical Assistance (VITA), Inc.
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(703)276-1800

I.T. Power Ltd.
Mortimer Hill, Mortimer
Reading Berks RG7 3PG, U.K.
(0734)333231

D. Host Country:

Mr. Chieckna Traore, Director
Laboratoire d'Energie Solaire, Bamako

17. Obligations by Fiscal Year (US$000):

FY 78	2,174.0
FY 79	600.0
FY 80	800.0
FY 81	526.0
TOTAL	4,100.0*

*Does not reflect increase in LOP funding.

(Source: Project Paper, 8/16/78, PDBAU400)

18. Host Country Funding of R.E. Components (US$000): 1,191

(Source: Fifth Amendment to the Project Grant Agreement, 7/30/83, PDBAM713)

19. Summary of R.E. Costs (US$000):

Technical assistance	1,642.3
Training	206.9
Commodities	1,277.0
Other costs	752.7
Construction	638.1
TOTAL	4,517.0

(Source: USAID/Mali Comprehensive Pipeline Report, 6/30/86, PDBBD882)

20. R.E. Component Revisions:

A. The PACD was extended several times, to September 30, 1984, to September 1985, and to November 15, 1985.

(Source: Project Implementation Report, 10/30/86, PDBBE677)

B. LOP funding was increased by $417,000 (from $4.1 million to $4.517 million) to strengthen the technical assistance component and to provide for increases in the cost of the solar energy laboratory construction due to inflation.

(Sources: Project Implementation Report, 11/9/83, PDBAW399; Advice of Program Change, 6/28/83, PDBAX529)

21. Follow-On Activities:

A. Commercialization of portable metal stoves was continued under the VITA Portable Metallic Woodstove Project (6290934) through a Cooperative Agreement. This effort shows signs of becoming a successful small private sector initiative in Mali. The project has systematically designed production equipment for the stoves that improves both the quality and rate of stove production. Approximately 450 stoves were field tested in 186 families of different sizes and with varying cooking needs. Private blacksmiths and producers were contacted to manufacture and disseminate the stoves. Two out of an anticipated seven production centers became operational;

the remaining five were to begin production by the end of June 1986. VITA estimated that up to 32% fuelwood savings could result through the use of improved stoves.

(Source: VITA Portable Metallic Woodstove Project Mid-term Evaluation, 4/86, available from VITA, P.O. Box 12438, Arlington, VA 22209, (703) 276-1800.

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: March 1987 (jrl)
Revised May 1987 (jrl)

1. Project Number: 6980424 2. Geo: AFRICA REGIONAL

3. Title: ENERGY INITIATIVES IN AFRICA

4. Project Life/PACD: 1982-87/September 30, 1987

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 17,500

   B. R.E. Components: Not specified

   (Sources: DIS; Project Data Sheet for PP Supplement No. 1, 7/31/84, PDJAB388)

7. Loan or Grant/Appropriation Category (US$000):

   G / SD / 13,500
   G / SH / 4,000

   (Source: DIS)

8. Project Purpose:

   To strengthen the institutional capabilities of African governments to plan and implement sound national energy programs and projects; To demonstrate and disseminate self-sustaining public and private sector initiatives to reverse problems of deforestation, oil import dependence, inefficient energy use, and lack of development of indigenous energy resources.

9. Renewable Energy (R.E.) Outputs:

   Trees planted; Energy advisors assigned to governments; Household energy survey conducted; Enterprise development undertaken (which included training in production and marketing of cookstoves and charcoal, and marketing of other energy-efficient R.E. technologies including cookers, growholes, food dryers, etc.); African stove dissemination groups trained; Mini-hydro subproject designed; Efficient charcoal kiln designed; Private entrepreneur assisted in developing a commercial charcoal operation; Fuel-efficient cookstoves disseminated; Microcomputer forest resources analysis and planning model developed; Video tape on cookstove and charcoal production and marketing produced; Papyrus development and energy utilization assessment

conducted; Charcoal production from mangrove project assisted; Charcoal export marketing study conducted; Experiment on the use of coffee husks as a feedstock for charcoal briquetting undertaken; Water pumping options for irrigation (including alternative power sources) studied; Wood gasification studied; Energy profiles for all African countries prepared; Regional training program on forestry and natural resources inventory and application conducted.

10. R.E. Inputs:

Technical assistance; Subproject fund; Training.

11. Summary of R.E. Components:

The Office of Regional Affairs, Africa Bureau (AFR/RA) manages the Energy Initiatives in Africa (EIA) project, furnishing the services of a contractor, Energy/Development International (E/DI) to undertake project development, technical assessments, training, and information/experience exchange in matters of energy policy, planning, and technologies. The first component contains a subprojects fund to furnish grants for public and private sector activities, loans to national development banks and other financial institutions, and support to governments for long-term energy planning advisors. ED/I maintains field offices in Abidjan and Nairobi. Partnership for Productivity/ International (PfP/I) was a subcontractor to ED/I, assisting with the assessment and development of small- and medium-scale subproject activities, particularly those involved with private voluntary organizations and the private sector. REFOS, an Ivoirian firm, was also a subcontractor to ED/I.

Project catagories consist of:

- Wood economics, including a communal afforestation project in Rwanda* (6980424.01);

- Fuel substitution/energy conservation activities, including micro-hydro for agricultural processing in Madagascar* (6980424.87); water pumping options for irrigation in Senegal; photovoltaics (PV) for isolated rural clinics in Guinea; coffee husks as a feedstock for charcoal briquetting in Uganda; papyrus as an energy resource in East Africa; wood gasification in Liberia; and a planned study on the state-of-the-art in PV pumping in Niger;

- Enterprise development, emphasizing cookstove and charcoal production and marketing, including a Kenyan-based project to provide an Africa-wide program of training, technical assistance, and networking among groups involved with the dissemination of improved

portable stoves* (6980424.23); assistance to intermediate credit institutions in Malawi to evaluate and identify energy-related investments for small and medium enterprises* (6980424.12); and a subproject in Lesotho involving the manufacture, marketing, and dissemination of a variety of R.E. technologies* (6980424.32); and

- o Technical assistance, through the assignment of energy advisors, including one in Liberia* (6980424.03).

EIA also provided partial funding of the multiproject Renewable Energy in Africa evaluation, initiated by the Bureau for Africa, which examined R.E. projects in seven African countries.

*Described separately under specific subproject numbers.

12. R.E. Project Descriptors:

Plantations; Energy use surveys; Cookstoves; Charcoal; Growholes; Crop driers; Hydroelectric power; Energy planning; Papyrus; Mangroves; Coffee husks; Briquetting; Water pumps; Gasification; Firewood; Irrigation.

13. R.E. Technology Applications:

A. The engineering firm, Gordon-Melvin & Partners, of Kenya, designed and performed market survey work for a charcoal briquette production facility in Uganda using coffee husks as raw material. In 1982, plant construction and operation costs were $25,000. It was designed to use non-mechanical, batch-type closed kilns and hand mixing and briquetting machines. As of January 1984, 13.5 tons of charcoal had been sold to the public. In September 1984, coffee husks were being converted into charcoal briquettes at the ratio of 6.8 tons of coffee husks to 2.3 tons of commercial briquettes. By April 1985, the Busoga Cooperative Union in Uganda had been operating the plant successfully for more than two years.

(Source: Outgoing State Department telegram, 4/85, PDJAB352)

14. R.E. Technical Reports and Publications:

A. Charcoal Production Model (CHAR Version IIA) User Manual. Energy/Development International, Washington, DC, Undated, 41 pp., PNAAX946.

A menu-driven charcoal production model written in Lotus 1-2-3 for IBM-compatible computers is described. The model analyzes the economics of small-scale charcoal production for a variety of kilns, calculating the

financial returns to the local entrepreneur. It covers all aspects of production including wood costs and costs of transporting the charcoal to market; labor incentives; and technical aspects of charcoal production, including the effect of moisture content and other characteristics of the wood on charcoal yields. The model is linked to the Transport Model BOGEY Version III, which calculates the distance from the market at which the crossover, or economic breakpoint, occurs between transporting wood or transporting charcoal. A listing of the model's equations is furnished. Graphs present sensitivity analyses for a number of variables.

B. Renewable Energy Technologies in Africa: An Assessment of Field Experience and Future Directions. Mark Ward, John H. Ashworth, and George Burrill, AID, Washington, DC, April 1984, 178 pp., PDJAB379. (A similar report, entitled "Technical Findings on the Performance of Renewable Energy Technologies in Africa: Results from Fifty-Five Projects in Seven Sample Countries", published concurrently by Associates in Rural Development, is also available on the same fiche.)

Data on 242 R.E. technology (RET) units (AID and non-AID funded) at 75 sites in Botswana, Kenya, Lesotho, Mali, Rwanda, Senegal, and Burkino Faso were collected during field visits in October and November 1982. The fact-finding mission investigated the performance and cost-effectiveness of R.E. systems and the social and economic acceptability of the systems in meeting end-user needs.

EIA furnished partial funding of this effort, undertaken by USAID, Associates in Rural Development, and independent consultants.

The major finding was that technical performance of most of the R.E. systems was deficient in terms of reliability, durability, and physical output levels. Low-cost efficient stoves, factory-produced windmills, and photovoltaic (PV) arrays had higher consumer preference and acceptance than other technologies. Biogas digesters and solar thermal pumps were plagued with operation and maintenance problems. At good sites, microhydro could provide low-cost energy, either in the form of direct shaft power or electricity.

Successful RET development was often linked to projects with on-going monitoring and evaluation. Field data based on dissemination efforts were scarce, due to the fact that many R.E. technologies were still in the laboratory prototype or field-testing stages. Widespread application was hampered by lack of local repair facilities, spare parts, and trained operation and

maintenance personnel. Little financial and economic data existed, and data addressing the long-term economic viability was lacking.

The role of RETs in supplying Africa's energy needs varied widely depending upon the end-use application. Water pumping was the only major near-term application of RETs for agricultural production. Water heating and remote-site lighting and refrigeration were the major applications for urban and institutional uses. Small-scale RETs had little opportunity to reduce fossil fuel demand in areas of transportation and electricity generation; however, certain energy conservation measures directed at truck drivers and electric utilities would help those sectors.

The assessment recommends that AID do the following: the Bureau for Africa's R.E. activities should address the problems of dependence on expensive petroleum products, biomass/natural resource base depletion, low agricultural productivity, and low quality of life; missions should make use of the services of the REDSOs, the EIA field specialists, or ST/EY to evaluate and select cost-effective and appropriate energy sytems; the Africa Bureau and missions should reduce support to technologies such as biogas digesters, solar cookers, and small solar dryers that show only limited ability to address priority energy-related problems; missions and ST/EY should support surveys of user experiences with systems, equipment, and tools, under field conditions where appropriate; ST/EY and the Africa Bureau should support development of uniform methodologies for comparative testing of technical and economic performance; missions and S&T/EY should insist upon determining economic performance and user acceptance before proceeding with marketing/dissemination; missions should ensure, by employing assistance from REDSO, EIA, and S&T/EY, that project designs incorporate project management systems to track costs and benefits and collect data on social acceptability and financial and marketing environments; the Africa Bureau should study how to improve the collection and dissemination of R.E. information; more emphasis should be placed on the marketing aspect of RETs; and promotion should concentrate on those RETs that are durable, cost competitive, and require low maintenance.

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

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Kenn Ellison
Partnership for Productivity/International (PfP/I)

D. Host Country: Not specified

17. Obligations by Fiscal Year (US$000):

PROPOSED PROJECT OBLIGATION SCHEDULE BY YEAR*

1st Year	868
2nd Year	3,430
3rd Year	4,415
4th Year	4,872
5th Year	3,915
TOTAL	17,500

*Fiscal year not specified; does not reflect subsequent funding changes.

(Source: Project Paper, 4/29/82, PDJAB347 or PDAAN260)

18. Host Country Funding of R.E. Components (US$000): 2,650*
522**

*For entire project, R.E. costs not specified separately; at initial project funding level.
**For entire project, R.E. costs not specified separately; at minimum LOP funding level.

(Sources: *Project Paper, 4/29/82, PDJAB347 or PDAAN260; **Project Paper Supplement No. 1, 7/31/84, PDJAB388)

19. Summary of R.E. Costs (US$000):

A. Projected inputs:

Prime contractor technical assistance	6,050
Other consultants	150
Subprojects fund	10,550
Training	350
Information/experience	200
Project evaluation	200
TOTAL	17,500

*For entire project, R.E. costs not specified separately; does not reflect subsequent funding changes.

(Source: Project Paper, 4/29/82, PDJAB347 or PDAAN260)

B. Minimum LOP cost estimate:

Prime contractor (includes training, information sharing, project development, assessments)	5,910
Subproject funds	2,088
Project evaluation	140
TOTAL	8,138*

*For entire project, R.E. costs not specified separately.

(Source: Project Paper Supplement No. 1, 7/31/84, PDJAB388)

20. R.E. Component Revisions:

A. $17.5 million was authorized for the project. Although this remained in effect, funding constraints within AID's Office of Regional Affairs, Africa Bureau (AFR/RA), required adjustments, and the project was amended to permit operation at a minimum LOP level of $8.24 million. A Project Paper Supplement was drawn up, and project activities were adjusted accordingly. Modifications included reducing reliance on the subproject fund to achieve project objectives; increasing use of technical assistance to support mission requirements in energy analysis, including project design; replacing training as a specific project function to a support role in specific project programs; and eliminating country energy assessments because of World Bank involvement in this area. EIA was to focus on more effective energy use in agriculture/rural development and on improved balance of payments resulting from increased energy efficiency and indigenous energy production, at the same time emphasizing AID target groups and local entrepreneurs.

(Source: Project Paper Supplement No. 1, 7/31/84, PDJAB388)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: April 1987 (jrl)

1. Project Number: 6980424.01 2. Geo: AFRICA REGIONAL/ RWANDA

3. Title: ENERGY INITIATIVES IN AFRICA. SUBPROJECT 01: COMMUNAL AFFORESTATION

4. Project Life/PACD: 1983-87/September 30, 1987

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Subproject: 500

   B. R.E. Components: Not specified

   (Source: Project Implementation Report, 4/6/84, PDBAR762)

7. Loan or Grant/Appropriation Category (US$000):

   G / SD / 500

   (Source: Energy, Forestry, and Natural Resources Activities in the Africa Region, p. 130, AID/Bureau for Africa, 4/86, PNAAW771)

8. Project Purpose:

   To improve the effectiveness of the Government of Rwanda (GOR) forestry extension service in the project area to enable it to deliver technical information and to manage the nurseries and existing forest plantings.

9. Renewable Energy (R.E.) Outputs:

   Extension service set up; Management of nurseries improved, their output increased, and new nurseries established; Seedlings raised; Communal woodlots established and on-farm tree plantings encouraged; Extension agents trained.

10. R.E. Inputs:

    Training; Technical assistance; Construction.

11. Summary of R.E. Components:

    This subproject funds the establishment of individual and communal forests, the training of extension workers, and the development of an agroforestry program in Rwanda. In 1986,

240 hectares of communal forest and 450 hectares of privately owned land had been planted. Twenty five nurseries were operative as of September 1985, and 900,000 seedlings had been planted outside nurseries.

The Ministry of Agriculture/Department of Water and Forests is the implementing agency. Peace Corps furnished forestry specialist volunteers.

12. R.E. Project Descriptors:

Plantations; Firewood.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

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B. AID/Mission:

Ed Robins, Field Project Officer

C. Contractors:

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Julia Demichelis, Project Coordinator
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D. Host Country:

The Ministry of Agriculture/Department of Water and Forests

17. Obligations by Fiscal Year (US$000):

FY 84	72
FY 85	181
FY 86	142 (estimate)
FY 87	Not specified

(Source: Energy, Forestry, and Natural Resources Activities in the Africa Region, AID/Bureau for Africa, p. 130, 4/86, PNAAW771)

18. Host Country Funding of R.E. Components (US$000): 335.8

    (Source: Annual Report: FY 1986, p. 41, 11/86, PDAAW029)

19. Summary of R.E. Costs (US$000): Not specified

20. R.E. Component Revisions: Not specified

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: April 1987 (jrl)

1. Project Number: 6980424.03 2. Geo: AFRICA REGIONAL / LIBERIA

3. Title: ENERGY INITIATIVES IN AFRICA. SUBPROJECT 03: NATIONAL ENERGY PLANNING ADVISOR

4. Project Life/PACD: 1983-85/December 31, 1985

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Subproject: 250

   B. R.E. Components: Not specified

   (Source: Grant Project Agreement, 7/29/83, PDJAE252)

7. Loan or Grant/Appropriation Category (US$000):

   G / SPA 106 / 250

   (Source: Semi-Annual Project Implementation Report, 9/30/83, PDJAE249)

8. Project Purpose:

   To assist the Government of Liberia (GOL) to formulate a National Energy Plan, develop pilot and demonstration activities in renewable energy technologies, and institutionalize the GOL's energy assessment and planning capabilities.

   (Source: Project Data Sheet, 7/25/83, PDJAE253)

9. Renewable Energy (R.E.) Outputs:

   Integrated National Energy Program (INEP) developed; Pilot project(s) and/or study design(s) initiated in the area of R.E.; Studies on the economics of wood production in Liberia undertaken.

10. R.E. Inputs:

    Technical assistance; Training.

11. Summary of R.E. Components:

This subproject funds a contract with Oak Ridge National Laboratory for the placement of a national energy planning advisor with the National Energy Committee/Government of Liberia for a period of two years. Planned activities include (1) investigating a strategy for hydroelectric power, which looks at the relative roles of large-scale hydro versus smaller hydro projects; (2) investigating a strategy for exploiting biomass resources through gasification and other means; and (3) developing study designs and pilot projects in R.E. resources and assisting the GOL in obtaining funding for these projects.

The implementing agency is the National Energy Committee (NEC).

12. R.E. Project Descriptors:

Hydroelectric power; Biomass; Gasification; Energy planning; Firewood.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

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B. AID/Mission:

James Pagano, Field Project Officer

C. Contractors:

William Barron, Liberia National Energy Planning Advisor
Oak Ridge National Laboratory

Cathryn Goddard, Project Manager
Julia Demichelis, Project Coordinator
Energy/Development International
1015 18th Street NW, Suite 802
Washington, DC 20036 (202) 822-8817

D. Host Country:

Dr. Fodee Kromah, Chairman
Dr. Miedi-Himie Neufville, Secretary
National Energy Committee

17. Obligations by Fiscal Year (US$000):

FY 82	250

(Source: Energy, Forestry, and Natural Resources Activities in the Africa Region, p. 131, AID/Bureau for Africa, 4/86, PNAAW771)

18. Host Country Funding of R.E. Components (US$000): 83.5*

*For entire subproject; R.E. costs not specified separately.

(Sources: Annual Report: FY 1986, p. 35, 11/86, PDAAW029)

19. Summary of R.E. Costs (US$000):

Illustrative Budget

Technical Assistance	178.5
Local support	37.4
Micro-computer & equipment	5.0
Contingency & inflation	29.1
TOTAL	250.0

(Source: Grant Project Agreement, 7/29/83, PDJAE252)

20. R.E. Component Revisions: Not specified

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: April 1987 (jrl)

---------- AID RENEWABLE ENERGY DATA BASE ----------

1. Project Number: 6980424.12 2. Geo: AFRICA REGIONAL/ MALAWI

3. Title: ENENRY INITIATIVES IN AFRICA. SUBPROJECT 12: ENERGY FOR SMALL AND MEDIUM ENTERPRISES

4. Project Life/PACD: 1985-87/July 15, 1987

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Subproject: 150

   B. R.E. Components: Not specified

   (Source: Grant Agreement No. 85-698-1, 8/22/85, PDJAE236)

7. Loan or Grant/Appropriation Category (US$000):

   G / SD / 150

   (Source: Energy, Forestry, and Natural Resources Activities in the Africa Region, p. 133, AID/Bureau for Africa, 4/86, PNAAW771)

8. Project Purpose:

   To strengthen the institutional capability of INDEFUND and, to a lesser extent, other intermediate credit institutions (ICIs) to (1) identify, develop, appraise, and monitor energy-related improvements that can be made in small and medium enterprises; and (2) identify investment opportunities in the energy sector for small and medium enterpreneurs.

9. Renewable Energy (R.E.) Outputs:

   Solar drying activities for crops and fish undertaken; Solar water heating activities performed.

10. R.E. Inputs:

    Technical assistance; Training; Credit; Commodities.

11. Summary of R.E. Components:

    This subproject is designed to support INDEFUND, a Malawian intermediate credit institution, in improving its services to current and potential clients through the provision of

technical assistance in energy efficiency, conservation, fuel substitution, and energy supply. A Malawian engineer/ will join the staff of INDEFUND to evaluate and identify energy-related investments for small and medium enterprises; INDEFUND staff will be trained to perform these services; and INDEFUND clients will be advised on incorporating energy-related improvements into their businesses. INDEFUND will set up an energy improvement program for the financing of client goods and services to upgrade, improve, or modify energy facilities.

INDEFUND will have overall management and monitoring responsibilities. Projected activities include solar drying of crops and fish and solar water heating.

12. R.E. Project Descriptors:

Solar energy; Crop driers; Fish; Water heating; Energy conservation.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

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B. AID/Mission:

Murl R. Baker, Project Officer

C. Contractors:

Cathryn Goddard, Project Manager
Julia Demichelis, Project Coordinator
Energy/Development International
1015 18th Street NW, Suite 802
Washington, DC 20036
(202) 822-8817

D. Host Country:

INDEFUND
c/o Investment & Development Bank of Malawi Limited
(INDEBANK)
P.O. Box 358, Blantyre, Malawi

17. Obligations by Fiscal Year (US$000):

FY 85 150

(Source: Energy, Forestry, and Natural Resources Activities in the Africa Region, p. 133, AID/Bureau for Africa, 4/86, PNAAW771)

18. Host Country Funding of R.E. Components (US$000): 250* + 1,153.5** +

+For entire subproject, R.E. costs not specified separately.

(Sources: *Grant Agreement No. 85-698-1, 8/22/85, PDJAE236; **Annual Report: FY 1986, p. 37, 11/86, PDAAW029)

19. Summary of R.E. Costs (US$000):

ILLUSTRATIVE BUDGET*

	AID	INDEFUND	TOTAL
Energy officer	22.5	7.5	30
Energy Improvement Program			
Services	45	-	45
Commodities	55	-	55
INDEFUND staff, mgt and administrative support	-	28	28
INDEFUND Credit	-	200	200
Training	20	-	20
Misc. & Contingencies	7.5	14.5	22
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	150	250	400

*For entire subproject; R.E. costs not specified separately.

(Source: Grant Agreement No. 85-698-1, 8/22/85, PDJAE236)

20. R.E. Component Revisions: Not specified

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: May 1987 (jrl)

1. Project Number: 6980424.23 2. Geo: AFRICA REGIONAL/ KENYA

3. Title: ENERGY INITIATIVES IN AFRICA. SUBPROJECT 23: REGIONAL IMPROVED STOVES PROGRAM

4. Project Life/PACD: 1985-87/August 15, 1987

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Subproject: 200

   B. R.E. Components: 200

   (Source: Subproject Authorization, 8/23/85, PDJAE268 or PDAAR956)

7. Loan or Grant/Appropriation Category (US$000):

   G / 200 / SDA

   (Source: Project Data Sheet, 8/23/85, PDJAE268 or PDAAR956)

8. Project Purpose:

   To initiate an Africa-wide improved cookstove coordination and support program utilizing local personnel and expertise to identify, develop, promote, disseminate, and market improved cookstoves; train groups and individuals in stove evaluation; improve stove information exchange; and identify support for continued stove development, improvement, and marketing.

9. Renewable Energy (R.E.) Outputs:

   Stove workshops conducted; Groups/individuals trained in stove evaluation (e.g., testing, quality control); Stove information exchange improved; Projects assisted with the design, production, and marketing of stoves; Stove training and dissemination material produced.

10. R.E. Inputs:

    Technical assistance; Training; Travel; Commodities.

11. Summary of R.E. Components:

This subproject provides a grant to the Kenya Energy Non-Governmental Organizations Association (KENGO), a Kenya umbrella organization composed of local and international non-governmental organizations (NGOs), which is active in stove and community forestry work at both a local and regional level. The grant will enable KENGO to expand its improved stoves activities by the hiring of a bilingual subproject coordinator; financing workshops, training, technical assistance, and follow-up in the field; and funding limited publication and distribution of training and dissemination materials. The subproject is focused on the development of viable indigenous stove programs and improved interaction between key local and regional stove groups within Sub-Saharan Africa.

12. R.E. Project Descriptors:

Stoves; Cookstoves.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

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B. AID/Mission: Not specified

C. Contractors:

Cathryn Goddard, Project Manager
Julia Demichelis, Project Coordinator
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(202) 822-8817

D. Host Country:

Kenya Energy Non-Governmental Organizations (KENGO)
Karuna Road, Westlands, P.O. Box 48197, Nairobi, Kenya
Phone: 749747

602

17. Obligations by Fiscal Year (US$000):

FY 85 200

(Source: Action Memorandum for the REDSO/ESA Director, 7/9/85, PDJAE268 or PDAAR956)

18. Host Country Funding of R.E. Components (US$000): 115.5*
110**

(Sources: *Project Data Sheet, 8/23/85, PDJAE268 or PDAAR956; **Annual Report: FY 1986, 11/86, PDAAW029)

19. Summary of R.E. Costs (US$000):

FINANCIAL PLAN

Regional planning, strategy, and training workshops	56.5
KENGO operating expenses	44.5
Regional country reconnaissance	18.5
TA & training follow-up	41.0
Audio-visual program development	15.0
Dissemination materials	15.0
Contingencies	9.5

TOTAL	200.0

(Source: Subproject Paper, 8/15/85, PDJAE268 or PDAAR956)

20. R.E. Component Revisions: Not specified

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: May 1987 (jrl)

1. Project Number: 6980424.32 2. Geo: AFRICA REGIONAL/ LESOTHO

3. Title: ENERGY INITIATIVES IN AFRICA. SUBPROJECT 32: IMPROVED RURAL PRODUCTIVITY THROUGH MARKETING AND DISSEMINATING ENERGY TECHNOLOGIES

4. Project Life/PACD: 1984-86/January 31, 1987

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Subproject: 250

   B. R.E. Components: 250

   (Source: State Department Incoming Telegram, 9/84, PDJAE272)

7. Loan or Grant/Appropriation Category (US$000):

   G / SD / 250

   (Source: Energy, Forestry, and Natural Resources Activities in the Africa Region, p. 136, AID/Bureau for Africa, 4/86, PNAAW771)

8. Project Purpose:

   To increase agricultural productivity in the rural sector through the marketing and dissemination of energy technologies in Lesotho.

9. Renewable Energy (R.E.) Outputs:

   Survey of rural household energy use completed; Media campaign conducted using radio programs, extensive field training and demonstration, and other media; Metal stoves manufactured and marketed; Individuals trained in construction of stone paolas, and stone paolas built; Retained heat cookers, growholes, and solar food dryers built and marketed.

10. R.E. Inputs:

    Technical assistance; Training.

11. Summary of R.E. Components:

This subproject focuses on the manufacture, marketing, and dissemination of a number of R.E. technologies developed under the AID-funded Renewable Energy Technology Project (6320206). Technologies consist of stone paola stoves, metal stoves, retained heat cookers, growholes, and solar food dryers. The subproject also funded Phase II of a rural household energy use survey.

The Appropriate Technology Section (ATS) of the Ministry of Cooperatives and Rural Development (MINRUDEV) is the implementing agency. Save the Children Federation in Lesotho collaborated with the ATS in the construction of over 200 stone paolas in nearly one-tenth of all primary schools in the country.

12. R.E. Project Descriptors:

Energy use surveys; Stoves; Cookstoves; Retained heat cookers; Growholes; Solar energy; Crop driers.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

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B. AID/Mission:

Lyle Dean Bernius, Program Officer

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D. Host Country:

B. Kanetsi, Chief
Appropriate Technology Section
Ministry of Cooperatives and Rural Development

17. Obligations by Fiscal Year (US$000):

FY 85 250

(Source: Energy, Forestry, and Natural Resources Activities in the Africa Region, p. 136, AID/Bureau for Africa, 4/86, PNAAW771)

18. Host Country Funding of R.E. Components (US$000): Not specified

19. Summary of R.E. Costs (US$000):

Technical assistance	62
Training	14
Other costs	174

TOTAL	250

(Source: State Department Incoming Telegram, 9/84, PDJAE272)

20. R.E. Component Revisions:

A. Following USAID concerns over staffing and performance issues which led it to consider terminating the subproject, The Ministry of Cooperatives and Rural Development was given until December 15, 1986, to come up with a suitable operational plan. The PACD, which had been extended, was set for January 31, 1987, unless the Ministry could resolve these problems to USAID's satisfaction.

(Source: Annual Report: FY 1986, 11/86, PDAAW029)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: May 1987 (jrl)

---------- AID RENEWABLE ENERGY DATA BASE ----------

1. Project Number: 6980424.87 2. Geo: AFRICA REGIONAL/ MADAGASCAR

3. Title: ENERGY INITIATIVES IN AFRICA. SUBPROJECT 87: HYDROPOWER FOR AGRO-PROCESSING

4. Project Life/PACD: Unspecified/March 31, 1987

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Subproject: 150

   B. R.E. Components: 150

   (Source: Project Grant Agreement, undated, PDJAE263)

7. Loan or Grant/Appropriation Category (US$000):

   G / SD / 150

   (Source: Energy, Forestry, and Natural Resources Activities in the Africa Region, p. 138, AID/Bureau for Africa, 4/86, PNAAW771)

8. Project Purpose:

   To develop indigenous capabilities in Madagascar to use locally available energy resources for agro-processing and electricity generation through the local design, fabrication, installation, and operation of a prototype hydropower plant in the village of Ampefy; To improve Malagasy capabilities to identify and develop potential sites for small-scale decentralized hydropower systems; To encourage the development of small-scale hydropwer systems as an alternative to use of imported petroleum fuels.

9. Renewable Energy (R.E.) Outputs:

   Mini-hydro facility constructed and made operational at Ampefy; Local manufacturers of mini-hydro equipment assisted; Training provided for operation and maintenance of the Ampefy mini-hydro facility.

10. R.E. Inputs:

    Technical assistance; Training; Commodities.

11. Summary of R.E. Components:

This project will support construction of a 60 kW (30 kW in hydroelectric power and 30 kW in hydromechanical power) mini-hydro facility at Ampefy for agro-processing and local power supply. Local firms will receive training and participate in turbine redesign, manufacture, and installation.

The Energy Service of the Ministry of Industry, Energy and Mines is the implementing agency. The National Electricity and Water Corporation (JIRAMA) and the Ampefy village committee will assist with construction, operation, maintenance, and management of the facility.

12. R.E. Project Descriptors: Hydroelectric power.

13. R.E. Technology Applications: Not specified

14. R.E. Technical Reports and Publications: Not specified

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

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B. AID/Mission: Not specified

C. Contractors:

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D. Host Country:

Energy Service, Ministry of Industry, Energy and Mines

The National Electricity and Water Corporation (JIRAMA)

17. Obligations by Fiscal Year (US$000):

FY 86 150

(Source: Energy, Forestry, and Natural Resources Activities in the Africa Region, p. 138, AID/Bureau for Africa, 4/86, PNAAW771)

18. Host Country Funding of R.E. Components (US$000): 407*

*Does not include an estimated $106,000 value of in-kind contributions by local communities (labor and administration time).

(Source: Project Grant Agreement, undated, PDJAE263)

19. Summary of R.E. Costs (US$000):

ILLUSTRATIVE FINANCIAL PLAN

	USAID	GDRM	LOCAL	TOTAL
Civil eng. and construction	-	162.0	77.5	239.5
Mech. equip. fabrication & site assembly	13.0	90.0	15.0	118.0
Electrical & electronic equip.	27.0	22.0	-	49.0
Mech. equip. design, TA, installation & training	51.0	1.0	-	52.0
Electrical & electronic equip. installation, test, training	9.0	-		9.0
Vehicle/purchase and maintenance	18.0	10.0	-	28.0
Assessments	-	44.7	-	44.7
Other training/workshops	12.03	14.0	-	26.03
Printing/publications	-	10.0	-	10.0
Contingencies	19.97	53.3	13.5	86.77
TOTAL	150.00	407.00	106.00	663.00

(Source: Project Grant Agreement, undated, PDJAE263)

20. R.E. Component Revisions: Not specified

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: May 1987 (jrl)

1. Project Number: 9365701 2. Geo: CENTRALLY FUNDED

3. Title: LOW COST ENERGY TECHNOLOGIES*

   *Phase II of "PVO Alternative Energy Initiatives," 1979 - 1984.

4. Project Life/PACD: 1985-86(extended to 87)/June 30, 1987

5. Status: Active

6. LOP Funding (US$000):

   A. Entire Project: 350

   B. R.E. Components: 350

   (Source: Amendment No. 1 to Contract No. LAC-5701-C-00-5057-00, 6/86, PDFAV015)

7. Loan or Grant/Appropriation Category (US$000): Not specified

8. Project Purpose:

   To ensure that complete and current information is available to people and organizations throughout the world engaged in the research, development, and dissemination of small-scale renewable energy technologies; To promote and support research, development, dissemination, and evaluation of efficient, economic, and culturally acceptable small-scale renewable energy technologies.

9. Renewable Energy (R.E.) Outputs:

   Computerized data base on AID-funded R.E. projects; Assessment of wind energy to pump water in Morocco; Assessment of R.E. technologies in AID-funded projects; Design and implementation of an International Woodstove Network.

10. R.E. Inputs:

    Technical assistance.

11. Summary of R.E. Components:

    This project has three components: development of a computerized Renewable Energy Data Base describing AID-funded R.E. projects; compilation of R.E. assessments and undertaking

6/6

of one or two assessments identified by AID; and development of a multi-year international woodstove strategy and work plan for woodstove technology assessment, research and development, dissemination and marketing, and information sharing.

Volunteers in Technical Assistance is the implementing agency. Research Triangle Institute is a sub-contractor assessing wind energy for water pumping in Morocco.

12. R.E. Project Descriptors:

Photovoltaic energy; Windmills; Information centers; Wood; Stoves; Wind energy; Water pumps.

13. R.E. Technology Applications:

A. Employing life-cycle cost analysis, compared unit water costs for water pumped at 20 meter, 40 meter, and 60 meter heads by photovoltaic, wind, and diesel water pumps. The comparison was based on costs of pumps currently in Morocco and also included projected costs of "improved" windmills and photovoltaic (PV) pumps. ("Improved" windmills refer to new windpumps, designed recently in Europe for fabrication and use in developing countries, having lower costs and an 8% overall efficiency at minimum monthly wind speeds of 3, 4, and 5 m/s, compared with 6% overall efficiency for conventional wind pumps. "Improved" PV pumps refer to pumps with 45% pump efficiency (versus 35% for conventional solar pumps) and with cost reductions due to the lifting of the present import duty (55% of market value) and to some engineering improvements.) Windmill-pumped water costs were calculated at 2 m/s, 3 m/s, 4 m/s, and 5 m/s wind speeds. Extensive tabular data on pumped water costs and details on assumptions and life-cycle costing procedures are provided.

(Source: Water Pumping with Wind Energy in Morocco, August 1986, document number pending)

14. R.E. Technical Reports and Publications:

A. Water Pumping with Wind Energy in Morocco: Draft Report. Alan Wyatt, Research Triangle Institute, August 1986, 117 pp., document number pending.

This study reviews water resources and consumption, water pumps currently in use, wind regime, and past and present water-pumping windmill use in Morocco. It identifies key factors to windpump applicability as well as major constraints, and outlines a comprehensive revitalization program of the Moroccan wind industry. Included are results of a life-cycle cost analysis of the use of

windpumps versus two competing technologies, solar pumps and diesel pumps, under a variety of wind speed, water demand, and pumping head conditions. Unit water costs are tabulated for all three technologies and compared for a variety of applications. Extensive maps and tables are provided. Appendices include surveys of windmills in Morocco and names and addresses of Moroccan windmill manufacturers, distributors, and installers.

B. An Assessment of Evaluations of AID Renewable Energy Projects: A Search for Cost-Effective Replicable Technologies. William Ramsay and Michael Zink, Volunteers In Technical Assistance, Inc., Arlington, VA, March 1987, 37 pp., PDAAV570.

A review of AID project documents, essentially project evaluations and audits, has been made to determine which of the R.E. technologies utilized in AID projects are (1) the most cost-effective; (2) the most easily replicable; and (3) capable of making the best contribution to the development of private enterprise and/or the achievement of national economic goals. Summary findings are presented for photovoltaics (PV), wind energy, solar water heating, biogas, small-scale hydro, producer gas, wood/charcoal stoves, fuelwood production, and other R.E. technologies. Brief recommendations are made for further support. An appendix reviews some project experiences with R.E. technologies.

15. Evaluations/Major Findings: Not specified

16. Key Persons:

A. AID/Washington:

Sam Schweitzer
S&T/EY, 508 SA-18
235-8918

B. AID/Mission: Not applicable

C. Contractors:

Steve Hirsch, Project Director
Volunteers in Technical Assistance (VITA), 1815 N. Lynn Street, Suite 200, Arlington, VA 22209
(703) 276-1800

Alan S. Wyatt, Technology Specialist
Research Triangle Institute, Office for International Programs, P.O. Box 12194, Research Triangle Park, NC 27709
(919) 541-6485

616

D. Host Country: Not applicable

17. Obligations by Fiscal Year (US$000): Not specified

18. Host Country Funding of R.E. Components (US$000): 78.2*

*VITA's contribution.

(Source: Amendment No. 1 to Contract No. LAC-5701-C-00-5057-00, 6/86, PDFAV015)

19. Summary of R.E. Costs (US$000):

Salaries and Wages	93.250
Fringe Benefits	29.840
Occupancy	13.988
Consultants	54.213
Travel	20.000
Per Diem	20.000
Other direct costs	31.285
Project Review/Evaluation	5.000
Overhead	82.424
TOTAL	350.000

(Source: Amendment No. 1 to Contract No. LAC-5701-C-00-5057-00, 6/86, PDFAV015)

20. R.E. Component Revisions:

A. PACD extended from May 31, 1986, to June 30, 1987.

(Source: Amendment No. 1 to Contract No. LAC-5701-C-00-5057-00, 6/86, PDFAV015)

21. Follow-On Activities: Not specified

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: November 1986 (jrl)
Revised April 1987 (jrl)

1. Project Number: 9365703 2. Geo : CENTRALLY FUNDED

3. Title: ENERGY POLICY AND PLANNING

4. Project Life/PACD: 1979-83/PACD not specified

5. Status: Completed

6. LOP Funding (US$000):

   A. Entire Project: Not specified

   B. R.E. Components: Not specified

7. Loan or Grant/Appropriation Category (US$000): Not specified

8. Project Purpose:

   To promote policy development and planning with regard to fuel substitution and energy conservation in the non-oil producing countries of the developing world.

9. Renewable Energy (R.E.) Outputs:

   For Resources for the Future subproject: R.E. research reports completed.

   For BOSTID subproject: Workshop conducted and proceedings published.

   For Morocco subproject: Energy information system established; Microcomputer acquired and computerized energy investment model developed.

10. R.E. Inputs:

    Technical assistance; Training; Commodities.

11. Summary of R.E. Components:

    This project had three major components: a program of research on issues relating to energy and economic development through a Cooperative Agreement with Resources for the Future (RFF); an international workshop on Energy Survey Methodologies managed by the Board on Science and Technology for International Development (BOSTID) of the National Academy of Sciences-National Research Council; and

country-level energy planning assistance and studies implemented in a number of countries, including Sudan and Morocco.

Through the research component, RFF produced a series of discussion papers entitled "Energy in Developing Countries Series." This included a study on the cost effectiveness of various rural electrification schemes in India, conventional as well as decentralized renewable energy approaches.

The BOSTID workshop compiled, for the first time, an international listing of energy surveys and assessments, survey methodologies, secondary data collection, and data analysis systems dealing with developing countries; proceedings of the workshop were published. Many of the surveys dealt with the traditional renewable energy sources (firewood and charcoal), while several concerned other R.E. technologies. Included were studies in the Dominican Republic, Philippines, Jamaica, Indonesia, and Sudan as well as regional studies.

The Sudan Energy Policy and Planning subproject (SEPAP) received partial funding from the USAID-funded Energy Planning and Management Project (6500059) which succeeded it. The two projects overlapped in both time and scope. See project (6500059) for description and details of the SEPAP subproject.

The four principal activities of the Morocco subproject were the establishment of an energy information system, an analysis of energy demand management opportunities (especially for industry), an assessment of alternative energy supply technologies, and an analysis of investments required by various energy supply/demand scenarios. Energy and Environmental Engineering, Inc. (E3I) was the prime contractor, and Development Sciences, Inc. (DSI) was subcontractor.

12. R.E. Project Descriptors:

Energy planning; Energy policy; Energy surveys; Firewood; Charcoal; Photovoltaic energy; Biomass; Solar energy; Hydroelectric power; Biogas; Windmills; Sudan; Morocco; India; Indonesia; Philippines; Dominican Republic; Jamaica; India.

13. R.E. Technology Applications:

A. For technology applications of Sudan Energy Policy and Planning Project (SEPAP), see project 6500059.

14. R.E. Technical Reports and Publications:

A. Fuelwood Use in Morocco: Final Report. Energy and Environmental Engineering, East Cambridge, Massachusetts, October 1984, 61 pp., PDAAT834.

This study investigates fuelwood and charcoal use in the urban and rural areas of Morocco. It presents current fuelwood resources by region and tree specie, the fuelwood and charcoal demand structure, a regional and national energy balance, a 30-year demand/supply projection, and options and interventions, including various policy and technical options to remedy the fuelwood crisis. Numerous tables are provided, many in French.

B. Some Aspects of Rural Electrification in India. R. Venkatesan et al., Resources for the Future, Washington, D.C., July 1983, 160 pp., PNAAT488.

This report presents the findings of a cost-benefit analysis of centralized rural electrification projects in 30 Indian villages. It also examines the cost effectiveness of decentralized energy systems, namely biogas, horizontal axis windmills, vertical axis windmills, solar thermal, and photovoltaics. Electricity costs for decentralized sources were computed for three villages and compared to the cost of providing electricity through a centralized grid system.

C. Proceedings of the International Workshop on Energy Survey Methodologies for Developing Countries. Board on Science and Technology for International Development, National Academy of Sciences-National Research Council, National Academy Press, Washington, D.C., 1980, 224 pp., PNAAH940.

The workshop was conducted on Jekyll Island, Georgia, between January 21-25, 1980, with the aim of providing a forum for sharing knowledge and experience about ways to improve information for energy planning and policymaking. The proceedings present reports of rural, urban, industry, and transportation working groups. A directory of energy surveys, mostly unpublished, dealing with general energy survey designs, energy assessments, and data analysis systems is included, as are excerpts from some of the surveys. The list of surveys includes: "Dominican Republic Energy in the Food System Project" (No. 2-010); "Patterns of Energy Utilization in a Philippine Village: Sources, End-Uses and Correlation Analyses" (No. 2-013); "Energy Assessment in Jamaica" (No. 2-018); "Indonesian Energy Demand Survey: A Revised Methodology" (No. 2-025); "Wood for Fuel--Energy Crisis

Implying Desertification: The Case of Bara, The Sudan" (No. 2-027); "Methodology of Fuelwood Surveys, with Reference to Indonesian Data" (No. 2-030); Full survey reports (not all available) can be obtained by contacting VITA, 1815 N. Lynn Street, Suite 200, Arlington, VA 22209, (703) 276-1800.

15. Evaluations/Major Findings:

A. For the June 15, 1984, evaluation of the Sudan Energy Policy and Planning Project (SEPAP), see project 6500059.

B. Evaluation of the Sub-Project for Technical Assistance to the Government of Morocco on Energy Planning and Policy Development: Project Numbers 9365703 and 9365728. Daniel F. Kohler, John Peschon, and Gary Ackerman, USAID/Office of Energy, June 14, 1983, 57 pp., PDAAN950.

This evaluation looks at two centrally funded projects: Energy Policy and Planning (9365703) and Energy Policy Development and Conservation (9365728), treating them as a single entity, to which the Energy Planning Assistance Project (6080180) is a follow-on. Project 9365703 was extended and its funding nearly doubled. It was extended again, its funds increased, and it became incorporated under project 9365728. The major outputs of the two projects were the development of the ENVEST decision-making computer model and acquisition of a microcomputer for the Energy Directorate of the Ministry of Energy and Mines (MEM). Accomplishments and ENVEST capabilities fell far short of those planned. Nonetheless, contractor and MEM performance was judged very good, and the shortfall was attributed rather to overly ambitious expectations. A major concern of the evaluation team was the use of sophisticated computer language programs for ENVEST I and II, when simpler commercial software might produce the same results. Advantages and disadvantages of ENVEST I and II are discussed. Hardware modifications are suggested. A memo by Ulrich Ernst provides comments on the evaluation report. A description of the follow-on project, 6080180, is included.

16. Key Persons:

A. AID/Washington:

Pamela Baldwin, formerly S&T/EY, now PPC/DC/DAC, 3643 NS, (202) 647-3358

Jim Bever, NE/TECH/HRST

B. AID/Mission:

Gary Bricker
USAID/Morocco

C. Contractors:

Resources for the Future, Center for Energy Policy Research, 1616 P Street, N.W., Washington, D.C. 20036 (202) 328-5000

John Hurley, Deputy Director
BOSTID, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington, D.C. 20418

Ulrich Ernst, Resident Director
Energy & Environmental Engineering Inc. (E3I)

Development Sciences Inc. (DSI)
P.O. Box 444
Sagamore, Mass. 02561

D. Host Country:

For host country contacts for the SEPAP subproject, see project 6500059.

17. Obligations by Fiscal Year (US$000): Not specified

18. Host Country Funding of R.E. Components (US$000):

Not specified

19. Summary of R.E. Costs (US $000): Not specified

20. R.E. Component Revisions:

A. The entire project was extended by one additional year (FY81), with additional grant funding of $950,000 from SDP appropriation category.

(Source: Project Authorization, 5/81, PDAAG855)

B. The Morocco subproject originally consisted of an economic analysis of the energy sector and its relationship to the national development plan, emphasizing institution building and training. The project was extended, funds nearly doubled, and a new scope of work designed which placed importance on development of a decision-making model and acquisition of a microcomputer. The project was further extended, funds increased, the contractor (E3I) and the subcontractor (DSI) were interchanged, and another statement of work

developed as the project was placed under the Energy Policy Development and Conservation Project (9365728).

(Source: Evaluation of the Sub-Project for Technical Assistance to the Government of Morocco, 6/83, PDAAN950)

21. Follow-On Activities:

A. Sudan Energy Policy and Planning (SEPAP) subproject was followed by the USAID-funded Energy Planning and Management (EPM) Project (6500059) which continued much of the former's work. The two projects overlapped in time as well as scope, EPM beginning in August 1982 and SEPAP running from 1980 through March 1984. See the EPM project (6500059) for description of SEPAP.

B. The Morocco subproject work was continued under the Energy Policy Development and Conservation Project (9365728) to ensure continuity of energy planning technical assistance to the Government of Morocco until the Mission's follow-on Energy Planning Assistance Project (6080180) was initiated.

(Source: Evaluation of the Sub-Project for Technical Assistance to the Government of Morocco, 6/83, PDAAN950)

22. Comments on the R.E. Components: Not specified

23. Date/Data Preparer: November 1986 (jrl);
Revised February 1987 (jrl)

Agricultural wastes as fuel

2630016.01
3880045.07
4920294
4930304
4970266.03
4970268
4980265
5320065
6080159
6150205
6320206
6500041
6500059
6980424

Alcohols

4920294

Anaerobic digestion. See Biogas

Animal traction

4980265
5220157
6330209
6830205.01
6830240
6850201
6850208

Aquatic weeds as fuel

4970266.03

Bagasse as fuel

5320065

Banana residues as fuel

6500059

Bangladesh

3880045.07

Barbados

5380049

Battery chargers

4970266.03
6030013
6880217

Biogas - unspecified uses

2630103
4920294
4970266.03
5180029
6080159
6500059

Biogas for cooking

2630016.01
4930304
6880217

Biogas for industrial uses

2630016.01
4930304

Biogas for lighting

4930304
6080159
6880217

Biogas water heating

2630016.01
6880217

Biogas water pumping

3860465
4930304
6330209

Biomass. See specific topics

Botswana

6330209

Bread-baking

6080158.01

Briquetting

4970268
4980265
6150205
6500041
6500059
6980424

Building design

6030013
6320206
6330209
6830235
6880217

Canning

6080158.01

Cape Verde

6250937.03

Carbonization. See Charcoal production

Caribbean

5380049

Cassava as fuel

4970268

Ceramics firing

6080158.01
6490122

Charcoal kilns

4920343
4920375
4930304
5170144
6250937.07
6500041
6500059

Charcoal production

4920343
4920375
4930304
4970268
4980265
5150138
5170173
6150205
6250937.07
6500041
6500059
6980424

Charcoal stoves

4930304
4980265
6150205
6250937.07
6320206
6490122
6500041
6500064 (continued)

Charcoal stoves (continued)

6980424.23
6980424.32

Charcoal supply/demand analysis

4920375
4930304
4970318
5170126.01
5170173
6030013
6080180
6150205
6500041
6500059
9365703

Chipping machines

4980265

Coconut wastes as fuel

4980265

Coffee drying

5180029
5320065

Coffee husks as fuel

6150205
6980424

Cold frames. See Growholes

Cookers. See retained heat cookers

Cookstoves. See Charcoal stoves, Woodstoves

Costa Rica

5150138
5150145
5150175

Cotton stalks as fuel

6500041

Crop dryers - charcoal fueled

4980265

Crop dryers - solar

2630123.02
3860465
3910366
4920294
4930304
4980265
5180029
5220157
5320065
6320206
6880217
6980424.12
6980424.32

Crop dryers - waste fueled

4980265

Dendrothermal power plants

4920343
4920375
5150145
5150175

Desalinization

2630123.02

Distillation. See Solar distillation

Djibouti

6030013

Dominican Republic

5170126.01
5170143
5170144
5170173
9365703

Ecuador

5180029

Egypt

2630016.01
2630103
2630123.01
2630123.02
2980192

Electric power generation. See Dendrothermal power plants, Hydroelectric power, Photovoltaic topics, Wind electric power

Energy conservation

2630123.01
3910478
5180029
5320065
6030013
6150205
6980424.12

Energy planning

2630123.01
3860474
3910478
4920343
4930304

Energy planning (continued)

4970318
4970333
5150175
5170143
5180029
5220168
5320065
6030013
6080180
6150205
6500059
6830230
6980424
6980424.03
9365703

Energy training

3910366
4970300
5150175
5170143
6500059

Ethanol

4970266.03
6500059

Fertilizer evaluation

2630016.01

Fireless cookers. See Retained heat cookers

Firewood production

3860475
3860478
3860495
3910481
4920343
4920375
4930304
4970340 (continued)

Firewood production (continued)

5150145
5170126.01
5170144
5170173
5180029
5200274
5220168
5320065
5380049
6150205
6490122
6500064
6830205.01
6850219
6850243
6850247
6980424.01

Firewood research

3860474
3860488
3860495
3910481
4970318
5150145
5170144
5320065
6500041
6830230

Firewood supply/demand analysis

3910481
4970318
5150175
5170173
6030013
6080180
6150205
6330209
6490122
6500041
6500059
6830230
9365703

Fish drying

4930304
4980265
5180029
6250937.07
6880217
6980424.12

Fruit drying

2630123.02
4930304
5320065
6880217
6980424.12

Fuelwood. See Firewood

Furnaces

4980265
6080158.01

Gasification

3860474
4920375
4930304
4970266.03
4970340
5150175
6500059
6980424
6980424.03

Geothermal energy

4920262
4920264
4920343
5150138
5180029
6030013

Geranium flour as fuel

2630016.01

Grain drying

3860465
3910366
4930304
4980265
5180029

Grasses as fuel

5170126.01

Greenhouses

6320206
6640325

Growholes

6320206
6980424.32

Guatemala

5200245
5200274

Guinea

6980424

Haybox cookers. See
Retained heat cookers

Honduras

5220071
5220157
5220166
5220168

Hot springs

4920294

Human power

4980265
6330209

Hydraulic rams

5220157

Hydroelectric power

2630123.01
3860465
3860474
3910478
4930304
4930324
4970266.03
5150138
5170144
5180029
5270226
6080159
6320206
6500059
6980424.03
6980424.87

Ice-making

2630123.02
4930304

Incubators

6600114

India

3860465
3860474
3860475
3860478
3860488
3860495
4980265
9365703

Indonesia

4970266.03
4970268
4970300
4970318
4970333
4970340
4980265
9365703

Industrial applications

2630016.01
3860465
4930304
5320065

Industrial process heat

2630123.02

Industrial wastes as fuel

4930304

Information centers

3860474
4920294
4930304
5150175
5170143
5180029
5320065
6150205
6320206
6500041
6500059
6880217
9365701
9365703

Irrigation

2630123.02
3860465
4920375

Irrigation (continued)

4930304
5220071
5220157
6030013
6250937.03
6640325
6830235
6850208
6980424

Israel

2980192

Jamaica

5320065
5380049
9365703

Kenya

6150205
6980424.23

Kilns

4920343
4920375
4930304
5170144
6030013
6250937.07
6490122
6500041
6500059

Lesotho

6320206
6980424.32

Liberia

6980424
6980424.03

Lighting

2630123.02
3860465
4930304
5180029
6030013
6080159
6330209
6500041
6600114
6640325
6880217

Lumber drying

5180029

Madagascar

6980424.87

Malawi

6980424.12

Mali

6880217

Manure as fuel

2630016.01
6080159
6320206
6500059
6880217

Manure supply analysis

4930304

Methane

2630016.01
4930304

Methanol

4970266.03

Molasses as fuel

6500059

Morocco

6080158.01
6080159
6080180
9365703

Niger

6830205.01
6830230
6830235
6830240
6980424

Ovens. See Solar ovens

Pakistan

3910366
3910478
3910481

Palm trees as fuel

4970266.03

Papyrus as fuel

6980424

Passive cooling

4920294
6030013
6830235
6880217

627

Passive solar heating

6320206
6330209
6640325
6880217

Pedal power

4980265

Peru

5270226

Pest control

2980192

Philippines

4920262
4920264
4920294
4920343
4920375
4980265
9365703

Photovoltaic battery charging

6030013
6880217

Photovoltaic desalinization

2630123.02

Photovoltaic ice-making

2630123.02

Photovoltaic lighting

2630123.02
3860465
5180029

Photovoltaic lighting (continued)

6030013
6330209
6500041
6600114
6640325
6880217

Photovoltaic refrigeration

5180029
6030013
6330209
6500041
6600114
6640325
6880217

Photovoltaic water pumping

2630123.02
3860465
4920294
4930304
5180029
5220166
6030013
6080159
6330209
6500041
6600114
6640325
6830235
6880217
6980424
9365701

Photovoltaics - unspecified uses

4970333

Pyrolysis

4930304
4970268

Radios

3860465
6600114

Refrigerators

4930304
5180029
6030013
6330209
6500041
6600114
6640325
6880217

Retained heat cookers

6320206
6330209
6980424.32

Rice wastes as fuel

3880045.07
4920294
4930304
4970266.03
4970268
4980265

Rwanda

6980424.01

Senegal

6250937.07
6850201
6850208
6850219
6850243
6850247
6980424

Soil sterilization

2980192

Solar - unspecified uses

4970333

Solar concentrators

3860465

Solar distillation

4920294
4930304
5320065
6880217

Solar dryers - coffee

5180029
5320065

Solar dryers - fish

4930304
4980265
5180029
6250937.07
6880217
6980424.12

Solar dryers - fruit, vegetables

2630123.02
4930304
5320065
6880217
6980424.12

Solar dryers - grain

3860465
3910366 (continued)

629

Solar dryers - grain (continued)

4930304
4980265
5180029

Solar dryers - lumber

5180029

Solar dryers - tobacco

4930304

Solar dryers - unspecified uses

4920294
5220157
6320206
6980424.32

Solar furnaces

6080158.01

Solar heating

6320206
6330209
6640325
6880217

Solar heating of soils

2980192

Solar market analysis

2630123.01
3860474
3910478
5320065

Solar ovens

6080158.01
6320206

Solar ponds

5320065

Solar radiation measurement

3910478
4920294
4930304
5150138
5320065
6030013
6250937.03
6330209
6880217

Solar refrigeration and freezing

4930304
6330209

Solar water heating

3860474
4920294
5180029
5320065
6080158.01
6150205
6320206
6330209
6500059
6640325
6880217
6980424.12

Solar water pumping

6830235
6850208

Solar-powered wind measurement system

6330209

Somalia

6490122

Steam engines

4980265

Steam production

6080158.01

Sterilization of soils

2980192

Sterilizers

6080158.01
6600114
6640325

Stills. See Solar distillation

Stirling engines

3880045.07
4920294

Stoves

5200245
6030013

See also Charcoal stoves, Woodstoves

Sudan

6500041
6500059
6500064
9365703

Sugar cane wastes as fuel

5320065

Thailand

4930304
4930324
4980265

Threshing machines

4980265

Tobacco drying

4930304

Tunisia

6640325

Turbines

3860465
3910366
5180029

Uganda

6980424

Vegetable oils as fuel

5170126.01

Waste oil as fuel

6030013
6490122

Waste treatment

4930304

Water heaters - biogas fueled

2630016.01
6880217

Water heaters - solar

3860474
4920294
5180029
5320065
6080158.01
6150205
6320206
6330209
6500059
6640325
6880217
6980424.12

Water heaters - waste fueled

4980265

Water hyacinths as fuel

4970266.03
6500059

Water pumps - animal powered

5220157
6330209

Water pumps - biogas fueled

3860465
4930304
6330209

Water pumps - human powered

4980265
6330209

Water pumps - photovoltaic

2630123.02
3860465
4920294
4930304
5180029
5220166
6030013
6080159
6330209
6500041
6600114
6640325
6830235
6880217
6980424
9365701

Water pumps - solar thermal

6830235
6850208

Water pumps - wind

4930304
5220071
5220166
6030013
6080159
6250937.03
6330209
6500059
6640325
6880217
9365701

Water purifiers

6600114

Watermelon residue as fuel

2630016.01

Waterwheels

5220157

Wind electric power

2630123.02
4920294
4970266.03
6080159
6640325

Wind measurement

2630123.02
4920294
4930304
5150138
5320065
6030013
6250937.03
6330209
6880217

Wind water pumping

4930304
5220071
5220166
6030013
6080159
6250937.03
6330209
6500059
6640325
6880217
9365701

Wind-powered desalinization system

2630123.02

Wood. See Firewood

Wood chips as fuel

4920375
4930304
5150175

Wood shavings as fuel

6150205

Woodstoves

3910478
4930304
5180029
5220157
5220168
6150205
6250937.07
6320206
6330209
6490122
6880217
6880217
6980424.23
6980424.32
9365701

Zaire

6600114

Zeolyte refrigerators

6880217