PROJECT ASSISTANCE COMPLETION REPORT

RENEWABLE ENERGY FIELD TESTING
PROJECT NO. 263-0123.2

OFFICE OF ENVIRONMENT

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
CAIRO, EGYPT

Drafted by: PDS/ENV

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LIST OF ACRONYMS

EEA	Egyptian Electricity Authority
EREDO	Egyptian Renewable Energy Development Organization
GOE	Government of Egypt
IDEA	International Development and Energy Associates
LBII	Louis Berger International Inc.
LOP	Life of Project
MOEE	Ministry of Energy and Electricity
NREA	New and Renewable Energy Authority
ORNL	Oak Ridge National Laboratory
PACD	Project Assistance Completion Date
PP	Project Paper
ProAg	Project Agreement
PV	Photovoltaic
QHREA	Qattara Hydro Renewable Energy Authority
REFT	Renewable Energy Field Testing (project)
REIS	Renewable Energy Information System
USAID	US Agency for International Development

BACKGROUND

In 1982, USAID approved an "Energy Policy Planning, Renewable Energy Field Testing, Utilities Management Project" for Egypt. The terms of the agreement initiated a "Renewable Energy Field Testing" subproject (263-0123.2 -- hereafter referred to as "The Project") which called for assistance to the Government of Egypt (GOE) in the areas of field tests of renewable energy technologies, supporting analyses, training and new initiatives relating to renewable energy systems.

The project was authorized for $24.1 million. The GOE and USAID signed the first Activities Grant Agreement on August 29,1982, obligating $5.3 million and establishing a Project Assistance Completion Date (PACD) of December 31, 1986. Two subsequent Agreement Amendments increased the obligated total to $17.3 million and extended the PACD to August 28, 1990. The final three Amendments de-obligated $4.3 million, leaving a total obligation of $13.0 million and extended the PACD to August 27, 1992. The Egyptian contribution to the project, L.E.3.09 million in cash and in kind, exceeded the GOE ProAg commitment of L.E.1 million. (See Annex A for Activity Illustrative Financial Plan.)

PROJECT PURPOSE AND DESCRIPTION

The purpose of the project was to collect and analyze information on the technical, economic and cultural feasibility of utilizing selected renewable energy technologies through field tests in Egypt which permit a widescale replication by both the public and private sector in the ten year timeframe.

During the 70s, Egypt enjoyed a relative abundance of energy resources as well as the benefits of technological advances in electric power generation. These two factors sheltered Egyptian enterprises from the realities of resource constraints and allowed the GOE to heavily subsidize most categories of energy at the expense of revenues from petroleum export sales at world market prices. Declining oil production in the 80s, together with the recognition of the need to maximize foreign exchange earnings for development plans, necessitated the exploration of alternatives to fossil fuels to satisfy domestic energy demands.

The purpose of the project was to determine, through field tests and data collection, which renewable energy applications, if any, could potentially provide alternatives to conventional energy sources in Egypt. (The original scope of the project involved all renewable energy technology and related applications with the exception of biomass and mini-hydro, which were subjects of other specific USAID/GOE projects.) By performing this function, USAID sought to assist the GOE in achieving the effective development and utilization of indigenous and imported energy resources in a manner consistent with, and supportive of, overall national economic and social development plans. The project was divided into four major elements: Field Tests, Supporting Analyses, Training and New Initiatives.

I. PROJECT STATUS

A) FIELD TESTS

The purpose of this element was to conduct field tests and collect data on selected renewable energy technologies which would permit a judgement as to their technical, economic and social feasibility in a variety of Egyptian industrial, agricultural and remote settings. The Project Paper identified eleven field tests:

- Solar Water Heating for Milk Products Plant
- Solar-Assisted Fruit Dehydration
- Solar Energy and Heat Recovery for Poultry Processing
- Solar Energy and Heat Recovery for Textile Dyeing
- Solar Water Heating for Metal Processing
- Photovoltaic/Diesel-Powered Ice-Making System
- Photovoltaic-Powered Irrigation System
- Photovoltaic-Powered Reverse Osmosis Desalination System
- Village Wind Power System
- Wind-Powered Reverse Osmosis Desalination System
- Solar Ranking Cycle Cold Storage System

The project's field tests were based on the following criteria:

- The country's regional and overall growth and development requirements, emphasizing improvements in industrial and agricultural productivity and the potential for these technologies to contribute to that development in the long run;

- The technical feasibility of renewable energy technology to reliably meet GOE-identified needs and applications;

- The general applicability and replication potential associated with the selected application and technology;

- Local ability and willingness to utilize, maintain and contribute to the installation of the technologies selected and data collection requirements for the field test and the perceived chance for a successful test;

- The visibility of the field test and the potential opportunity to meet a need and to stimulate the introduction of the technology through a successful prototype or pilot plant field test;

- The economic and social feasibility of renewable energy technology compared to alternative conventional energy sources; and

- The inability or inappropriateness of conventional energy sources to meet current and/or future GOE-identified needs.

Economic feasibility was categorized in the following manner:

1) Technologies, matched to identified needs, which have proven nearly economic, compared to conventional systems, under certain conditions in the United States and elsewhere and are worth testing out in Egypt in order to obtain actual data on installation, operation and maintenance costs;

2) Remote applications, though not economic, where alternatives may not exist or where providing conventional fuel may be prohibitive in cost and unreasonable in terms of personnel requirements for operation and maintenance; and

3) Applications such as in the agriculture sector where GOE plans extensive development and, though perhaps not currently economic, so little information exists as to merit investigation.

Completion Status: The REFT did not fully accomplish its field test objectives. Only four of the planned eleven field tests were implemented. Three of the four suffered serious delays resulting in three PACD extensions. (For test descriptions, see Annex B.

For contracts information, see Section IV.) The status of the four field tests is as follows:

1) ***Poultry Processing Industrial Heat Process:*** E.A. Mueller Inc. successfully completed field test, design, installation, training and hand-over of plant to GOE.

2) ***Helwan Textile Industrial Heat Process:*** NREA completed the field test design about a year behind schedule and after they had obtained assistance from E.A. Mueller Inc., who originally were only responsible for procuring equipment. NREA oversaw installation of equipment which was completed in November 1991.

3) ***Photovoltaic/Diesel Power Ice-Making Plant:*** The field test contractor, Solarex, experienced serious delays and numerous installation shortcomings. Solarex finished the plant three years behind schedule. USAID extended the PACD to August 1992 to enable Solarex to complete its contractual obligations.

4) ***Ras Ghareb Wind Farm:*** Wincon completed basic construction by mid 1988, but failed to complete activity and subsequently defaulted on the contract resulting in a three year delay in completion of field test installation. IDEA had completed installation, acceptance test and turn-over by June 1991.

B) SUPPORTING ANALYSES

The purpose of this element was to provide both USAID and GOE with initial data and technical, economic and social analyses needed for decision-making and project implementation and to provide AID/W with information for an evaluation network. This element was categorized into four tasks:

1) The definition of additional candidate renewable energy technologies and applications and associated field tests;

2) The acquisition and analyses of technical and social data and the development of design and performance specifications required for specific field tests;

3) Continuing economic and environmental analyses covering both currently planned and future field tests of renewable energy applications; and

4) The establishment of an information system on this and other Egyptian renewable energy projects as well as state of the art developments which will permit a judgement as to the feasibility of their replication in the five to ten year time frame.

Completion Status: NREA has collected, analyzed and disseminated data from field tests. NREA, working with IDEA, completed and disseminated a comprehensive wind resource analysis. NREA produced a solar energy map for the entire country. NREA and their contractors conducted studies of wind generated electricity feasibility, markets for solar industrial heat and photovoltaic application, and renewable energy options appropriate for tourist village development along the Red Sea. The final tourist village report has been completed and disbursed to help planners of small and medium sized tourist villages on the Egyptian Red Sea coast to understand the options available to them and the effects of key decisions on energy consumption, water consumption, and the environment. Project contractors established the Renewable Energy Information System (REIS) at NREA and trained staff in its operation and maintenance. NREA currently is using the REIS to analyze environmental, technical, economic and social data for public and private sector companies.

C) TRAINING

The training element was designed to create better understanding of the technologies, economics and practical applications involved with the project. In order to implant such understanding across many levels within Egypt, the training element was classified into three categories: General, Field Test Training and Information Dissemination.

1) ***General Training*** included seminars for policy/decision-makers in the GOE ministries, governorate officials and industry executives. The seminars included broad exposure to relevant technologies, economics and specific applications. This category also included in-depth technical training of engineers and technical managers in design, installation and maintenance of renewable energy systems.

2) ***Field Test Training*** provided on-the-job training, on system operation and maintenance, to managers and personnel responsible for specific field test sites.

3) ***Information Dissemination*** involved mass communication of renewable energy potentials and the REFT project to the general public through television, radio, printed matter and test site visits.

Completion Status: The PP performance indicator for training called for 40-100 policy decision-makers and 40-100 engineers/technicians to be trained. By the PACD, 152 policy decision-makers and 500 engineers/technicians were trained by the project. Each field test included training for operation and maintenance.

D) NEW INITIATIVES

This element deals with concepts and proposals for new field tests, both unsolicited and requested, that were expected to be reviewed by GOE and USAID during the lifetime of the project. Additional field tests were also identified by studies under the Supporting Analyses element.

Completion Status: The PP performance indicators cited that six new initiatives be studied, with one or two implemented. By the PACD, 56 new initiatives were proposed and one was selected for implementation. This new initiative, a manual on renewable energy options for tourist villages was accomplished by IDEA under the extended PACD.

II. PROJECT ACHIEVEMENTS

Though the project was not a success, it did accomplish some achievements:

- Conducted four field tests; data were collected and analyzed.
- Trained 152 policy-makers and 500 engineers.
- Established an information system (REIS).
- Considered 56 new initiatives and implemented one.
- Completed numerous analyses.

III. GOE CONTRIBUTION

The Project Agreement indicated a GOE contribution in cash or in-kind of L.E.1 million. By the end of the project, GOE had spent L.E.3.68 million in cash and in-kind; this figure is more than the amount in the Project Agreement.

IV. IMPLEMENTING AGENCY

The New and Renewable Energy Agency (NREA) assumed the function of implementing agency for the project following its establishment in 1986. NREA became an autonomous body after spending more than a year under the financial jurisdiction of the Egyptian Electricity Authority (EEA). Before the establishment of the NREA, responsibility had been shifted among other Ministry of Energy and Electricity (MOE) agencies.

The Qattara Hydro Renewable Energy Authority (QHREA) was the first GOE implementing agency. In 1984, the GOE shifted implementation authority to EEA, whose main function is the generation of electric power in Egypt. In 1987, the GOE established the New and Renewable Energy Authority (NREA) and gave it responsibility for implementing the REFT Project. Only one GOE individual accompanied the project through these three different implementing agencies. The GOE shifts in implementing agencies were a major reason for the serious delays suffered by the REFT project.

The NREA's purpose is the development, testing and application of renewable energy technologies. Its broad mandate includes training, outreach and extension services. The NREA utilizes the Renewable Energy Information System (REIS). The REIS has enabled NREA to manage the information gathered by the field tests, its ancillary activities, as well as the information acquired by the NREA from external sources.

V. US CONTRACTORS

The following U.S. contractors assisted in implementation of the project.

CONTRACTOR	SERVICES	SIGN DATE END DATE	CONTRACT* DOLLARS	CONTRACT TYPE
Louis Berger	Technical Assistance	05/28/84 04/21/89	$5,072,032	FP-Direct
Solarex Corp.	PV/Diesel Ice maker	06/08/87 06/28/91	$1,155,080	FP-Direct
Wincon Energy Systems Inc.	Ras Ghareb Wind Farm	06/30/87 08/28/90	$1,302,480	FP-Direct
EA-Mueller Assoc.	Industrial heat Poultry/Textile	07/03/88 02/28/91	$1,583,465	FP-Direct
Oak Ridge National Lab.	Project Tech Review	03/89 08/89	$34,450	CR-Direct (Buy-In)
Int'l Develop. & Energy Assoc.	Technical Assistance	04/20/89 06/28/90	$2,505,278	CR & FF Direct (8a)
Burns & Roe Co.	Wind power plant pre-feasibility	09/22/89 07/17/90	$220,484	CR & FF Direct
IDEA	Ras Ghareb Wind Farm	06/27/90 06/28/91	$187,737	CR & FF
PROJECT TOTAL			$11,840,522	

LEGEND:

CR	Cost Reimbursable
FF	Fixed Fee
Direct	USAID-Contractor Agreement
8a	Minority & Women Firms
FP	Fixed Price

* Represents Actual Expenditures under each contract

VI. EVALUATION

During the life of the project AID contractors conducted one formal evaluation and one technical review.

In June of 1987, a team from Delucia and Associates Inc. prepared a **Mid-term Evaluation**. It concluded that the evaluation should have been started a year earlier and that the project itself was behind schedule. The team also said that, although technical assistance to the project had been insufficient, the NREA was finally operational, several renewable energy applications looked promising and renewable energy was gaining political support in Egypt. It recommended a PACD extension in conjunction with a redesign of the project to put it on a more solid economic and administrative footing. The team also suggested that USAID and GOE promote greater private sector participation in training, testing and funding involved with the project.

In June of 1989, a consultant team from Oak Ridge National Laboratory prepared a **Review of New Implementation Activities**. The report recommended a PACD extension of two years, an adjustment in the nature of the technical assistance contract and a shift in project attention from implementation of remaining field tests to the creation of an information system, information dissemination, economic and replicable analyses and smaller, more practical demonstrations of renewable energy.

VII. AUDIT REPORT

Project was not audited.

VIII. OUTSTANDING PROBLEMS AND RESOLUTIONS

The project partially fulfilled its immediate purpose of conducting tests, analyzing data, establishing an information dissemination system and providing training. However, significant progress was not made towards solving the main problems, development and utilization of renewable energy, i.e., economic, bureaucratic, and administrative constraints. In short, the project addressed lack of appropriate technology which is not the main constraint.

IX. FINAL DESIGN ADJUSTMENT RECOMMENDATIONS

There are no recommendations for adjustment in the design of the project at this point.

X. POST-PROJECT ACTIVITIES COMPLETION DATE - AID RESPONSIBILITIES

With a continued interest in renewable energy, USAID will maintain its relationship with NREA following the termination of the project. USAID will continue to monitor NREA installation of the industrial process heat system at the Helwan textile plant.

XI. LESSONS LEARNED

(1) Successful technology transfer includes not only adequate attention to technological issues, but also financial viability including appropriate policy on pricing, incentives and subsidies; local infrastructure for technology dissemination, that is, for the manufacture, sales and marketing, and development of a strategy for organizational financial, technological and policy elements required.

(2) Interaction between U.S. contractors and the GOE should be improved. The REFT project and the field tests system designs suffered from insufficient interaction among the U.S. contractors, the NREA staff, and the host organization personnel. A second related problem dealt with the amount of time and money spent in writing, reviewing, and obtaining approval from NREA and USAID/Cairo for field test application and system design documentation.

(3) Training must be structured to provide both comprehensive and better quality engineering-experimental data acquisition and analysis experience (including micro-computer use), as well as complete practical exposure to hands-on renewable system operation and trouble shooting in similar environments.

(4) Ensuring that a system can "pay" its own way, through some form of a monetary collection model, can greatly contribute to project sustainability.

(5) When possible, portable data loggers should be used instead of central PC units, which can complicate data collection processes and are more susceptible to hardware and software failures under adverse environmental conditions.

(6) Planners should avoid excessive detail when drafting Requests for Proposals (RFP) for smaller-scale field tests.

(7) Overly centralized project management and evaluation can create unnecessary delays. Also, localized evaluation can produce more productive results since evaluators are more familiar with projects and their implementors.

RECOMMENDATION

That the Associate Director, Program Development and Support (PDS), approves the Renewable Energy Field Testing Project's Project Assistance Completion Report and make a recommendation to the Mission Director to change the project status from "active" to "completed".

APPROVE: Jeffrey C. Malick

DISAPPROVE: _____

DATE: 12 August 1993

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ANNEX A

RENEWABLE ENERGY FIELD TESTING ACTIVITY ILLUSTRATIVE FINANCIAL PLAN

(Following the Fourth Amendment to the Activity Agreement)

(000's)

	(----------USAID----------)			(-GOE-)
ACTIVITY ELEMENTS	PREVIOUS BUDGET	DEOBLIG. AMOUNTS	NEW BUDGET	GRANTEE (LE)
Technical Assistance	5,522	(16)	5,506	1,045
Field Tests	10,000	(2,899)	7,101	1,418
Training and Invitational Travel	1,000	(699)	301	75
Evaluation	50	(6)	44	550
Contingency	698	(685)	13	0
Audit	30	5*	35	1,273
TOTAL	17,300	(4,300)	13,000	4,361

* Not a deobligated amount; this line item was increased by $5,000 to pay for additional audit costs.

ANNEX B

FIELD TEST DESCRIPTIONS

(1) SOLAR THERMAL INDUSTRIAL PROCESS HEAT AT GENERAL POULTRY COMPANY AND HELWAN TEXTILE FACTORY

Just before he departed post in 1987, the Acting Mission Director approved the Helwan field test in a meeting with the Minister of Electricity. In July 1988, USAID signed a fixed price contract with E.A. Mueller for the design and installation of an Industrial Process Heat (IPH) field test at the General Poultry plant and procurement of equipment for the Helwan field test. The General Poultry plant application was tested and accepted during the period of March 24, 1990 through April 23, 1990. NREA was responsible for designing and installing the Helwan IPH system using GOE funds. E.A. Mueller was responsible for procuring the commodities for the Helwan IPH system and for "system supervision support and system check-out support." Thus, E.A. Mueller could not complete its contract obligation or obtain its final payment until after the Helwan IPH system was fully installed and acceptance tests were completed.

NREA was slow to complete the Helwan design and, thus, USAID amended the E.A. Mueller contract to provide NREA assistance with this task. Completion and turnover of the first IPH was accomplished by May 1990. Installation of the Helwan IPH was completed in November 1991. The GOE was responsible for funding and implementing installation of these activities.

Actions Tasks	Responsibility	Target Date
- Delivery of equipment for Helwan plant	E.A. Mueller	June 90
- Go out for bid	NREA	May 90
- Award of GOE funded contract for installation	NREA	November 90
- Completion of installation	NREA	September 91
- Acceptance test & training	NREA	October 90
- System supervision support & system check-out support	NREA	November 91

(2) PHOTOVOLTAIC (PV) ICE-MAKER

In June 1987, USAID signed a fixed price contract with Solarex Inc. for the design and construction of a hybrid diesel-PV ice-making facility located at Wadi El Raiyan, an isolated community about 40 miles west of Fayoum. The intended use of the ice was for preserving fish caught in the lake of Wadi El Raiyan.

Solarex completed construction of the plant in May 1989, but was slow to submit acceptance test procedures and training plans, despite USAID's persistent inquiries. In meetings with USAID and NREA on February 11, 1990, Solarex agreed to work with NREA to complete the contract by June 1990. Acceptance test/turnover begun in April 1990. The original Solarex contract did not provide for water purification because all ice was intended only for preserving locally caught fish. A reverse osmosis water purification plant was not added to the Solarex contract on the grounds that the ice was for preservation of fish, the work could not be accomplished before the PACD and there were ample warning signs on the plant (in English and Arabic) indicating that the ice was made from non-potable water. The acceptance testing was completed in June 1992 due to delays caused by the Gulf War, shipping problems for equipment and a reluctance on the part of NREA to sign on approval documents for completed activities. The plant was turned over to NREA following completion of contract documents with Solarex Inc. in February 1993.

Actions Tasks	Responsibility	Target Date
PV Ice Plant		
- Acceptance Test, training and turnover	Solarex, NREA	June 92

(3) WIND ELECTRICITY GENERATION

In June 1987, USAID signed a fixed price contract with Wincon Energy Systems for design and construction of four, 100kw wind turbines at Ras Ghareb on the Red Sea Coast. Wincon completed basic construction in mid 1988. However, Wincon suffered severe financial and cash flow problems and was not able to deliver the data collection system and some of the control equipment required under the contract. USAID terminated the contract for default in August 1989.

HRDC/S&T hired a contractor to provide and install the needed data collection system and control equipment and make the necessary repairs. This work cost $180,000 and took nine months from the date of contract award. IDEA developed a preliminary proposal to do the required work. The schedule of tasks below was based on non-competitive procurement.

Actions Tasks	Responsibility	Target Date
Ras Ghareb Wind Farm		
- PIO/T issued	HRDC/S&T	April 90
- Contractor's proposal	Contractor	May 90
- Contract award	USAID, Contractor	July 90
- System evaluation	Contractor	August 90
- Start procurement	Contractor	September 90
- Start installation	Contractor	January 91
- Complete installation	Contractor	March 90
- Acceptance test/turnover	Contractor, NREA	May 91