PDGAR 709

UNITED STATES GOVERNMENT

memorandum

DATE: March 11, 1986

REPLY TO ATTN OF: Mark H. Karns

SUBJECT: Retrospective Analysis of Hammam Biadha Renewable Energy Project

ATTACHMENT: March 18, 1986 Yellow Top on same subject

TO: Mr. James R. Phippard, Director

The long-awaited Hammam Biadha PV system socio-economic evaluation report was prepared by two RMA consultants (sociologist/anthropologist and an economist) based on a consultancy to Tunisia from December 30, 1985 to January 7, 1986. Malcolm Lindsay, Resident RMA Energy Advisor, participated in the evaluation. I developed the scope of work and supervised the consultants' work.

The report was financed from the RMA Host Country Contract financed under the Energy Planning Project 664-0326.

You may recall that after 19 months of continuing discussions with STEG on completing the Social Impact Analysis (SIA) called for under Project 664-0325, STEG still refused to complete the SIA, refused to show us a copy of what had been done to date on it and refused to agree on the need for even finishing it or engaging US consultants to assist STEG to finish the SIA.

Negotiations with the Société de la Maitrise de l'Energie (SME) to finance a surrogate SIA using RMA Inc. as the contractor were concluded successfully during June 1985 (the PACD of Renewable Energy Project 0325 was 12-31-84 and all funds were expended).

I've informed RMA and SME that we will treat the evaluation report as a draft-final on which we may comment for subsequent modification. The SME will do the same.

The report addresses each point of the scope of work. In particular, it documents a number of "lessons learned." These reveal that project design was flawed, implementation was spotty, and that project records in AID, in the Peace Corps, and particularly in STEG, were incomplete or missing. This lack of project data, combined with STEG's lack of cooperation in sharing the incomplete SIA or any other data, were serious obstacles to undertaking this retrospective analysis/evaluation. Hence, the report is liberally sprinkled with qualified statements on findings.

Per your 3/-18 note, the report's basic findings were:

1. The PV system is operational and providing electricity to the village.

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2. Agricultural demonstration effects planned were not successful. Informal demonstration effects have resulted (the photovoltaic system has been regularly visited by numerous GOT and other donor personnel, gaining wide publicity for the PV system).

3. Some STEG personnel have benefited from training in operations.

4. The system is not covering its recurrent costs and is not amortizing any of its fixed investment costs. The system only generates about $800 annually in revenues, and is losing $13,000 (equivalent) per year as a result of its operation.

5. Although data are not available to permit an adequate cost/benefit economic analysis, it is clear from the large initial investment, the large yearly operating loss, and the small number of beneficiaries (25 families and a school), that the system's operation is uneconomic and represents an inefficient deployment of GOT (and project) assets.

6. Socio-economic impacts are limited and do not justify either the initial system investment nor the net yearly operating loss.

7. The project, as designed, was really an integrated rural development project in disguise. There was a serious lack of institutional coordination among GOT entities which were involved in project implementation. STEG, as the national electricity company, was inappropriate as the prime GOT implementing agency. (The report implies that the Ministry of Agriculture might have been more appropriate since the project was really an integrated rural development activity).

8. No new net economic activity has resulted in the village due to the PV system.

9. There is little evidence that the village's aggregate productivity or the local farm economy were improved by the project.

10. The only employment impact of the project was generation of jobs for 4 STEG persons (3 guards and 1 operator for the PV system).

11. The report raises the question of what should be done with the system (given the generally dismal findings and apparently equally bleak future). The report mentions that the system could be made part of a controlled and monitored research station for applications in drip irrigation, solar greenhouses, and small revenue producing activities connected with the village school.

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I would be pleased to discuss the report's findings with you at your convenience. After our acceptance of the report, I'll pouch a copy to ANE/TR/EY.

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REPORT RMA/GOT-TD-39

RETROSPECTIVE ANALYSIS OF HAMMAM BIADHA RENEWABLE ENERGY PROJECT

(Huddleston/Roberts Trip Report)

in

THE TUNISIAN ENERGY PLANNING PROJECT

for

THE GOVERNMENT OF TUNISIA
MINISTRY OF NATIONAL ECONOMY

by

RESOURCE MANAGEMENT ASSOCIATES OF MADISON, INC.
520 University Avenue, Suite 260
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February 7, 1986

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I. INTRODUCTION AND SCOPE OF WORK

This report is an evaluation of the renewable energy project undertaken in Hammam Biadha, Tunisia. The evaluation is based upon analysis conducted by Mr. Allen Roberts and Mr. Jack Huddleston of Resource Management Associates (RMA), in Tunisia from December 30, 1985 to January 7, 1986. The evaluation covered two broad areas of interest: 1) the specific project and its components, and 2) the demonstration (or technology transfer) effort that was to promote development of in-country expertise and experience in renewable energy technologies.

The scope of work for this evaluation effort included the following elements:

1. Examine the background and perceived objectives of the organizations and individuals involved with the project.
2. Assemble data on the socio-economic and technological aspects of the project, including project impacts.
3. Assess the success of the project in meeting its various objectives.
4. Assess the financial and economic dimensions of the project, where feasible.
5. Examine the implications of the project for future renewable energy projects elsewhere.

Mark Karns, Program Development Officer, (AID-Tunis), summarized the purpose of the evaluation succinctly, stating that the study should document the "lessons learned" from the Hammam Biadha renewable energy project.

Numerous interviews conducted prior to and during the site visit to Tunisia are reported in Appendix A. Visits to the village were undertaken on December 30, 1985, and January 3, 1986. The short time available for project evaluation, and a paucity of benchmark and followup data prevented detailed analysis of certain questions. Dr. Malcolm Lindsay of RMA was especially helpful in facilitating the analysis that was undertaken.

This report has the following structure. Section II describes the objectives and assumptions that were associated with project conception. Section III gives a brief description of the project and then assesses its technical and economic performance. An attempt is made to document the dimensions of the cost-revenue imbalance that is associated with the existing project. Section IV presents an evaluation of the demonstration aspects of the Hammam Biadha effort. For reasons which are documented, the demonstration impact of the project is minimal in several key areas. Section V represents our evaluation of the social and economic impacts of the project. Although such measurement is difficult, little evidence was found of socio-economic impact. Finally, in Section VI, the "lessons learned" are identified and possible future options are discussed.

II. BACKGROUND

A. National Energy Strategy

The petroleum crisis of 1973 shook both oil producers and those dependent upon them. In previous years, it seemed that fossil fuels might supply the growing industrial sectors and rural electrification programs of developing countries "forever." In the US, Secretary of State Henry Kissinger promised delegates to the UN General Assembly to make American advances in renewable energy technology available to developing countries, and a set of policies were devised. The National Aeronautics and Space Administration's Lewis Research Center (NASA LeRC) was charged with conducting research on terrestrial applications of the photovoltaic technology developed for the space program, as well as several other programs to improve wind turbines, storage batteries, and other relevant devices. The Solar Energy Research Institute (SERI) was founded to further explore both passive and active solar applications. The Carter Administration proposed that by the year 2000, the United States should approach a 20% dependency on renewable rather than fossil energy sources. Many states and municipalities created tax and other incentives to encourage progress toward this goal. Concern for the plight of developing countries was linked with enthusiasm at home for implementing "clean" renewable energy programs.

Tunisia, as an oil-producing state, did not suffer from the oil crisis as did many other, less fortunate developing countries. Yet in the mid to late 1970s, there was widespread awareness among GOT decision-makers that oil reserves were finite, and that action must be taken to define and develop alternative energy sources (Stevenson, 1979). The Ministry of Industry, Mines, and Energy (MIME) of the GOT participated in the Tenth World Conference on Energy in 1977, and proposed that the Eleventh, to be held in 1980, concentrate on "Energy Problems of the Third World." A Tunisian led the ad hoc planning committee meeting in 1978 and suggested that each participant country

draw up an energy strategy. The GOT forecast the following possible scenario for Tunisian energy demand (MIME, 1979):

Energy Source	Annual Energy Consumption (in 10^{15} joules) 1972	1985	2000	2020
Oil	115	216	195	106
Gas	46	77	143	125
Coal	66	115	170	259
Nuclear	2	23	88	314
Hydro	14	24	34	56
Non-Conventional Oil & Gas	0	0	4	40
Solar, Geothermal, & Biomass	26	33	56	100
Total Energy Consumption	269	488	690	1000

With a more than three-fold growth in energy consumption forecast by the year 2020, oil production would peak in the mid-1980s and then decline rapidly as local stocks were depleted. Other energy sources--including renewables--would be an increasingly important part of total energy supply (MIME, 1979). It was recognized that other factors might intervene, such as access to Algerian gas; but that immediate action would be necessary to prepare for the moment, sometime in the late 1980s or early 1990s, when Tunisia would no longer be self-sufficient in oil production. By 2020, renewables might be expected to supply nearly the same percentage of energy as oil.

B. Renewable Energy Strategy

A significant place in the GOT energy strategy was given to the promotion of solar energy technologies. Tunisia receives somewhere between 2800 and 3600 hours of sunlight per year, so that among renewable energy sources, the sun is of obvious importance. AID/Tunisia Science and Technology Officer Richard Stevenson noted that "GOT officials have a broad understanding that future energy options will generally cost the consumer more that current fossil fuel supply technologies, and in particular the capital requirements will be greater per unit of production capacity than present conventional technologies" (Stevenson, 1979:11). In other words, the ten percent dependence upon renewable energy sources that the GOT foresaw by the year 2020 would require significant initial capital investment, which the GOT was willing to undertake.

According to the energy strategies of both GOT and AID, innovative research and development work should begin as soon as possible, "so that the trial period can occur before real needs are felt" and that "when measures must be taken, a wide range of solutions will be ready" (Gorden, et al, 1979:6,8). Plans were made for basic research, as well as for the eventual production of renewable energy system components. A team of researchers was assembled at the National Program for Research on Solar Energy within the National Institute for Technical and Scientific Research (INRST), to study the creation of production facilities in Tunisia for photovoltaic cells at the Photovoltaic Unit of Borj-Cedria (STEG, 1984:3,15).[1]

In the late 1970s, there was "a uniformly high level of awareness of the general energy problem faced by the nation", yet enthusiasm for deploying new--and particularly renewable--energy technologies was "usually based on only fragmentary knowledge" of the same. It was suggested that an AID program be undertaken to assist in the "comprehensive, analytical, and disinterested" dissemination of "information on alternative energy technologies examined in the Tunisian

setting" (Stevenson, 1979:2,4). The Hammam Biadha renewable energy program would be an important component, "to demonstrate the economic, social, and technical value of alternative energy sources and technologies in assisting development and in improving the quality of life in Tunisia" and "to demonstrate the ability of alternative energy/resources of sun and wind and alternative energy technologies to meet the energy needs of a village and its surrounding agricultural activities" (AID, 1979). These goals were a first exemplification of the broader AID "Tunisia Energy Policy" (Stevenson, 1979).[2] The key to these goals, as posited in 1979, was the verb to demonstrate.

The Hammam Biadha demonstration would be based upon a village project of several parts. It is essential to differentiate between these two terms, "demonstration" and "project". A few individuals in this small, rural community would receive training and direct, tangible benefits from use of the renewable energy systems. This would be the Hammam Biadha "project." More importantly, as the "demonstration" was originally conceived, AID would use Hammam Biadha as the backdrop for training of upper and middle echelon GOT decision-makers for whom renewable energy applications would have relevance (e.g., staff from ministries of energy, agriculture, health, education, and the like). Tunisian engineers or other experts would be sent to the U.S. for intensive training. Aside from these organized efforts, the Hammam Biadha demonstration could provide an important "hands-on" experience for interested individuals from within Tunisia and from abroad. Such improvement of understanding would "long outlast the project period and . . . continue to help Tunisians help themselves" (Gorden, et al, 1979:3).

C. The Hammam Biadha Project

Hammam Biadha is composed of two villages in the Omda or administration unit of the same name, in the chef-lieu of Le Krib, Governorate of Siliana. In 1980, some 2000 people lived in the Hammam

Biadha Omda. The demonstration facilities are in South Hammam Biadha, a small weekly market is held in North Hammam Biadha, and homestead farms are sprinkled across the 18,000 hectares of valley floor running roughly north-south. About 6000 hectares are under cultivation, most in cereal crops (wheat and barley). In South Hammam Biadha in 1980, twelve families of about fifty-three individuals lived around a small center composed of a mosque, a primary school, two small stores, and a dispensary. The village is sixteen kilometers from Route GP.5 where it passes through Bordj Messaoudi, and the same distance from the national electrical grid which follows that road. No plans existed in 1979 to connect Hammam Biadha to the grid, which combined with the active agricultural life, the enthusiasm for the proposed program of Hammam Biadha residents, and its relatively convenient location (about 160 km from Tunis and 25 from Le Krib), made Hammam Biadha an appropriate site choice (Anon-[Tahar Bsila] 1980; STEG 1984:7-8).

A range of renewable energy technology applications would be implemented at Hammam Biadha in two categories of power needs: agricultural and village. In 1979, it was felt that "the agricultural sector provides . . . the best target of people's needs toward which new energy technologies can be directed so as to increase productivity without accentuating dependence upon fossil fuels" (Gorden, et al, 1979:3). Tunisia receives a great deal of sunlight annually, and has semi-arid, arid, and desert climates in its various regions. Irrigation is a preoccupation. In comparison to open-trench irrigation practiced by ancient methods and now often facilitated by diesel pumps, drip irrigation appears to be an innovative method of water and energy conservation: as much as sixty percent of water can be saved over the open trench method.

In the mid-1970s, the Tunisian Centre de Recherche du Genie Rural (Center for Research on Rural Development/Engineering) began studying drip irrigation, as linked to photovoltaic (PV) powered water pumps. A Solar Power Corporation 600-watt PV array was installed at the Hendi Zitoun experimental station in Central Tunisia; an ALTA water pump was

used to fill a $1000m^3$ tank, to provide water for irrigation of fruit-tree saplings. Tunisian scientist S. El Amami suggested that ten thousand similar drip irrigation systems be installed throughout Tunisia as a practical means of increasing agricultural output. He estimated that the drip irrigation systems would be cost-competitive with such large-scale projects such as the Sidi Saad dam, while doubling the surface area that could be irrigated from the dam and its associated water system (El Amami 1978:133-7). The deployment of so many systems would greatly decrease the cost of each one of them. Drip irrigation might be perfected through the pilot project at Hammam Biadha. Furthermore, as Gorden noted, American agronomists had only limited experience with this method at the time, and the Hammam Biadha drip irrigation project might prove a valuable demonstration providing reverse technology transfer, from Tunisian back to U.S. farmers (Gorden, et al, 1979:9).

Drip irrigation could be linked to use of energy-efficient, passive solar greenhouses. In the late 1970s, while greenhouses might be fairly common in Tunisia for use as seedbeds and for the growing of less-hardy plants, none existed that was equipped with a passive solar heat storage and recirculation system. This new technology, developed in the U.S. and elsewhere, allows maintenance of a temperature above 4^oC, critical for growing tomatoes and other vegetables during the winter.

These agricultural applications would be linked to village power needs, "based on the desire to minimize rural-urban migration and to concentrate people in villages in Central Tunisia. Hence, the need for rural electrification to help make village life more attractive" (Scudder, 1984:4). As Gorden, Schaffer and Westfield noted in 1979, "our Tunisian colleagues have found that one cannot expect an increase in production/output from an agricultural application of solar energy, when farmers are leaving rural areas to live in the capital" (1979:6).

The village-power applications, then, were conceived originally as secondary to and in support of the primary objective of improving agricultural output through use of renewable-energy technologies. If

the quality of life for rural villagers could be improved by providing electricity for home (lighting, TV, and small appliance), municipal (dispensary, school, mosque), and commercial (stores, cafe, barbershop) uses, then people might be more enthusiastic about remaining in rural settings. It should be noted that the predominance of the agricultural applications of renewable energy technologies was not stressed in the wording of the eventual AID project paper and succeeding documents; and to foreshadow this paper's conclusions, the agricultural aspects have proven the weakest portion of the overall project at Hammam Biadha.

The Hammam Biadha project was to have a number of different technology demonstrations. As such, a critical assumption as the program was being conceived[3] was that staff of the various GOT ministries and other institutions would join in a collective effort. In effect, energy should not be considered an end unto itself, but rather a means to achieve certain goals. Renewable energy technology applications in Hammam Biadha were meant to do such things as increase crop production (Ministry of Agriculture); provide power for lighting, refrigeration of vaccine, and other devices at a dispensary, and so improve health care delivery (Ministry of Health); and provide electricity for lighting, audio-visual equipment, wood shop tools and sewing machines at the school (Ministry of Education).

In 1979, Richard Stevenson of AID/Tunis was struck by the "apparent willingness to cooperate across organizational lines, both within and among ministries and between ministry and private sector groups" in trying to solve Tunisia's energy dilemmas (Stevenson 1979:4,8). As a project, Hammam Biadha[4] would be most effective if extension agents, researchers, and planners from each institution were to take active interest in the details of various applications, so that as a demonstration, Hammam Biadha could provide them with a model for similar rural communities. Although perhaps never called this, the complexity of Hammam Biadha made it an integrated rural development program for AID. As experience in many places has shown, such projects often have difficulty in overcoming problems of bureaucratic compartmentalization

and are unable to maintain an "apparent willingness to cooperate across organizational lines" for significant periods of time.

In partial recognition of this problematic aspect of the Hammam Biadha demonstration, two Peace Corps Volunteers (PCVs) were sent to the village, and were "primarily assigned to carry out agricultural extension but . . . [would] also observe social change and acceptance of the technologies and assist villages to incorporate the new technologies in their daily lives" (Anon. n.d.). As noted in the logical framework, the PCVs would collect and document technical, social, and economic data These reports would be instrumental in verifying and evaluating the program (Telex Self to Zouiten, 22 May 1981). Similarly, it was noted in 1979 that "of particular interest to AID are the sociological effects of introducing new energy sources into the village . . .[5] The Evaluation Plan will provide for periodic visits to the Project site by a Tunisian sociologist. The sociologist [whose services were to be obtained from the Ministry of Higher Education and Scientific Research] . . . will be part of the final design team [and] will be responsible for ensuring that the societal effects of the project are evaluated carefully" (AID 1979:annex I, pp. 7-8). In important ways, then, the PCVs and Tunisian sociologist would be interface agents, linking project to demonstration.

The final aspect of background to be mentioned here is the participation of the NASA Lewis Research Center's (LeRC) Solar Projects Office. A Participating Agency Service Agreement between AID and NASA (PASA AID/NASA, 1979) was "amended to provide technical and management services" for the implementation of the Tunisian Renewable Energy Project, while "AID retained responsibility for the implementation of the Training Subproject" (Scudder, 1984:5). NASA LeRC, working with GOT colleagues, prepared a conceptual design and project implementation plan. "The final design, fabrication, testing, shipping, installation, and checkout of all the solar technology applications was accomplished through contracts with US or Tunisian companies. NASA, with the involvement of STEG, was responsible for the procurement of the PV power

systems . . . and all other US-procured systems and hardware," as was STEG for Tunisian hardware and services (Scudder, 1984:9-10). The history of this collaboration, and of the program's evolution from a technical viewpoint, are adequately reviewed in the final reports of NASA Lewis and STEG (Scudder, 1984; STEG, 1984).

III. TECHNICAL AND ECONOMIC PERFORMANCE OF PROJECT

A. Overall System Description

The location and specific content of the Tunisian Renewable Energies Project changed considerably between its early conceptualization in 1979 and its final realization in 1983. The original project proposed for Hassi El Frid contained provisions for several farm systems, including two wind-driven pumping systems, two wind-driven electricity systems, two solar-powered drip irrigation systems, and two solar electric systems; two greenhouse solar heating and wind-powered systems; and various village applications including photovoltaic power for domestic and commercial uses and solar space heating for the infirmary. (AID, 1979, and AID, 1980).

The final project implemented in Hammam Biadha consisted of:

Agricultural Applications

1. A 1.4 KWp (battery-less) PV-powered drip irrigation system for open field farming (orchard);
2. A 1.4 KWp (battery-less) PV-powered drip irrigation system for use in a solar greenhouse constructed by STEG;
3. A 1.4 KWp PV electrical system (including storage batteries, DC/AC inverter, and monitoring equipment) for domestic use on a single nearby farm; and
4. Two additional greenhouses and a wind-powered water pump constructed by STEG.

Village Applications

1. A central 28.6 KWp electrical system (including storage batteries, DC/AC inverter, and monitoring equipment) and distribution grid for residential, commercial, clinic, school, mosque, village well pump, and public lighting; and
2. A medical refrigerator provided by AID and a solar hot water system provided by STEG for the village clinic (Scudder, 1984).

B. System Performance

Performance data is generated on KWh of consumption for the village and farm (domestic use) PV electrical systems, and cubic feet of water pumped for the two PV-powered drip irrigation systems. Performance data is not available for the three greenhouses, the wind-driven pump, nor the solar hot water system for the village clinic. In general, performance data on usage, down time, and cost of repair and maintenance are not maintained in a centralized and consistent fashion (if at all).

1. Village PV Electrical System

The village PV electrical system commenced initial operation on February 5, 1983. Problems detected during the system checkout operation forced the system to be down until March 19, 1983. Although records do not appear to be kept on down time, the system appears to experience occasional electrical problems that are easily correctable by the local STEG facility operator.

Although operation data for the village system is incomplete, it appears that the facility has produced between 20,000 and 23,000 KWh of electricity from startup through November, 1985. The detailed monthly meter account (Appendix B) shows approximately 3,600 KWh consumed in 1983, 7,600 consumed in 1984, and 8,700 consumed in 1985 (through November). As shown below, detailed account records clearly indicate that the largest use of village electricity has been by residential and commercial customers.[1]

	Electrical Consumption through November 1985 (KWhs)	% of Total
Household/Commercial	15,421	77
Village Facilities	2,400	12
Public Lighting	1,409	7
STEG Operations	765	4
	---	---
	19,995	100

As originally conceived, the village system was to supply electricity to the users shown below. By December, 1985, the anticipated pattern had generally materialized exception for the number of homes served and the absence of a cultural center.

	Anticipated Users	Actual Users (December, 1985)
Stores/shops	3	3
Mill	1	1 (lighting only)
Homes	22	26
Clinic	1	1
School	1	1 (3 meters)
Mosque	1	1
Cultural center	1	-
Well pump	1	1
Public lighting	1	1
Facility operations	-	2

By December 1985, anticipated end uses had also been mostly realized (Scudder, 1984:17). As shown below, refrigerators have been utilized slightly less, and room fans more, than was first anticipated.

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	Anticipated End Use	Estimated Actual End Use (December, 1985)
Lights	159	undocumented
Refrigerators	19	15
Televisions	21	23
Village well pump	1	1
Fans	-	6
Other appliances	-	1

To partially investigate the impact of current end uses on electricity consumption, the variation in 1985 average monthly consumption by 25 household units was examined using analysis of variance. The average monthly KWhs of consumption in 1985 for each household was regressed on a series of dummy variables pertaining to the household's ownership of a television, room fan, or refrigerator. The omitted classification included home lighting and other electrical devices. The results shown below suggest that, on average, the use of a room fan involves about 19 KWhs of electricity consumption per month, a television about 12 KWhs, a refrigerator about 5 KWhs, and home lighting and other uses about 6 KWhs per month. Although these estimates include the influence of both device energy requirements and average usage, it appears that the load profile that has evolved is slightly more intensive in devices that are associated with high average consumption (fans and televisions) that originally anticipated, and less intensive in devices associated with low average consumption.[3]

Appliance	Average Consumption (KWh per month: 1985)	Standard Error
Television	11.6	5.9
Fan	19.4	7.9
Refrigerator	4.8	6.5
Home lighting and Other Uses (Constant)	5.8	5.1

Coefficient of Determination: 0.58

In the aggregate it appears that the system as designed is certainly suitable for current village uses. The data below contrasts the daily average energy outputs as anticipated by NASA (Scudder, 1984:18) against the average daily consumption that occurred over the twelve months of 1985. On average, load is running about 31 percent of the system's probable (or potential) output.

	Anticipated Monthly Energy Output (KWh/day)	Average Monthly Energy Consumption (KWh/day)	Consumption as Percent of Output
January	67.4	19.4	.29
February	81.3	19.5	.24
March	89.0	19.9	.22
April	103.4	26.4	.26
May	114.7	34.1	.30
June	116.4	40.2	.35
July	119.0	38.6	.32
August	108.5	38.3	.35
September	101.2	33.1	.33
October	84.1	30.5	.36
November	72.3	23.9	.33
December	64.8	25.6	.40

Figure III-1 shows seasonal loads over 1985 of the various categories of users (residential/commercial, village facilities--public, and public lighting). It is clear from the figure that highest electricity loads are experienced in the six months of spring and summer and that residential/commercial uses largely determine total consumption of electricity in the village. Electricity used for village facilities (mosque, clinic, school, etc.) and public lighting is relatively small in comparison to total electricity consumption, and is stable over the year.

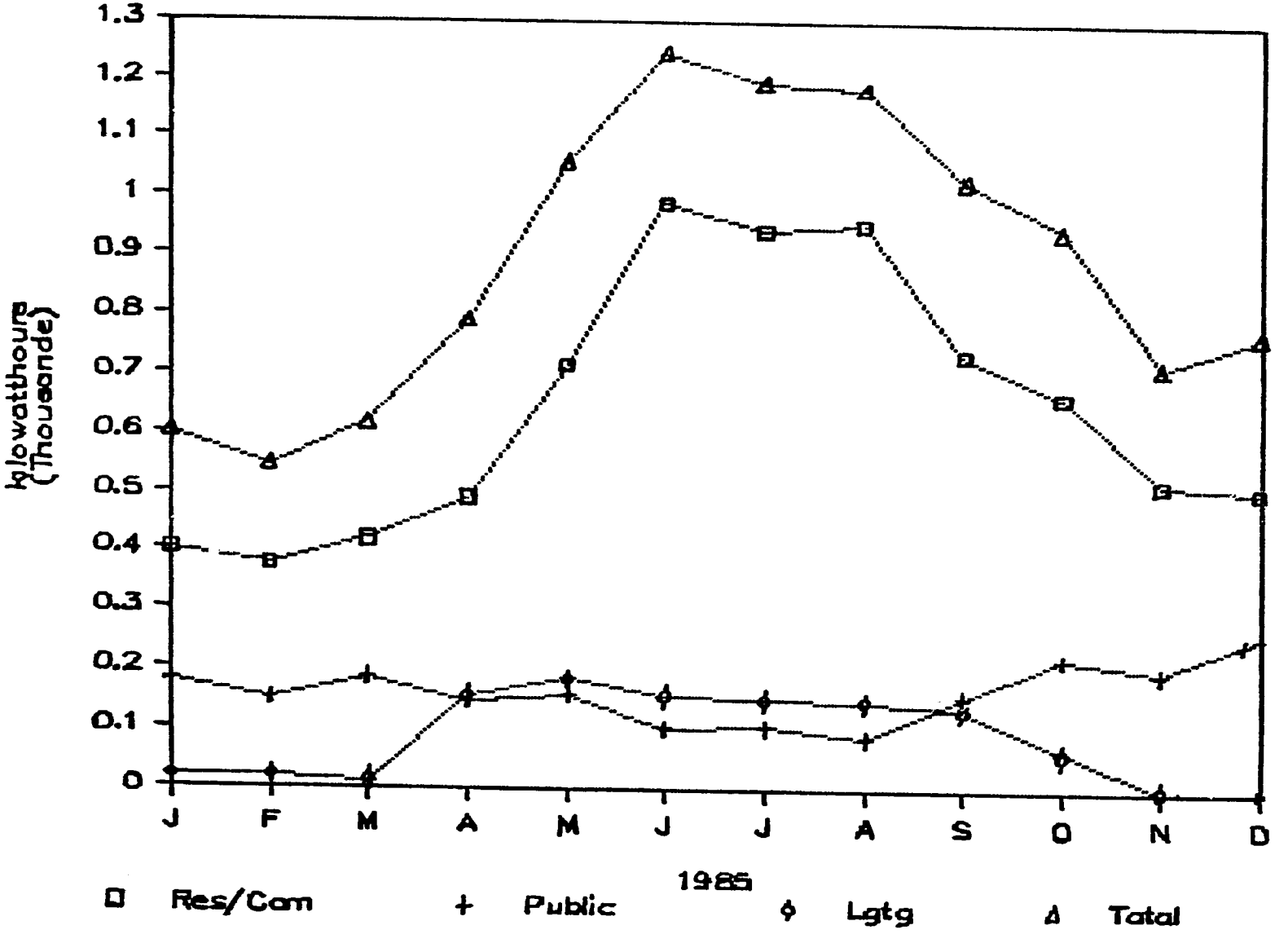
The daily operations data that were made available to us were not suitable for analysis of peak demands. Meter readings were reported for 8:00 a.m., noon, and 6:00 p.m., but hourly demands within these periods were impossible to measure. Analysis of this data for the month of June, 1985 shows that the period noon - 6:00 p.m. has the highest average consumption per hour and the 8:00 a.m. - noon period the lowest, but peak demands within these periods cannot be identified. We found no evidence of the system being unable to provide ample electricity as demanded by village users.

2. Farm (Domestic Use) PV Electrical System

The farm PV electrical system for domestic uses also commenced initial operation on February 5, 1983, and experienced difficulties similar to those of the village electrical system. The inverter for the farmhouse system was not repairable in the field and had to be replaced by the U.S. supplier, causing a lengthy delay in repair. The recollection of local STEG personnel is that the system only worked two months in 1983 and the first nine months of 1984. The meter for the farmhouse unit shows 49 KWh for January, 1984 and has not changed since. There is little evidence by which to gauge the performance of the PV electrical system for farm domestic use.

FIGURE III-1

ELECTRICITY USE, BY CATEGORY OF METER



3. Drip Irrigation PV Electrical Systems

The two PV-powered drip irrigation systems showed few signs of use during our field inspection. The drip irrigation system associated with the greenhouse appeared to have been disconnected from the pump for a long period of time.

Output from the two stand-alone PV drip irrigation systems is measured in cubic feet of water pumped (rather than electricity used). Once again, this information does not appear to be maintained in a centralized and consistent fashion. Meter readings were available for the two pumps for February through October, 1985, and were obtained on site January 3, 1986. As shown below, the pump associated with the greenhouse has shown almost no use (842 cubic feet) over its existence, while the pump associated with the fruit orchard shows slightly greater use with peak flow occurring April through June.

	Greenhouse PV Pump Cu Ft of Usage	Orchard PV Pump Cu Ft of Usage
February 1985	11	62
March	9	78
April	12	96
May	12	120
June	14	119
July	15	78
August	10	77
September	13	80
October-January 1986	48	116
Total since February 1983	842	3851

4. Greenhouses, Wind-Powered Water Pump, and Solar Water Heater

To our knowledge, no information was collected on the performance of the three solar greenhouses, the wind-powered water pumps, nor the solar water heater (for the clinic).

C. Economic Performance

It is important to note that "Cost effectiveness, per se, was not a primary factor in implementing the solar technology demonstrations at Hammam Biadha Sud" (Scudder, 1984:44). The system was designed to be large and reliable so that the Tunisians could gain experience with solar technologies.

Although cost effectiveness was not a primary design consideration, some of the most important lessons to be learned pertain to the economics of providing electricity to rural villages and farms, using solar technologies. Normal requirements for successful projects are that: 1) they can be replicated in other places; 2) they make efficient use of available resources; and 3) they are able to recover costs in a reasonable time period.

The financial analysis reported here primarily pertains to the village PV-powered electrical system. Unfortunately, the lack of use of the remaining solar applications, or the lack of data, prevents meaningful economic analysis in these cases.

D. Distribution of Initial Costs

Costs of the various solar applications should be categorized into either fixed (initial) or recurring costs for economic analysis. Fixed costs are the one-time expenditures that are made to bring a facility to the point of initial operation (or subsequent modification). Recurring costs are those expenditures that are made each year in producing a given amount of electricity.

The length of time that has passed since project inception, and the apparent absence of detailed cost accounting information (in the field) make allocation of initial costs among the various Hammam Biadha solar applications difficult. Table III-1 allocates reported aggregate project spending for both AID and GOT among the various applications.

Where possible, costs for specific items such as PV modules, batteries, etc., were allocated on the basis of the physical distribution of each item among the various applications.[4] More general costs, such as planning and project studies, were allocated on the basis of the distribution of the above specific costs. Aggregate expenditures reported in the STEG project summary report (STEG, 1984:29-30) were used for Table III-1. There appears to be only slight discrepancies between AID and GOT cost figures for the total project.

Table III-1: Allocation of Initial Costs Among Hammam Biadha Project Components

USAID (US$)	Total Reported Expenditure	Village PV System	Farm-House PV System	Drip Irrigation Systems	Green-houses	Other
NASA Administration	160,541	123,617	17,659	19,265	-	-
PV Equipment	885,569	681,888	97,413	106,268	-	-
Project Studies	59,252	45,624	6,518	7,110	-	-
Trans. of Equipment	43,214	33,275	4,753	5,186	-	-
Spare Parts	31,424	24,196	3,457	3,771	-	-
Misc.	20,000	15,400	2,200	2,400	-	-
TOTAL USAID (US$)	1,200,000	924,000	132,000	144,000	0	0
GOT (DT)						
Civil Engineering	50,000	30,000	-	20,000	-	-
Greenhouses	10,000	-	-	-	-	10,000
Drip Irrigation	2,000	-	-	-	2,000	-
Vil. Elec. Lines	16,000	16,000	-	-	-	-
Windmill	3,500	-	-	-	-	3,500
Solar Water Heater (clinic)	1,000	-	-	-	-	1,000
Project Studies	40,000	22,400	-	10,800	4,800	2,000
Trans. of Equip.	18,000	10,080	-	4,860	2,160	900
Misc.	5,500	3,080	-	1,485	660	275
TOTAL GOT (DT)	146,000	81,560	0	39,145	17,620	7,675
TOTAL EXPENDITURE (US$)*	1,451,100	1,064,300	132,000	211,300	30,300	13,200

* 1982 exchange rate of $1:0.5812 DT used to adjust GOT expenditures.

Total 1982 expenditures for all project applications in Hammam Biadha amounted to about $1,450,000 for both governments. Of this amount, approximately 73 percent was used for creation of the village PV system and nine percent for the farmhouse domestic use PV system. About seventeen percent of total project expenditures was used for the drip irrigation and greenhouse applications.

Table III-2 summarizes the expenditure and revenue information for the village PV system that either have occurred or are likely to occur over the 20 year expected useful life of the project. Initial expenditures have been taken from Table III-1 and recurring costs were provided by STEG. Electricity consumption has been obtained for 1983 to 1985 from the customer account information provided by STEG (Appendix B) and projected to the Year 2002 using the assumptions noted in the table. Annual revenues have been derived by applying actual STEG rates and charges to the anticipated or reported electricity consumption and the number of meters. Several categories of expenditures or revenues are identified for which no data was available. All amounts are stated in current year U.S. dollars (i.e., amounts have not been adjusted for inflation).

FINANCIAL ANALYSIS - VILLAGE PV SYSTEM
(in U.S. Dollars)

EXPENDITURES	1982	1983	1984	1985	1986	1987	1988	1989	. . 2002
Project Planning & Design									
* STEG (a)	43,800	-	-	-	-	-	-	-	-
* USAID (b)	184,600	-	-	-	-	-	-	-	-
Equipment Infrastructure									
* STEG	96,500	-	-	-	-	-	-	-	-
* USAID	715,200	-	-	-	-	-	-	-	-
Maintenance & Repairs (c)	24,200	598	683	600	600	600	600	600	600
Personnel (c)									
* Operator	-	3,577	4,132	3,570	3,570	3,570	3,570	3,570	3,570
* Custodial/Guard (3)	-	8,115	9,372	8,100	8,100	8,100	8,100	8,100	8,100
Vehicle (c)	-	1,548	1,792	1,550	1,550	1,550	1,550	1,500	1,550
Insurance (d)	-	-	-	-	-	-	-	-	-
Administration (e)	-	-	-	-	-	-	-	-	-
Total Annual Expenditure	1,064,300	13,838	15,979	13,820	13,820	13,820	13,820	13,820	13,820
REVENUES									
Electricity Charges									
* Residential/Commercial (f)	-	278	497	560	620	630	630	630	630
* Village Facilities (f)	-	43	83	80	80	80	80	80	80
* Public Lighting (g)	-	11	10	40	40	40	40	40	40
Hookup & Meter Charges (h)	-	1,164	2,485	90	80	70	70	0	0
Misc. Charges (e)	-	-	-	-	-	-	-	-	-
Total Annual Revenues	0	1,496	3,075	770	820	820	820	750	750
ANNUAL OPERATING DEFICIT	-1,064,300	-12,342	-12,904	-13,050	-13,000	-13,000	-13,000	-13,070	-13,070
KWh of Consumption									
* Household/Commercial (i)		2,911	5,919	7,792	8,571	8,742	8,742	8,742	8,742
* Village Facilities (j)		482	964	1,145	1,145	1,145	1,145	1,145	1,145
* Public Lighting (k)		160	219	1,236	1,236	1,236	1,236	1,236	1,236
* STEG (l)		217	291	308	308	308	308	308	308
Total KWh of Consumption		3,819	7,442	10,481	11,260	11,431	11,431	11,431	11,431

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Notes to Table III-2

a. Tunisian expenditures adjusted to U.S. dollars using the following (June 30) exchange rates:

1982: $1 to .5812 DT	1984: $1 to .7513 DT
1983: $1 to .6698 DT	1985: $1 to .8430 DT

Source: Cashier's Office, U.S. Embassy, Tunis

b. All dollar amounts, except 1982 expenditures, are stated in constant 1985 dollars (Producer Price Index). 1982 amounts have not been adjusted for inflation so that amounts in Table III-1 and III-2 agree.

c. Except for maintenance and repair for 1982, these amounts have been estimated for 1985 by STEG and adjusted to U.S. dollars. Figures for 1983 represent 3/4 (9 months) of the 1985 estimates. Data was not available for the cost of repairs to date.

d. Normally, insurance would be included as part of operating expenditures, but (apparently) no such insurance has been purchased.

e. Expenditures for administration of the Hammam Biadha project in the Siliana and Tunis STEG offices should also be included, but none were reported. Certain expenditures are incurred for collection of delinquent bills, disconnections, etc., but these are assumed to be offset by special collections (codes 81 and 93).

f. The rate per KWh has been .061 DT throughout the project.

g. The rate per KWh has been .030 DT throughout the project.

h. Hookup charges were 65 DT for initial users and were raised to 71.5 DT in 1984. Payments are spread over 10 billing periods. A meter charge of .234 DT is collected each billing period for all meters except for public lighting (1.169 DT), the school (.468 DT), the clinic (.468 DT), and STEG (0 DT).

i. Ten month data for 1985 prorated to 12 months. Growth rate is assumed to be 10 percent for 1986, 2 percent for 1987, and 0 percent thereafter.

j. Ten month data for 1985 prorated to 12 months and assumed constant thereafter.

k. Public lighting meter readings available only for January to November, 1985. A total public lighting total of 379 KWh was allocated 3/8 (9 months) to 1983 and 4/8 (12 months) to 1984. Usage assumed constant after 1985.

l. Charges are not collected for electricity used by STEG.

The general financial picture that is observed in Table III-2 is one of significant initial costs, and annual recurring expenditures that far exceed the annual revenue stream of the village system. As previously mentioned, the project was not developed with cost-effectiveness or cost recovery as a design criteria. Thus, the initial outlay of over $1.0 million was not necessarily intended to be recovered via user charges. There appears to be little doubt that initial system costs could be significantly lower in future applications in other villages (Scudder, 1984:44-47).

The more significant problem in the Hammam Biadha situation is the relationship between annual operating expenditures and revenues. STEG policy is that Hammam Biadha users pay the same rate per KWh as users on the central grid (.061 DT per KWh). STEG also collects a one-time hookup charge that has generated a considerable proportion of local system revenues. As shown in Table III-2, annual revenues would average around $800 per year at current rates and usage levels. In comparison, annual operating expenditures for the village system amount to about $14,000 per year. The bulk of this expenditures is used for local personnel. The combined results of the facility's cost-revenue stream is an annual operating deficit of about $13,000. Thus, the village system not only fails to recover initial costs over time, but also loses additional money each year in paying for its general operation.

Financial difficulties for small rural energy applications can result from a number of factors. Common causes are: 1) initial costs too high; 2) market served too small; 3) marginal operating costs too high; and 4) regulated rate for electricity charges too low. In the case of the Hammam Biadha village system, almost all of the above factors existed. Although the annual operating deficits shown in Table III-2 are in themselves staggering, it may be instructive to list how extreme the conditions would have to be for the village system to "break even" financially:

(1) If there were no annual operating costs, the present timestream of annual revenues could recover the costs of only a $9,000 initial system investment at a 10 percent opportunity cost for money and no equipment replacement.

(2) If KWh rates and average consumption remain at current levels, 603 residential or commercial units would have to be added to the system to break even for just annual operating costs. Recovery of all costs would require the addition of over 2,900 residential or commercial units.

(3) If current consumption levels are maintained, it would take a rate of $1.321 (1.110 DT) per KWh to recover annual operating costs and $6.393 (5.372 DT) per KWh to recover total costs of the village system.

The extreme conditions above serve to point out an important lesson that should be observed if projects such as that in Hammam Biadha are to make efficient use of resources and are able to recover their initial investment. Rural electrification projects, like their urban counterparts, must have sufficiently large service areas over which fixed and variable costs can be spread. In the absence of this service base, resources, because of their "lumpy" or discontinuous nature, are under-utilized and costs become prohibitive. It is interesting in this regard to note that much discussion has taken place concerning the probable decline of unit costs for PV modules. In the Hammam Biadha case, falling initial costs for PV modules would not hasten the breakeven period for the system, since deficits are incurred each year simply due to operational costs.

It should be clear from the above discussion that a considerable subsidy is provided each year to Hammam Biadha electricity users through the rate charged by STEG. The impact of this subsidy on all STEG system users is unknown to us, but is probably small. At the same time, an important question to be addressed by STEG is whether a better use exists for the funds that are used for Hammam Biadha village each year (and many years into the future). Alternatives such as extension of the

central grid and use of diesel pumps have been considered by STEG (STEG, 1984:55-69). Indeed, it would seem that more economical ways exist for supplying village users with electricity than the current system.

Although we were unable to completely verify STEG calculations, we have estimated that costs of extending the grid could be made up by foregone annual subsidies in about 10 to 14 years (at a 10 percent cost of funds). This option has the added attraction of providing village residents with the opportunity for increased electrical consumption. But it also should be pointed out that $13,000 per year may be a small expenditure to make if important information and expertise is being developed concerning rural PV applications. To reiterate, this was the initial assumption justifying the cost of the Hammam Biadha demonstration.

E. Financial Analysis of Other Project Applications

In theory, it is possible to examine the remaining project applications in the same fashion as that done for the village system above. In practice, however, very little would be learned. The farmhouse domestic PV system has been used for only 49 KWh of consumption, producing about $5 in revenues. None of the other applications had cost recovery mechanisms associated with them, so the figures shown in Table III-2 are the costs to be considered. We find it interesting, in fact, that at least partial cost recovery was not made an aspect of the above applications. Further thought should be given to how fixed or variable charges might be assigned to drip irrigation and greenhouse applications.

IV. EVALUATION OF DEMONSTRATION ASPECTS

The Hammam Biadha Renewable Energies Project, as described in the project grant agreement, was to have two complementary activities: (a) "the demonstration of renewable energy technologies in a rural setting", via the project as defined here, of the technology applications benefiting particular individuals in Hammam Biadha; and (b) "various types of training to develop Tunisian capability to determine where, when, and how renewable energy can be applied to [sic] the future" (AID, 1979:1). These will be considered here in reverse order.

A. Training Components

Training as organized by AID was to have four components. The first would be "a one-day seminar for approximately fifteen of the highest level government policy-makers," held during the first year of the project. This would be a discussion of energy policy with special attention to the renewable energy technology applications demonstrated in the Hammam Biadha project. MIME was to suggest participants (AID, 1979:annex 1, p.5). While one AID/Tunisia staff member said this seminar "probably" was held, there is no documentation to the effect, and our STEG contact could not remember that such a seminar had taken place.

A second component would be a ten-day "Renewable Energy and Technology Applications Course" scheduled for the beginning of the second project year. Lectures during eight of the days would be complemented by a two-day visit to the project site. Twenty-five participants would come from GOT ministries and institutions "involved in using or relying on energy in their development programs" (AID, 1979:annex 1, p.5). Again, we could discover no record or recollection of such a course being held. It may be added that this was to be an AID/Tunisia responsibility, and not a NASA LeRC one; ironically and, in this case, unfortunately, NASA LeRC conducted just such week-long

technology transfer seminars in five capital cities of countries receiving other PV power system demonstrations (Quito, Georgetown, Harare, Nairobi, Libreville). A textbook on PV technology by Dr. Louis Rosenblum was commissioned and translated into Spanish and French for use at these seminars.[1] A similar exercise could have been held in Tunis with minimal cost and effort.

The third training component would be to hire a consultant cognizant of "solar and alternative energy power desalinization" to spend two weeks in Tunisia working with MIME-designated personnel on the particular matter of desalinization. This third component does not concern the Hammam Biadha project directly, and was not considered in our research. The fourth and final sub-project training component would involve sending "three Tunisian Government employees to the United States for four months of training in various aspects of alternative energy use" (AID, 1979:annex 1, p.6). With reference to this, the current AID/Tunisia training officer could find mention of two visits to the U.S. by STEG project manager Mokdad Maksoudi to participate in deliberation at NASA LeRC during the bid consideration process and system design review. No record or recollection could be found of Mr. Maksoudi or any other Tunisian associated with the Hammam Biadha program spending "four months of training in various aspects of alternative energy use" in the U.S.

With regard to this important sub-project, then, we are not prepared to assert that these training activities did not take place. Mokdad Maksoudi, the former STEG project manager, has been in Vienna for at least a year, reassigned as a participant in an international atomic energy commission; he is the person one could expect to have the most complete "institutional memory," and he has not been available to us. AID/Tunis project personnel such as Richard Stevenson (now reposted to the Philippines) and Saida Zouiten (in Washington with the Tunisian Scientific Mission) are away from the scene as well. Ms. Zouiten was contacted by telephone, but had no documentation at hand. Richard Stevenson was also contacted by phone and believes that the in-country

training programs did not take place. The point must be, then, that either these activities never took place, or no one has records or can recall that they did. In either case, the conclusion must be that the training sub-project has had little if any positive impact on GOT staff.

B. Demonstration Aspects

The project at Hammam Biadha, with its various renewable energy applications, was the other of the two program components. It had several demonstration impacts to be discussed here; as a project, its social and economic impacts will be discussed in the next section. The first of these project demonstration impacts is the set of meetings held early on, between AID/Tunisia and NASA LeRC staff on the one hand, and GOT personnel in MIME, STEG, the ministries of agriculture, health, and the like, on the other (PASA, AID/NASA, 1980). Such meetings were designed for information-gathering during site visits and as project documents prepared by AID/Tunisia and NASA LeRC, and were not formal training sessions; yet information gained was information shared, and the documentation that has resulted on all sides, as listed in the annex of references consulted, has undoubtedly been useful.

The availability of this documentation to GOT and AID decision-makers is debatable. The "central institution. . . to act as a . . . clearinghouse for information" which Richard Stevenson suggested in 1979 that AID might help to found (Stevenson, 1979:8), does not appear to have been created. There does not seem to be any library or central facility where documents on Hammam Biadha are kept and made available to interested parties. Reports have been circulated, but they remain in the offices of particular individuals. As buildings and offices have been relocated and as staff have been reassigned or have left the country, as is true of both AID and STEG, many of these documents appear to have been misplaced or, at the very least, to have become difficult to obtain (as we discovered ourselves, in the course of our research).

Positive project demonstration impact was gained by STEG personnel during the various phases of implementation and installation of the renewable energy systems, by working with AID, NASA LeRC and the contractor (e.g., Solar Power Corporation, Tri-solar Corporation) staff. Installation was accomplished by a team comprised of NASA LeRC, contractor, and STEG personnel, with assistance from Hammam Biadha residents as possible. Throughout the installation, start-up, and acceptance phases, STEG engineers and technicians received direct training "in the operation, maintenance, and troubleshooting procedures of the systems" (Scudder, 1984:41-2). As a first-of-a-kind experience with renewable energy technologies, this has been deemed invaluable by STEG as its personnel gained an understanding of power system performance and limitations (STEG, 1984:1). This process continued during the project period; James Martz of NASA LeRC visited Hammam Biadha in June, 1983, for instance, and reported that "although a number of problems were discovered during this visit, we feel that identifying and repairing them was good additional training for the STEG personnel" (Martz, 1983). No specific and cumulative information concerning the number or identity of these persons has been discovered.

Hammam Biadha has been of value as a demonstration on a less formal basis. STEG Project Manager Mokdad Maksoudi reportedly took scores of visitors there, both from GOT ministries, the military, and other institutions, and from abroad (S. Zouiten, private communication, 23 Dec 85); unfortunately, it appears that no records were kept of this (H. Nasri, private communication, 3 Jan 86). Such visits appear to have continued: a Saudi delegation went to Hammam Biadha, as have experts from the World Bank and the World Health Organization (H. Nasri, 3 Jan 86). Several newspaper articles (e.g., La Presse, 1984), magazine pieces (e.g., Perera, 1983), and pamphlets (STEG, 1983) have reached a wider, more general audience.

A final, and by no means the least important area of impact from the demonstration, was to result from the socio-economic research to accompany the project at all phases. As was noted in Section II, the AID

Project Grant Agreement with the GOT stressed that "of particular interest to AID are the sociological effects of introducing new energy sources into the village," and it was agreed that a Tunisian sociologist from the Ministry of Higher Education and Scientific Research (MHESR) would be engaged as the person "responsible for ensuring that the societal effects of the project are evaluated carefully" (AID, 1979: annex I, pp.7-8). Apparently such cooperative activity between STEG and MHESR was discussed, but there was never any formalized agreement reached; no Tunisian sociologist appears to have participated in the Hammam Biadha program at all. Instead, an economist at STEG, M. Tahar Bsila, wrote a baseline study in 1980, with a follow-up the next year (Anon [Tahar Bsila], 1980; 1981). Apparently, no socio-economic study has been effected subsequent to this, although one is said to have been begun; our attempts to consult the latter, however incomplete reports, met no success.

C. Socio-Economic Impacts

The baseline study by M. Bsila is an adequate document, given the background of its author. It contains significant data about economic aspects of the community which might provide the basis of comparison for a later, in-depth study. It lacks any information about local-level politics and decision-making, cultural attitudes toward farming and agricultural innovation, the lifestyles and status in the community of the particular farmers to receive the agricultural power systems input (upon whose shoulders success of the project demonstration would rest), cultural attitudes toward and experience with diesel generators and pumps (the competition technology) or other aspects of community life which a rural sociologist or development anthropologist would require to judge the social impact of the various project inputs. The usefulness of or means to collect this sort of data would be unfamiliar or unknown to most economists used to working for utility authorities on problems of rural electrification, hence the project agreements call for a Tunisian sociologist.

Furthermore, Tunisian higher education is modeled after French academic tradition, and many Tunisian attend French universities to obtain their advanced degrees. Applied social science of the sort required here is explained in some detail in the AID Handbook. A deliberate attempt is made to lay out a general set of questions that should be answered for each AID development project , so as to be able to understand the social impact of the project. While methodological approaches vary and there is on-going debate in this subdiscipline of the social sciences as to how a field study is best planned and undertaken, the Handbook authors have tried to provide a "cookbook" with which non-anthropoligists planning projects can become familiar.

Applied social science of this sort is very much an American invention. It is the product both of American cultural assumptions about what development projects ought to do, and how we can discover how well they do so; and a product of the collaboration over the past decade or so between American academics and AID and a few other agencies. It is a perspective and technique generally unfamiliar to French-tradition academics.

On other photovoltaic technology demonstrations managed by NASA LeRC, a development anthropologist associated with the NASA program was sent to consult with host-country counterpart social scientists, to assist them to devise and evaluate a field social impact research strategy. This was suggested by NASA LeRC to AID/Tunisia for the Hammam Biadha program as well, but the idea was rejected. The result is that no socio-economic impact data is available at present, which could "permit the analysis from . . . social perspectives of the effects of the introduction of such new technologies and therefore a better appreciation of their contribution to the development of Tunisia" (AID, 1979:annex I, p.1). As a demonstration, Hammam Biadha fails in this regard.

The lack of socio-economic data from a Tunisian sociologist and from subsequent reports from STEG after 1981 (still two years before implementation) might have been countered by end-use data collected by

the two Peace Corps Volunteers assigned to Hammam Biadha. The two PCVs had some relevant background: one has a B.S. degree in soil and plant sciences, the other has had some forestry courses and experience. Both received some training in the use of photovoltaic-powered devices. They worked with five or six farmers from Hammam Biadha on a daily basis, as extension agents to improve greenhouse use and production, to learn how to use and repair the drip irrigation equipment, and to market off-season vegetable produce.

The PCVs apparently reported to STEG and AID/Tunisia on the PV system and other project devices and activities, and filed end-of-service reports when their two-year tours expired in 1984. These last were deposited at Peace Corps headquarters in Tunis, with copies to STEG Project Manager Mokdad Maksoudi and AID/Tunisia (H. Nouri, PC/Tunisia, personal communication, 2 Jan 86). No copy could be found when AID officer Mark Karns searched several months prior to our visit, nor could one be found during our research. The PCVs work may well have been useful and significant to the project-participant farmers, then, but as for being the integral part of the demonstration it was meant to be, it is useless if no documentation can be found.

D. Conclusion

The failure of Hammam Biadha as a demonstration can be illustrated by two findings. AID/Tunis Agricultural Officer Paul Novick is overseeing a drip irrigation project at Sbeitla, where fruit-tree saplings, especially apple trees, will be irrigated; this will probably employ small diesel pumps, even though the supposed five-year life of these is more like eight months. Mr. Novick was surprised to learn that there has been an AID drip irrigation system demonstration at Hammam Biadha using renewable energy power systems (or that one of the drip irrigation systems was specifically used to water apple tree saplings). Thus, it is reasonably clear that the transfer of demonstration information among AID staff was difficult over time, which itself serves

to underscore the general unavailability of documentation on Hammam Biadha and the program's general "invisibility." One can conclude that the Hammam Biadha demonstration has had little effect on AID/Tunisia decision-making with regard to the development domains it has targeted.

As for the GOT, there is some indication that the same dismal assessment may be made. The Pragma affiliate company of AGIP, the Italian petroleum corporation, has been working since October 1984 to study with STEG the possibilities of deploying PV systems (which they produce and market) in Tunisia. The Pragma study group has not been to Hammam Biadha, we were told, and it appears they are studying some of the same questions, the answers to which Hammam Biadha was to provide and demonstrate. Granted, international as well as commercial interests are at stake in such a case; yet had the Hammam Biadha demonstration been successful, it is doubtful other governments and private companies would feel it useful or cost-effective to replicate the same basic research.

In conclusion, Hammam Biadha as a demonstration seems to have "fallen into a crack": the training and research called for in the project agreement do not seem to have been undertaken and if so, few if any can recollect what their results may have been. This is an especial pity, since the demonstration aspect of a program of this sort is the sole justification for the high initial and sustained capital costs. Again, a good deal may have--and undoubtedly has--been learned by some set of individuals in the GOT, AID, and other institutions; but if there is no proof of this, and no effort to sustain the didactic dimension of the project, one must question first why these conditions prescribed in the project agreement were not met, and secondly whether the Hammam Biadha project should be allowed to continue, running the annual deficit that it does.

V. EVALUATION OF PROJECT SOCIAL AND ECONOMIC IMPACTS

The Hammam Biadha project, as we are defining it here in distinction to the demonstration, comprises the various renewable energy technology applications in the village, with a view to understanding the benefits accruing to those few individuals with direct access to them. Information about the social impact of the project then has demonstration potential for others outside Hammam Biadha (or even in the village itself, for those who are not among the very few to receive agricultural systems).

As outlined in previous sections, data about the sociological importance of the project of is woefully lacking: either not undertaken, or now unavailable. The original thrust of the Hammam Biadha program was to be the demonstration of several renewable energy technologies for agricultural applications, with the photovoltaic village power system to generally improve the quality of life, to induce rural people to remain in the countryside. We know nothing about the farmers themselves: who they are, with respect to kinship, political or other bonds and positions in the greater community. What has their being chosen meant, with regard to the dynamics of everyday social relations? The STEG baseline reports contain economic, but no sociological data of this sort; the Peace Corps Volunteers' reports which may contain such pertinent information, are nowhere to be found. And yet one cannot understand decision-making by these individuals if such is not known. For the most part, the renewable energy agricultural applications have failed and have been rejected by the three farmers involved. We have very little understanding of why this has been the case.

A. The Agricultural Applications

The first farmer (M. Brahim Manai) was offered a PV-powered drip irrigation system for an orchard of fruit tree saplings, a stand-alone

PV power system for his household needs, and--when another farmer declined--a passive solar greenhouse with a burm wall for heat conservation. It is not clear why this particular farmer was chosen, except that his lands are adjacent to what has become the village center. His place in the community is unknown: would others resent his being so chosen for what were presented as solid economic advantages? Might his decision to reject the technology be influenced by such social pressure?

The farmer was repairing a diesel pump engine when we arrived and, although cordial, he did not seem especially interested in interrupting his work and speaking with us. The diesel pump is one of three he now owns; two purchased before, one after the PV pumping system was given to him. The two older diesel pumps have worked since 1976, and he regularly takes them apart, fixes and cleans them. They are used to irrigate surrounding cereal fields by open trench methods. The PV pump is working, and in answer to my question, the man said he uses it to run the drip irrigation system to the southwest of the pump and well. The some four hundred apple, peach, plum, and pear saplings were obtained from the Regional Commisariat of Agricultural Development, and were apparently bought and given to the farmer by STEG.

Upon cursory observation, we saw that the various pipes and hoses of the drip system are disconnected, scattered about, and do not appear to have been used for some time. There <u>is</u> mineral build-up around the juncture points of smaller into larger pipes, and the drip tubes are still laid out roughly parallel to the rows of dry (dead or just dormant?) saplings. The system looks as though it has been used, but certainly not recently. Data on seasonal <u>need</u> for irrigation, past use patterns, noticeable tree growth rate and farmer satisfaction with the system as it was/is being used is non-existent or unavailable. The passive solar greenhouse has not been used this past year (since the end of the AID project period) to grow anything. The farmer <u>has</u> recognized another application of the same technology, and has a large crop of red chili peppers drying in the building (passive solar crop driers do not seem to have been a technology application deployed in Tunisia).

The farmer's decision not to plant anything in the greenhouse is because the plastic covering has been badly ripped in several places, and requires extensive repair or replacement to conserve heat and maintain critical temperature control during cold winter nights. The farmer argues that STEG was to guarantee (hence replace) such equipment for a period of five years, while a STEG agent told the farmer in our hearing that such a guarantee was only for two years (the AID project period): it was up to the farmer to repair or replace the covering. He is not willing to do this because of:

a. a misunderstanding of responsibility
b. lack of willingness to accept and maintain this new technology application, and
c. probably insufficient profit from the greenhouse when it did function properly, to provide incentive to undertake needed maintenance.

"Probably" is used in this last phrase, because any end-use production data concerning amount and kinds of crops grown in the greenhouse, expenditures for fertilizer or other inputs, amounts of produce harvested, profits realized in marketing, the marketing network used and consumers contacted, and the like, is non-existent or unavailable.

The PV stand-alone system for the farmhouse has not operated for quite some time: we were told since October 1984, but STEG electricity consumption data indicate the system has been down since January of 1984. James Martz of NASA LeRC reported in October 1984 that the inverter on this system had failed, and suggested to STEG that it be sent to Warranty Services (the company assuming Solar Power Corporation responsibilities when the latter went out of business) (Martz, 1984). It would seem that this was not done. I was told that the farmer has been taken to task by STEG on two occasions, when, before Tunisian gendarmes, he has been accused of tampering with the system and causing it to fail; he was told that he must stop such action, or the systems

would be taken from him. As it is, it appears that none of the three application systems in question (drip irrigation, solar greenhouse, household electrical system) is in use.

A second farmer has a passive solar greenhouse irrigated with a PV-powered drip system. The greenhouse stands in the middle of fields, several hundred yards from any house; the STEG agent with us noted that the man is rarely to be found around the greenhouse, and no one came to talk with us during the time we visited. The PV pump was disconnected from any piping system, but seemed to work well when switched on by the STEG agent. A diesel pump feeds from the same well. The door to the greenhouse was ajar. The local STEG agent said the farmer had grown fava beans in the greenhouse. It was obvious that some animal(s) had gotten in and eaten the plants nearly down to the ground; we were told these were probably rabbits, but it looked more like an errant donkey had done the deed. We were told that the farmer had once mistakenly sprayed his greenhouse crop with a petroleum product, thinking it was an insecticide; this had killed all his plants.

There are no records existing or available documenting this or other aspects of the man's experience with this new technology system. The local STEG agent noted that the man rarely used the PV drip irrigation pump, as he preferred his diesel pump. James Martz noted in 1984 that a socio-economic study would be useful, as it seems the farmers have felt the solar pumps were too slow for irrigation, taking too much of their time. He added that it appeared that the drip system (for which the power system had been designed) had been abandoned in favor of open-trench irrigation with which the farmers are more familiar. The drip system was meant to be self-controlling and so would require very little if any of the farmer's time, if used properly (Martz, 1984). The course of this farmer's experience with the system, and his history of decisions, may be documented in the PCVs' reports; none of these are available, nor is it known whether such data were recorded there or elsewhere.

The third farmer received a windmill-driven pumping system and a passive solar greenhouse. In the preliminary conceptual design study, it had been determined "that wind resources at Hammam Biadha were not sufficient to permit a meaningful wind electric application. However, water pumping using wind-powered mechanical pumps were included" (Scudder, 1984:7). The farmer has complained that the wind is lowest or most infrequent during the very period of greatest water need. The windmill had been broken, fixed, and has been broken for the past ten months. It has functioned well and long enough, however, for the farmer to use the pump and solar greenhouse to grow crops producing sufficient profit for him to purchase a small diesel pump (at 1500 Dinars) that he has now attached to his well. The farmer was praised by the STEG agents with us for his hard work; he is clearly an entrepreneur, who has used the resources given to him by the project to upgrade his agricultural output and equipment.

Again, it is not clear how this or the other farmers' work has progressed, as there is no log or record of end-use data. The PCVs were to see this agricultural extension work, and were promised assistance by the Siliana agricultural ministry representatives; this apparently proved a fruitful collaboration for the first months after systems installation, but then STEG was told that the agricultural agents had no vehicle to get to Hammam Biadha, and they allegedly intimated they wanted to be paid to participate in the project. With this, local cooperation appears to have ceased. The farmers had only the PCVs to depend upon for agricultural extension advice thereafter. At the end of their two-year tour of duty, the two PCVs advised Peace Corps Headquarters in Tunis <u>not</u> to replace them in Hammam Biadha. There is no available written record of why this would be so. It is said that they felt the farmers expected <u>them</u> to run the renewable energy technology agricultural application systems. This would indicate a lack of acceptance of and identification with these project components, reflected in the apparent abandoning of the systems at present.

B. The Village Power System

The village power system, as a whole, has had a much more positive set of impacts than the agricultural applications appear to have had. The PV power system is used to run lights and a project vaccine refrigerator at the dispensary; in October, 1985, the Ministry of Health installed a sterilizer powered by the system electricity as well. This latter runs at a maximum of 1400 Watts or six amps, but when run at the five amps allowed the dispensary, it can still reach temperatures of between 120-150°C necessary for sterilization of syringes and other instruments. The nurse said he uses the sterilizer about half an hour per day; he has blown the interrupter several times doing this, but can reset it manually and now seems sufficiently familiar with this new piece of equipment to run it correctly within the five amp unit.

The nurse has a bachelaureat high school degree and two years training in nursing. He sees to injections and minor health care and hygiene problems; a medical doctor visits Hammam Biadha once weekly, and a trained midwife every fortnight. The nurse received no training to run the PV-powered refrigerator, but aside from a blown fuse causing the loss of some perishable vaccines, there have been no difficulties. Prior to system installation, a medical team from Siliana visited once a month to give vaccinations to infants; now the polio, DTC, BCG, measles, rabies, tetanus, and other vaccines are kept at Hammam Biadha in the PV-powered fridge. The nurse gives the series of vaccinations to all new-borns and infants. Population has grown around Hammam Biadha over the past few years, and this may account for part of the increase in patients now coming to the dispensary (88 patients in October, 1979; 236 in October, 1985); but the main reason, the nurse feels, is the availability of medicine via the fridge. People come from 15-20km, even though other dispensaries or salles de soins (a unit less important than a dispensary) may be closer to them; this is for administrative reasons, but also because of the upgrading of his dispensary.

PV-powered lighting allows night visits, but more importantly, the dispensary can be used in early morning and late afternoon when sunlight is weak in winter. The other renewable energy technology application installed at the dispensary is a passive solar water heater. The only medical use for hot water the nurse could cite is to clean blocked or infected ears, something he does infrequently. He could use it to take a shower too, he added. He does neither, claiming the pipes are clogged with minerals so that water will not flow. The STEG agent said later (as has been hinted elsewhere) that the water heater has not been used because the nurse refuses to take the trouble to pump by hand the required water, from ground level to the rooftop tank. He would probably do so if he saw a pressing medical or personal need; clearly, he recognizes neither. It appears the social appropriateness of this renewable energy technology application is doubtful.

The Hammam Biadha elementary school, built in 1958, has six classrooms in which twelve classes are held, two apartments for the director and teachers, and outbuildings for the wood shop and sewing machine room. About 450 students (50 more than at last count in STEG, 1981:14) come from a radius of eight kilometers or so. There are five permanent staff and eight teachers in training.

The electricity from the PV system is used almost entirely for lighting. The director said this was of great value in the mornings and late afternoons of the present season when days are short, for janitorial tasks, and for the occasional night use of the classroom. There are no organized evening activities such as homework sessions for pupils or adult literacy classes. Outside GOT representatives infrequently use the classrooms at night, such as during parliamentary elections. The director says the amount of electricity is sufficient, but he would like to acquire audio-visual equipment (limited now to a cassette tape deck) and to start student-run rabbit- and chicken-raising projects, with the hutches and coops lit.

The most innovative use of system power is to run a table saw in a student wood shop (a planer is broken) and three sewing machines for

girls' professional training classes. The furniture and clothing produced are sold, the profits used to purchase more wood, cloth, and other supplies needed to keep the program functioning. This training program was discussed prior to implementation of the PV system, and exists in other Tunisian schools of the same size; but could not exist in Hammam Biadha prior to provision of system electricity. A final activity of interest is a series of school gardens the children must work in; these efforts are organized through a voluntary association of parents and teachers. Commercial uses of the village power system electricity include a small grocery store and grain mill. Business is down radically at the mill from the 1980-81 studies of STEG, for two mills have been opened by competitors within 5km; the owner now operates an hour or two a day, rather than 7-8 hours. Only lighting is used at the store and mill, although the owner wants to purchase a refrigerator for the store (he has one at home for personal use). A cafè opened before the PV system was on line in 1983, with initial capital from the manager's brother working in France. Electricity is used to run a fridge for soft drinks, lights, a TV and coffee pot. An expresso machine was purchased, but consumes 8 KWh/day of electricity and draws too much power; it can be run on bottled gas as well, but does not establish sufficient steam pressure then. The owner will sell it soon. The cafe is a popular men's gathering point, for games of cards and dominoes. With lighting, it can be opened at 6 a.m. and remain open until 8 p.m. or occasionally later. The barbershop has not opened yet, but is expected to do so soon (as was said in 1981, STEG, 1981:8). The girls' rug-weaving school (Scudder, et al, 1980:annex, p.6) has apparently closed for lack of support.

In summary, the intention of this section has been to assess (as much as possible) the social and economic benefits that have resulted due to the Hammam Biadha project. In general, the benchmark and followup studies have been insufficient (or non-existent) to allow monitoring of change. Although mostly unquantifiable, the list below represents some of our major observations.

1. Health and educational status were enhanced by the use of electricity in the clinic and school. The solar water heater for the clinic appeared to have little impact on health status. It is unclear whether the increased use of refrigeration throughout the village has improved health status.
2. Leisure and amenity benefits have probably accrued to village residents through their access to various appliances and village lighting. It is unclear how social, cultural, or political attitudes have changed because of the residents' access to television.
3. There is little evidence that the productivity of the village or farm economy has improved because of the project. Although production records were apparently not kept, there is no indication that drip irrigation or solar greenhouse applications have significantly higher production than nearby land without these applications. It appeared that the hours of operation of the cafe might be slightly longer because of electricity.
4. We found no evidence of new economic activity or enterprises coming into existence due to the project.
5. The only employment impact that could be directly tied to the project was the four STEG personnel in the village. STEG reported the creation of 8 temporary jobs during site development (STEG, 1984:30).

VI. SUMMARY OF LESSONS LEARNED

Although the time allotted for our evaluation was extremely short, we have identified several areas in which valuable lessons can be learned from the Hammam Biadha renewable energy project and demonstration effort.

1. Looking at the Hammam Biadha project six years after its conceptualization in 1979-80, and three years after its implementation, one is left with the impression that some aspects of the effort "worked" and others "did not." The "successes" include the provision of electricity to a rural village and development of PV technical expertise among STEG personnel. On the other hand, none of the agricultural applications appear to be effectively utilized and little information on non-village renewable energy technology applications has been transferred (demonstration) or built upon.

2. Although the Hammam Biadha project was not designated as such, it had many of the characteristics of an integrated rural development project. As illustrated in numerous other situations, this type of project requires a strong central coordination mechanism to be effective in the long-run. It is not clear how this coordination was to be or might have been managed in Hammam Biadha. It also appears that sustained commitment on the part of the various agencies initially involved was not achieved. Those active early in project planning seem to have diminished their involvement in later phases of the project. The Hammam Biadha experience seems to support the recent movement toward small sectoral development projects, rather than large complex projects.

3. Given the interest in demonstrating agricultural applications (with village electrification serving as a means of supporting the agricultural applications), it is interesting that an energy agency was chosen to administer the program rather than an agricultural agency. It appears that STEG did well in the things it customarily does--namely, deliver electricity. It is not surprising that the agricultural applications were neither developed nor exploited. Future projects should weigh carefully the various applications involved and distinguish between "ends" and "means" in establishing project roles and responsibilities.

4. Shortcomings in the manner in which the demonstration activities of the Hammam Biadha program were executed or, at least, the lack of records and recall as to how they may have been, should not be considered an indictment of the renewable energy technologies in question. At this point, one cannot say whether the particular applications of these technologies were appropriate--nothing has been proven. It may be that small-scale drip irrigation is <u>not</u> appropriate, given the rejection of such an application by the three farmers of the project; on the other hand, we have no idea why the decision to abandon these project components was made, so no ultimate pronouncement concerning appropriateness is warranted. For the future, the AID/Tunisia strategy has relegated energy programs to a low priority. This is as it should be, <u>if</u> these renewable energy technologies are considered during the planning processes for other sorts of projects, as an appropriate means (power source) to achieve certain desired ends (e.g., better health care through use of PV-powered vaccine refrigerators for cold-chain immunization programs in remote regions).

5. Another important point is raised by the fact that it cannot be determined whether the particular technology applications are appropriate in the sorts of socio-economic and political conditions existing in Hammam Biadha. This project was meant to be an important demonstration exercise, whereby a variety of planners and users could gain hands-on experience of system maintenance and exploitation. Similar programs were devised in other developing countries, often with the sponsorship of AID or other American agencies. There should be a conscious attempt to pool information, both within Tunisia, and from other sources, so that what is, or at least might be, "appropriate" can be decided from as wide a range of cases as possible. Richard Stevenson once call d for the creation of as international hub for information collection and dissemination; this was never realized. Nevertheless, if one is to move from a concern for better understanding of new and renewable energy technologies as manifested in energy projects (energy as means and end), to projects for which energy is part of the process but only as a means; then greater attention must be given to information retention and use.

6. To the extent that the Hammam Biadha project was to "demonstrate" the ability of alternative energy technologies in meeting the energy needs of a village and its surrounding agricultural activities, too little regard was given to the development and implementation of a demonstration framework by which change could be measured. Such a framework would normally include: socio-cultural analysis of the village residents' beliefs and practices; selection criteria for participants; production records for pre-facility activities; on-going production records; and an overall socio-economic development strategy for the village or region into which a localized project might be fit. The current AID Handbook

details these and related components in considerable detail. Without this framework, determination of the suitability of various energy technologies is virtually impossible.

7. The social impact assessment prescribed in AID Handbook No. 3 is the result of American social science theory and method, linked to American political philosophy. People in other countries, including otherwise highly trained social scientists, cannot be expected to be familiar with or even to share these modes of thought and action. The effort to include host-country social scientists in American development programs is laudable and to be supported; it is they who can best influence their compatriots in decision-making and planning for feasible, socially-sound projects. Yet when American development officers seek to integrate host-country social scientists into these programs, they have a further responsibility to insure the transfer of applied social science technologies. In other words, guidance and oversight must be offered, so that host-country social scientists understand the purpose and implications of this sort of work.

8. In the specific case of Hammam Biadha, we found cursory evidence that electrification of the village caused it to be attractive enough for people to move to or remain in the village. The absence of a demonstration framework, however, precludes our being certain that the growth in village households was solely due to electrification. Further analysis should be given to this dimension of the project, since mitigation of rural-to-urban migration patterns is of concern to all developing countries.

9. In retrospect, the Hammam Biadha project is not an economically feasible way of providing electricity to a

village the size of Hammam Biadha. Costs exceed revenues at every imaginable level of consumption. This would be true even if the hardware cost of PV systems were greatly reduced over what they were in the Hammam Biadha situation. At levels of consumption represented by the village, economies of scale cannot be sufficiently realized in resource use to allow recovery of project costs. Thus, such projects become difficult to replicate in other places on a sustained level.

10. Related to the previous point, our analysis tends to confirm the concerns of STEG that annual operating deficits (exclusive of capital costs) of the village system are significant. Assuming that a more thorough social cost-benefit analysis would produce only minimal positive impacts, GOT may want to consider alternative methods for supplying electricity to the village. Alternatives here include extension of the national grid and the use of small scale diesel and biomass stations. Our analysis did not examine either of these two options in detail, but it does confirm the need to give serious consideration to these alternatives.

11. In the event that alternative systems are used in Hammam Biadha, the question will arise as to what to do with existing equipment. As discussed earlier (Point 6 above), we do not believe that the current Hammam Biadha "experiment" has been an adequate test of the various applications involved. In particular, little has been learned concerning the use of PV-powered drip irrigation and the solar greenhouses. Although further, more detailed analysis is required, we recommend that the various applications be incorporated more directly into a controlled and monitored research or experimental situation. This might involve, for example, moving one (or both) of the PV-powered drip irrigation systems to the village school.

Students could make agricultural applications (producing revenue and/or goods for the school) and learn about electricity generation and maintenance. The village system is, of course, more problematic. Rather than moving the system, some thought should be given to moving applications to the village. For example, a village industrial corporation could be established where subsidized (or free) electricity could be provided by the PV system. The key element in this option is to eliminate the high annual costs of system monitoring.

12. A final point can be made about the program, with regard to its basic assumptions at the outset, and the way it appears six years later. There has been significant change in the immediacy for which information about renewable energy technology applications is needed, given changes in world petroleum availability and pricing. One cannot conclude that Hammam Biadha was a foolish or wasteful program, because in hindsight, GOT and AID planners are less interested in immediate use of these technologies in 1986 than they were in 1979. Nor is it reasonable to complain about the lack of cost-effectiveness of a program never meant to be cost-effective. One can logically complain that components of the program, and especially demonstration activities, meant to mitigate high initial and recurring costs, were either not undertaken at all, or were executed with insufficient or no record. One can look back to the program's logical framework, and wonder why certains links were not followed. One should question the assumptions of the program, and especially those of assumed inter-agency cooperation (integrated rural development), the ability of host-country social scientists to undertake needed social impact assessment research, and the like. It is our hope that this program will not become a

simple jot on someone's list of less-than-successful programs. Rather, as Mark Karns of AID/Tunisia stated from the outset, we hope constructive learning can still be undertaken, both in regard to the history of the Hammam Biadha program, and to its next phase.

In conclusion, we must point out that we have conducted our social and economic analysis under the severe constraints of limited time and data. As a cultural anthropologist and an economist, we have not attempted to assess in any significant way the engineering aspects of the projects, deferring here to experts in this area. In the end, we believe that there are significant lessons to be learned from the Hammam Biadha experience and trust that this report will serve to bring these lessons to the attention of interested individuals.

SECTION NOTES

Section II

1. Apparently, there were misgivings among AID personnel as to these ambitious production goals of the GOT. A study was commissioned from the U.S. National Academy of Sciences to assist the GOT and AID to evaluate the possibility of fabricating photovoltaic cells and other renewable energy technology components (S. Zouiten, personal communication, 23 Dec 1985). No such report could be found at AID/Tunis, and no staff there had heard of one being performed.

2. A first site for the renewable energy demonstration, Hassi el Frid in south-central Tunisia, was rejected in favor of Hammam Biadha for several reasons, including greater agricultural activity due to better soil and a higher water table at the latter. Following criteria determined by STEG, AID/Tunis staff made this change in collaboration with and at the urging of GOT counterparts, but not before residents and regional administration of Hassi el Frid were led to believe that they would receive the project. These thwarted expectations apparently may have led to some ill feelings in the first village (personal telephone communications, Larry Scudder, former NASA LeRC Project Management; Saida Zouiten, Tunisian Scientific Mission to US and former AID/Tunis S & T Officer under Richard Stevenson, 28 Dec 1985. See also Scudder 1984 and and STEG 1984 for further historical details of project).

3. Significantly, this assumption does <u>not</u> appear in the logical framework (telex 22 May 1981, G. Self/S. Zouiten).

4. The name of the village, Hammam Biadha, is used here and elsewhere to refer to the AID renewable energy program, both as project <u>and</u>

as demonstration. It should be noted that most direct benefits of the program go to inhabitants of South Hammam Biadha, where the village power system is located.

5. In effect, Hammam Biadha was of the same late 1970s generation as AID-sponsored renewable energy demonstrations in Burkina Faso (Upper Volta) and Mali, where the study of the social impact of these technologies was of fundamental importance; it would be instructive, although outside the parameters of this paper, to compare the methodologies by which these studies were conducted, and the results gained. The question might be raised as to why at Hammam Biadha, despite the statement cited here from the project agreement, so little research was conducted compared to either of the other two. See, among other papers, D. Koenig (1983) and A. Roberts (1980).

Section III

1. STEG summary reports show 23,000 KWh of electricity consumption through September, 1985. It is probable that meters have been changed at some locations, thus giving rise to the 3,000 KWh discrepancy between these two data sources.

2. The number of homes served was expected to grow by 10 percent per year for the first three years (Scudder, 1984:44).

3. It should be noted that only the coefficients for ownership of a television or fan are statistically significant at the 0.10 level.

4. For example, the village system had 840 of the 966 total PV modules installed in the Hammam Biadha project. The village system was assigned 87 percent (or 840/966) of the expenditures for PV modules. This was repeated for other specific costs that could be identified.

Section IV

1. These materials are most readily available directly from the author, Dr. Louis Rosenblum, who has recently revised and updated his textbook. He may be contacted at 7696 Alan Parkway, Middlebury Heights, Ohio, 44130, Telephone (216) 234-3755.

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STEG, 1983. "Note d'Information Relative a la Recente Defaillance du Systeme Photovoltaique au Village de Hammam Biadha," Memo to AID/T.

STEG, 1984. "Etude Comparative du Cout du Chauffage de l'eau Sanitaire," April.

APPENDIX A: PERSONAL INTERVIEWS

Appendix A
Personal Interviews

Mr. Habib Nasri, Department de la Planification et des Etudes Generales, STEG-Tunis.

Director and various staff, STEG-Siliana.

Mr. Yahoubi, Station Manager, STEG-Hammam Biadha.

Mr. Tahar Jaouadi, store and mill owner, Hammam Biadha.

Mr. A. Backallah, school director, Hammam Biadha.

Mr. Mimouni Boudjemaa, cafe owner, Hammam Biadha.

Mr. Oueslati-Kamar, clinic nurse, Hammam Biadha.

Mr. Brahim Manai, farmer, Hammam Biadha.

Mme. Troudi, Agency de la Maitrise de l'Energie, Tunis.

Mr. Hedi Nouri, Peace Corps, Tunis.

Mr. Mark Karns, USAID-Tunis.

Mr. Paul Novick, USAID-Tunis.

Mr. Mohammed Ali Hassaira, USAID-Tunis

Mr. Malcolm Lindsay, Resource Management Associates, Tunis.

Mme. Saida Zouiten, Tunisia Scientific Mission, Washington, D.C.

Mr. Larry Scudder, NASA Lewis Research Center, Cleveland, Ohio.

Mr. Anthony Ratajczak, NASA Research Center, Cleveland, Ohio.

Mr. Richard Stevenson, USAID-Manila.

APPENDIX B - HAMMAM BIADHA METER READINGS, 1984-1985

APPENDIX B

HAMMAM BIADHA METER READINGS, 1984-1985

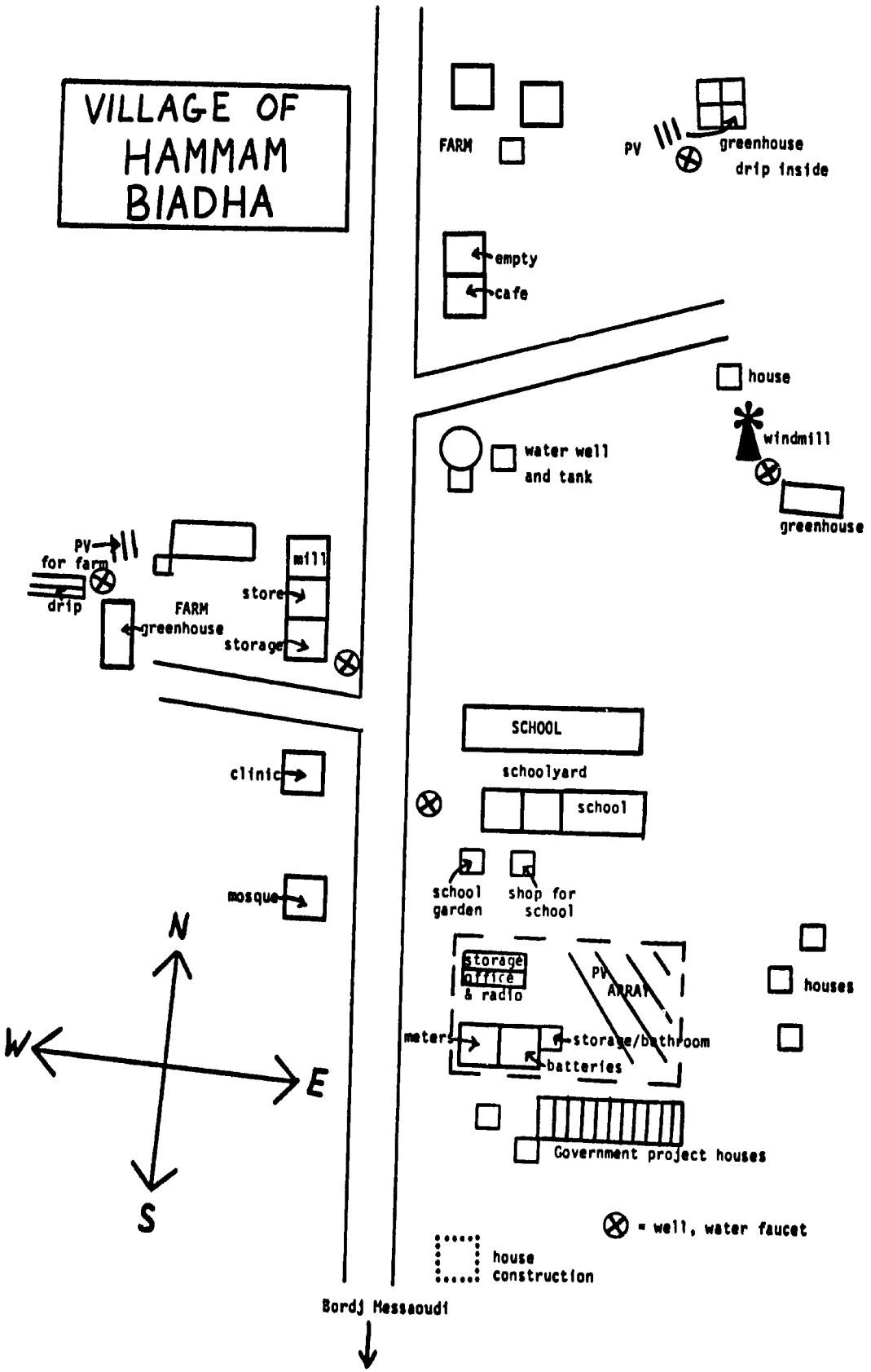
kilowatthours

	Meter ID	1/84	3/84	5/84	7/84	17/9/84	17/11/84	20/1/85	20/2/85	29/4/85	5/85	17/7/85	21/9/85	10/85	11/85
1 HH	451578	0	0	0	0	11	30	58.4	74.6	101	107	257	361.0	413.0	465
2 HH	4051515	2	2.5	3	5	6	7	14	17	22	23	64	98.7	116	119
3 HH	4056577	172	224	287	317	369	471	568	596	657	674.3	709	740	763	784
4 HH	4044876	48	48.0	48	79	93	106	125	135	150	154	166	178	187	193
5 HH	4062752	202	244.5	287	351	430	465	510	538	582	606	757	888	906	918
6 HH STEG	4066209	365	382.5	400	520	615	706	788	840	948.7	1003	1103.4	1203.8	1254	1281
7 HH	4062570	107	114.0	133	208	335	431	454	469	501	509	638	746	761	767
8 HH	139614	0	0	0		28	30	41	55	70	77	98	116	125	133
10 HH *	459820	15	19	26	35	44	51	51	52	62	68	97	127	149	164
11 HH	76588									8.0	8	8	8	14	19
12 HH	284616	63.0	65.0	67	69	78	88	117	132	150.7	160	173	181	191	202
13 HH	4058528	20	26.0	32	48	66	84	105	119	140	145	169	190	202	210
15 HH	4008152	225	252	301	388	475	526	571	589	627	640	751	892	944	975
16 HH	4010236	69.0	174.0	279	384	536	605	636	659	697	790	923	1162	1181	1189
17 HH	3960867	101	116	140	160	175	207	246	257	280.3	292	331	407	429	456
18 HH	4058224	60	74	95	106	117	137	169	179	209	218	225.5	233	272	293
19 HH	4035150	58	70	92	164	236	336	369	379	452	481	529.5	578	639	671
25 HH	8538019	46	57	57	86	87	107	133	144	169	177	192	224	308	363
26 HH	4056659	35	46	59.0	72	72	110	192	223	290	308	308	333	352	364
30 HH	3967596	448	508	650	828	1012	1160	1282	1332	1450	1499	1683	1860	1922	1952
31 HH	4058192	85.0	118	151	183	205	244	278	299	329	338	371	405	425.0	445
33 HH	3963203	163	172	238	439	683	815	884	920	993	1028	1278	1606	1716	1749
34 HH	4038102	10	36	44	51	58	68	79	84	97	102	119	129.0	134	148
37 HH	3960840	35	45.5	56	100	228	311	323.4	329.6	342	348	348	348	348	348
39 HH	526194											0	11	20	24
35 HH FARM	3961263	19.0	49	49	49	49	49	49	49	49	49	49	49.0	49.0	49
20 STEG	325359	39	40	41	42	45	46	48	49	51	51.7	53	59	59	60
21 STEG	321791	178.0	234	290	321	370	417	460	490	549	566	609	680	698	705
22 MOSQUE	4062482	113.0	143	173	201	316	348	278	295	332	345.0	371	395	417	424
23 CLINIC	4047028	247	284	400	512	607	690	782	812	926	982.0	1094	1252	1322	1359
24 WORKSHOP	283577	54	94	117	122	124.5	127	162	181	232	248	248	248	249	253
27 SCHOOL	320614	49	57	72	85	86	113	144	154	171	179.0	195	199	214	224
28 SCHOOL	212846	19	31	43	47	47	55	80	101	123	123.7	125	125	130	140
29 STORE	4001004	4.0	14	14	16	17	18	27	27	27	28	29	30	32	34
32 CAFE	3967357	568	577	608	703	799	828	858	870	900	909	999	1117	1144	1155
36 LIGHTING	49933735							379	409	563	706.7	994	1303	1409	1409
RES & COM	49954059							1975	2345	3342		5573	7480		
PUBLIC	49981302							555	666	1057		1379	1604		

* Meter changed
1/20/85 4059667

APPENDIX C - MAP OF HAMMAM BIADHA

APPENDIX C


VILLAGE OF
HAMMAM
BIADHA
FARM
PV
greenhouse
drip inside
empty
cafe
house
windmill
water well
and tank
greenhouse
PV
for farm
drip
FARM
greenhouse
mill
store
storage
SCHOOL
schoolyard
school
clinic
mosque
school
garden
shop for
school
storage
office
& radio
PV
ARRAY
houses
meter
storage/bathroom
batteries
Government project houses
N
W
E
S
= well, water faucet
house
construction
Bordj Messaoudi

Department of State

INCOMING TELEGRAM

PAGE 01 TUNIS 04985 211532Z 5188 066331 AID7367
ACTION EB-08

ACTION OFFICE PPDC-01
INFO FPA-02 ANDP-03 ANPD-05 AMAD-01 PPPB-02 ANTR-06 ANME-03
RELO-01 024 A0

INFO LOG-00 COPY-01 ADS-00 AID-00 INR-10 SS-00 CIAE-00
DINT-05 DODE-00 H-01 IO-17 EXIM-06 NEA-07 NSAE-00
COME-00 L-03 LAB-04 EAP-00 ITC-01 OPIC-07 PA-02
CEA-01 DOTE-00 OMB-01 STR-20 SIL-01 AGRE-01 FRB-01
JUS-01 USIE-00 SP-02 SNP-01 /101 W
----------256023 230111Z /63

R 211527Z MAY 86
FM AMEMBASSY TUNIS
TO DEPTTREAS WASHDC
INFO SECSTATE WASHDC 5072

UNCLAS TUNIS 04985

TREASURY FOR OASIA/IDB; AID FOR PPC/DC;
STATE FOR EB/IFD/ODF PLUS ALL OTHER WGMA AGENCIES

E.O. 12356: N/A
TAGS: EFIN, EAID, IBRD, TS
SUBJECT: TUNISIA - ENERGY CONSERVATION DEMONSTRATION PROJECT

REF: STATE 154107

1. ECON COUNSELOR MET WITH MONCEF BEN ABDALLAH, PRESIDENT OF THE NEWLY ESTABLISHED ENERGY CONSERVATION AGENCY (AGENCE POUR LA MAITRISE DE L'ENERGIE), TO DISCUSS FOUR MILLION DOLLAR IBRD ENERGY CONSERVATION LOAN (REFTEL). THE LOAN IS INTENDED TO COVER THE FOREIGN EXCHANGE COSTS OF A TWO YEAR PILOT PROGRAM TO DO ENERGY AUDITS OF 30 PUBLIC ENTERPRISES, TRAIN TUNISIAN STAFF, IDENTIFY ENERGY CONSERVATION PROJECTS AND DO FEASIBILITY STUDIES.

2. THE 30 ENTERPRISES ARE MAJOR ENERGY USERS. THEY INCLUDE 12 INDUSTRIAL FIRMS, 10 HOTELS AND 8 PUBLIC TRANSPORT COMPANIES. THESE COMPANIES ACCOUNT FOR ABOUT 30 PERCENT OF ENERGY CONSUMPTION IN TUNISIA. THE GOAL OF THE PILOT PROGRAM IS A 10 TO 15 PERCENT REDUCTION IN CONSUMPTION. THIS WOULD SAVE TUNISIA AN AMOUNT OF ENERGY EQUIVALENT TO ABOUT ONE YEAR'S GROWTH IN ENERGY CONSUMPTION.

3. THE LOCAL CURRENCY COSTS OF THE PROJECT WILL BE MET BY THE PARTICIPATING COMPANIES WHO WILL PROVIDE ONE-THIRD OF THE OUTLAYS; THE GOVERNMENT WILL PROVIDE THE REST VIA LOANS AND INCENTIVES. THE LOANS WOULD BE REPAID FROM THE ENERGY SAVINGS ACHIEVED.

4. MONCEF BEN ABDALLAH IS A SERIOUS, HARD WORKING OFFICIAL AT A TIME WHEN THE ECONOMY IS HARD PUT TO GENERATE NEW RESOURCES, ENERGY CONSERVATION CAN PLAY AN IMPORTANT ROLE. THE EMBASSY BELIEVES THIS LOAN IS WELL CONCEIVED AND URGES THAT THE U.S. EXECUTIVE DIRECTOR BE INSTRUCTED TO SUPPORT IT WHEN IT COMES BEFORE THE IBRD BOARD OF DIRECTORS.
SEBASTIAN

75

RMA/GOT-QR-12 (3-86)

TUNISIAN ENERGY PLANNING PROJECT
TWELFTH QUARTERLY REPORT

March 30, 1986

prepared for:

Republic of Tunisia
Ministry of National Economy

prepared by:

RESOURCE MANAGEMENT ASSOCIATES OF MADISON, INC.
520 University Avenue
Madison, Wisconsin 53703
USA

Submitted by: Wesley K. Foell, President

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Tunisian Energy Planning Project
Quarterly Report - March, 1986

1. Summary of Quarterly Activity

This twelfth Quarterly Report covers the period from December 1, 1985 through February 28, 1986. It summarizes project objectives, accomplishments, and plans for the remaining four months of the project.

1.1 Technical Highlights

* SME Staff Training in the U.S. - Mr. M. Majdoub of the SME Department of Economic Studies, on December 1 went to RMA home offices in Madison for three weeks training and follow-up work with Dr. Trevino who was previously in Tunis to assist SME develop expertise in industrial energy modelling and forecasting. The follow-up training at RMA enabled Mr. Majdoub to elaborate the application of the model to energy conservation and fuel substitution, which he subsequently documented in a working paper.

Short-term advisor trips completed during the quarter were as follows:

* Cost/Benefit Analysis of Hammam Biadha Photovoltaic Facilities - RMA advisors Dr. Allen Roberts and Dr. Jack Huddleston were in Tunisia from December 29 to January 7, 1986 to investigate the demonstration aspects and socio-economic impacts of the renewable facilities installed in 1983, with AID assistance, at Hammam Biadha. Their report was sent in February.
* Residential Energy Model Development - Mr. Robert Lopez was in Tunisia from February 2-15, to work collaboratively with Mr. Ben Jabara of the Agence de Maitrise de l'Energie (AME) in setting up a model of the Tunisian residential sector's energy use. A microcomputer model was designed, implemented, and applied to simulate and forecast national and regional energy use, disaggregated by type of fuel and end use.

1.2 Management Overview

The project assistance completion date was extended from December 31, 1985 to June 30, 1986, on December 18, when the GOT signed AID Project Implementation Letter No. 3. GOT/RMA contract Amendment Number 5, extending the duration of the contract and the position of resident advisor to June 30, was signed by the DGE on December 31 and approved by AID on January 7.

Changes in GOT/RMA Amendment Number 4, to budget solar demonstration project monitoring equipment at $10,000, were signed by the DGE on December 9.

The Agence de Maitrise de l'Energie (AME) was established January 1, 1986. M. M. Ben Abdallah was appointed PDG of the AME and the Department d'Etudes (DET, formerly the DEE) was transferred to the AME from the SME. AME moved to a different location on February 21.

A trip to the U.S. by Messrs. Nouri-Ammar and Ben Abdallah is scheduled to take place in the second half of March. In addition to attending the 13th Energy Technology Conference and post-Conference energy management courses in Washington, D.C., their program includes meeting with RMA president, Dr. W. Foell, to review and finalize plans for the three remaining months of the project.

The direct effort charged this quarter was that of the resident advisor, the short-term advisor trips and SME staff training in the U.S. noted in Section 1.1. The amount remaining in the project budget at the end of the quarter was approximately $140,000. RMA invoices for December, January, and February are summarized in Section 4 of this report.

2. Project Background and Objectives

The Government of Tunisia, recognizing the need for a comprehensive policy that addressed all aspects of the energy problem, has undertaken a broad-based program to enhance its capability to conduct energy policy and planning. This program includes the development of an improved data

and information base, an increased analytical capability, and an enlarged cadre of trained and experienced professionals for carrying out the requisite policy.

As indicated in the USAID Project Agreement and the original RMA contract, the project reported here was designed to assist the Government of Tunisia in the following areas of need:

* General energy analysis, planning, and policy formulation;
* Collection of end-use data in the residential and tertiary (commercial/institutional) sectors; and detailed audits of buildings;
* Field testing and assessment of renewable energy technologies; and
* Institutional development through staff training in energy analysis, planning policy formulation, and relevant program implementation.

Most of the effort in the project has been directed toward these initial goals. However, during the conduct of the project, some areas of emphasis changed, as both the national and international energy conditions evolved.

The contract between Resource Management Associates of Madison, Inc. (RMA), and the Republic of Tunisia, represented by the Ministry of National Economy (MEN), was effective 14 January 1983. The Project Commencement Date was 7 March 1983, when the Long-Term Resident Advisor began work in Tunis. The project duration was originally set for 30 months, but was extended by amendment to 40 months through June 30, 1986. This RMA effort is funded through USAID Project No. 664-0326. The contract amendment for the agricultural sector study was funded from the remainder of the now-terminated Ferguson-Bryan contract, supported under the AID/ST/EY centrally-funded Energy Planning Project (36-5703), which expired 30 April, 1984.

This twelfth Quarterly report covers the period through February 28, 1986. The financial data summarizes the RMA invoices

for December, January, and February.

3. Technical Status

3.1 Task A - Renewable Energy Technology

3.1.1 Objectives: This task was initially designed to assist the Government of Tunisia in the development of methods and data for evaluating the technical performance and cost effectiveness of renewable energy systems in Tunisia, specifically solar water heating and wind energy systems. The task emphasizes assessment of potential applications and impacts of the system, including substitution for other energy forms, potential market penetration, and industrial development, to provide information to guide future programs and policies for the implementation of systems, such as testing and certification, performance guarantees, or financial incentives. As the project and long-term goals of SME evolved, this task focused increasingly on demonstrations of solar water heating systems in commercial and institutional buildings. These demonstrations will provide realistic experience with system design, installation, and operation. This experience and additional training will also help develop the technical skills of Tunisian staff and other capabilities of the Tunisian solar industry.

3.1.2 Accomplishments: Benefits and costs of the existing photovoltaic facilities at Hammam Biadha were investigated by Dr. Allen Roberts and Dr. Jack Huddleston, assisted by Dr. Malcolm Lindsay. The consultants, accompanied by M. Nasri of STEG, Ms. Troudi of SME, and M. Hessairi of AID, went to Hammam Biadha twice and to STEG offices in Siliana to gather information about the costs, performance, and use being made of the solar energy facilities. The consultants evaluated the project in terms of its objectives as an instructive experiment in the practical application of a group of complementary renewable energy

technologies intended to serve the needs of the local community. Their report (RMA/GOT-TD-39) was sent to SME and AID in February.

There were further developments during the quarter with regard to implementation of solar demonstration projects at selected hotels. Proprietors of the Sahara Beach at Monastir and El Kanta at Sousse, on December 3 and 4, respectively, requested SME to examine the possibility of subsidizing projects which they intended to pursue with the designers, Serept Energies Nouvelles (SEN). Sahara Beach advised SME that they had adopted the SEN project that showed the maximum energy savings (billed at 284,000 DT). El Kanta advised SME of their firm commitment to SEN for four installations, contingent upon specific financing conditions being obtained. Similarly, the proprietors of El Sultan at Hammamet communicated to SEN that their final decision would depend on obtaining (under circular no. 62535, December 4, 1984 of the Central Bank of Tunisia) a 7 year loan at 6.25 percent p.a. for ninety percent of the installation costs.

SME, in agreeing (December 19) to consider the requests of Sahara Beach and El Kanta, asked for copies of proposed contracts and stated that, since demonstration aspects would be the basis for SME support, the installation of performance monitoring equipment would be warranted. Provision for purchasing up to $10,000 of solar monitoring equipment had been included in the GOT/RMA contract and signed by the DGE on December 9.

SEN proceeded to try to arrange financing under the terms of the Central Bank circular. This proved to be more difficult than anticipated and remained unresolved at the end of the quarter.

In February, SME was in the process of analyzing and evaluating the preliminary studies furnished by SEN. Plans for executing the work and specifying the instruments to be used for monitoring the performance of the solar equipment, were requested by SME on February 13. SME reminded SEN that the monitoring equipment could be provided under the terms of the GOT/RMA contract, after RMA approval of SEN detailed studies. SME

urged SEN to furnish the requested documents by mid-March in order to ensure procurement and delivery of monitoring equipment before the GOT/RMA contract expires on June 30.

3.1.3 Plans for the Next Quarter: RMA anticipates reviewing SEN detailed studies between mid-March and mid-April. Mid-April is regarded as the latest time at which procurement of solar monitoring equipment could be initiated to ensure timely delivery to SME. It is anticipated that an RMA advisor mission to Tunisia may be warranted to provide technical assistance with regard to the installation and use of the monitoring instruments and analysis of the data to be collected.

3.2 Task B - Energy Consumption Data and Sectoral Analysis

3.2.1 Objectives: This project task assists the Ministry in the collection and analysis of data on energy consumption by sector and by use. The Ministry's studies of the residential and tertiary (commercial/institutional) sectors are being conducted within the period of the RMA contract. The study of the agricultural sector was already underway, but a contract amendment has provided for RMA technical assistance in the completion of the work. An initial study of the transportation sector has been completed, but outside this project. That of the industrial sector was completed in 1982, before the RMA contract began. During the course of the project, RMA has been asked to give further assistance in the transport and industrial sectors, primarily in modeling and forecasting (Task C).

RMA technical assistance with the initial sectoral studies includes advice on data collection, development of analytic methods, training of staff, and review of results by outside experts. With the completion of the first round of sectoral studies, there existed a set of current data on energy consumption by sector and by end use. Combined with other relevant economic data, it can be assembled and presented in a data base useful to analysis in the Ministry and other organizations.

Specifically, in this current project, the data will be used in energy consumption forecasting and policy analysis (Task C, Section 3.3 below).

It is recognized that the data must be updated periodically, with additional major studies when necessary, but by less elaborate approximate methods surrounding intervening periods. Therefore, a key part of this project is to develop and apply valid techniques for the periodic (for example, annual) updating of the energy consumption data. This work includes consideration of questions such as how frequently surveys or other major studies are needed; what are the key data that must be checked frequently; what approximate methods can be used in interim years, such as extrapolation or simply models based on indices; and how to verify or correct those approximations when more primary data becomes available.

3.2.2 Accomplishments: A National Commission on Energy Consumption Data (Commission Nationale de Base de Donnees sur la Consommation d'Energie), headed by M. Ounali, was appointed by the DGE in December to recommend means of improving the scope and quality of energy data collection and dissemination. Representatives of government agencies and energy companies serve on the Commission. Four working committees were set up to address: 1) energy information needs, with particular regard to the national energy balance sheet; 2) standardizing factors of conversion (tons of oil equivalent per cubic meter of gasoline, etc.); 3) standardizing the definition of major economic sectors (industry, agriculture, etc.); and 4) data compilation and processing. Work in these areas was the major activity of DET staff and the RMA resident advisor during January and February. The Commission's report is scheduled to be submitted to the DGE in March.

3.2.3 Plans for the Next Quarter: It is planned that the RMA resident advisor will assist AME staff to complete estimates of 1985 sectoral energy use and review AME sectoral energy consumption and

related data compilations with regard to recommendations of the Energy Consumption Data Base Commission.

3.3 Task C - Energy Demand Forecasting

3.3.1 Objectives: The forecasting task expands from the sectoral data, which presents a largely static picture of energy consumption by sector and end use, to provide a dynamic and fully integrated view of future energy consumption in relation to other economic variables. Specifically, this project task will develop and apply methods to estimate future energy consumption under certain self-consistent sets of assumptions (scenarios) representing alternative possible futures. The forecasts will be both for individual sectors and integrated to give an overall intersectoral forecast for each scenario. The analysis will evaluate impacts of various energy policy options, including effects of energy efficiency improvement, fuel substitution, or increased use of renewable resources, and will illustrate the relationship and sensitivity of energy consumption to other economic variables, such as industrial output or household formation. The forecasting models will be implemented at an operational level, and Tunisian staff will be trained in their use. One major event proposed in the task is a working/training session of several days' duration in Tunis to present sectoral results, scenarios, and analytical methods.

3.3.2 Accomplishments: Mr. M. Majdoub, of the SME Department of Economic Studies, on December 1 went to RMA home offices in Madison for three weeks training and follow-up work with Dr. Trevino, who was previously in Tunis to assist SME in developing expertise in industrial energy modelling and forecasting. The follow-up training at RMA enabled Mr. Majdoub to elaborate the application of the model the energy conservation and fuel substitution, which he subsequently documented in a working paper.

In a second collaborative effort with AME staff, RMA consultant Mr.

Robert Lopez worked with Mr. Ben Jabara at AME from February 2-15, setting up a model of the Tunisian residential sector's energy use. A microcomputer model was designed, implemented and applied to simulate and forecast national energy use disaggregated by type of fuel and type of use. Further disaggregation, between urban and rural sectors, was made to provide flexibility in forecasting and policy analysis. Mr. Lopez also discussed forecasting methodology and his recommendations for further elaboration and application of the model.

In January and February, AME and RMA proceeded with plans for integrating all sectoral (industrial, residential, etc.) modelling and forecasting to provide a unified perspective on the evolution of national energy use, as described in the "Proposal on Project Extension". On January 13, RMA proposed a two-week mission in February, overlapping with Mr. Lopez's visit, to assist integrating residential with tertiary or other sector analyses. SME responded, January 2, requesting a proposal for a three-week mission covering integration of all sectors. RMA subsequently suggested including a seminar, as a culmination presentation and discussion of the sectoral integration mission. This was considered by M. Ounali, who decided it was best for AME to first have a mission devoted to accomplishing the sectoral integration and producing some scenario results for internal review. At the end of February, AME approved RMA's proposal for such a mission by Dr. J. Huddleston from March 10-28.

3.3.3 Plans for the Next Quarter: Assistance with integrating all sectoral energy modelling and forecasting activities will be provided by Dr. Jack Huddleston, during a mission from March 10-28. It is tentatively planned to schedule a seminar in April or May to culminate the collaborative work in this aspect of the project.

3.4 Task D - Conservation Actions (Maitrise de l'Energie)

3.4.1 Objectives: This project task assists the Ministry in the

development and implementation of programs to promote the realization of energy conservation in all sectors of the economy. Possible activities include:

* Public information;
* Training and program development in energy management;
* Efficiency improvement campaigns;
* Development of norms and standards related to energy consumption or use of renewables;
* Provision of technical services (such as building energy audits).

The project discussion of October, 1984 and the resulting protocol give a plan for addressing conservation actions in the industrial, residential, tertiary, and transportation sectors.

3.4.2 Accomplishments: The second part of the SME/RMA technical assistance program for the Compagnie Tunisienne de Naviation (CTN) was carried out during the first half of February by Prof. N.A. Hamlin, of the Webb Institute of Naval Architecture, assisted by Mr. G. Bauer. The object of the mission was to discuss and recommend methods for economizing energy use by CTN ships. To determine potential fuel savings by examining the ship's performance, operating conditions, and constraints, the consultants sailed on the "Tozeur" from Tunis to Cadiz, February 5-8. They were accompanied by Messrs. Ghannouchi of CTN and Bahri of SME. Messrs. Hamlin and Bauer worked for the remaining time, between February 2 and 15, at the offices of SME and CTN. Part of this time was required to collect and analyze data on the ship's voyages prior to and since its latest drydocking. The consultants also devoted time to discussing their methods and findings with CTN and SME personnel. Prof. Hamlin's report is scheduled to be submitted to SME at the end of March.

Consultants for energy audit work at CIOK cement plant were proposed by RMA and approved by SME. The scope of work to be undertaken

during an anticipated mission next quarter was in the process of being finalized at the end of February.

3.4.3 Plans for the Next Quarter: The scope of work for the RMA consultants energy audit mission to CIOK cement plant will be finalized and scheduled to be carried out during the next quarter.

3.5 Tunisian Staff Training in the U.S.

M. Majdoub's training trip in the U.S. is described in Section 3.3.2.

The possibility of further training in the U.S. for a small number of engineers is on the agenda for the March 21 meeting of Messrs. Nouri-Ammar, Ben Abdallah, and Foell. Messrs. Nouri-Ammar and Ben Abdallah will be in Washington March 17-20 to attend the 13th Energy Technology Conference and post-Conference courses in energy management and auditing. Their registration is funded under the Energy Planning Project. Further arrangements are being made by Messrs. Nouri-Ammar and Ben Abdallah to visit solar equipment manufacturers, including a company in Colorado which last year expressed interest in establishing production facilities in Tunisia.

4. Level of Effort and Financial Expenditures

4.1 Direct Effort - Original Contract

Table 1 gives the quarterly and cumulative direct effort (person-months) of RMA project staff. The associated figures shows cumulative direct effort in comparison to hypothetical linear expenditures of total direct effort. Table 2 lists current and planned trips by short-term advisors.

4.2 Financial Expenditures - Original Contract

Table 3 gives the quarterly and cumulative financial expenditure. The associated figure shows the cumulative project expenditures in comparison to a hypothetical linear financial expenditure.

AID Project 664-0326
DIRECT EFFORT OF PROJECT STAFF

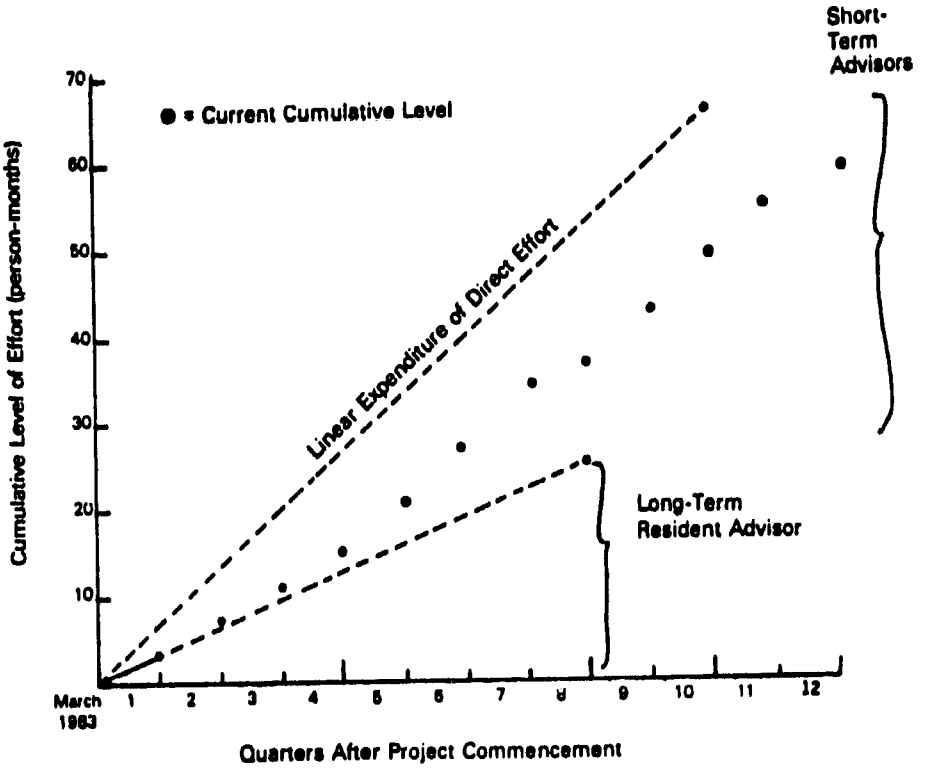

Table 1
DIRECT EFFORT OF PROJECT STAFF*
(Person-Months)

	Quarters after Project Commencement											
	1	2	3	4	5	6	7	8	9	10	11	12
Long-Term Resident Advisor	3.2	3.0	3.0	3.0	2.2**	3.0	3.0	1.0	3.0	3.0	3.0	3.0
Short-Term Advisors	0.0	1.0	1.0	1.1	3.5	3.0	2.2	2.1	4.0	3.5	2.5	2.2
Total in Current Quarter	3.2	4.0	4.0	4.1	5.7	6.0	5.2	3.1	7.0	6.5	5.5	5.2
Cumulative	3.2	7.2	11.2	15.4	21.0	27.0	32.2	35.3	42.3	48.8	54.3	59.5

* This table has been revised from previous Quarterly Reports to exclude efforts under the Agricultural Task (Contract Amendment).

** Portions of Resident Advisor's time in March-April 1984 charged to Agriculture Task (936-5703).

Table 2
Short-Term Advisors

Note: Per the RMA contract, all short-term advisors are jointly selected by RMA and GOT, and formal approval by GOT must be granted before a trip begins.

Quarter 12 (Completed)

Name: Allen Roberts
Date: 27 December - 8 January
Task: Cost/Benefit Analysis of the Hammam Biadha Photovoltaic Facility

Name: Jack Huddleston
Date: 27 December - 8 January
Task: Cost/Benefit Analysis of the Hammam Biadha Photovoltaic Facility

Name: Robert Lopez
Date: 2-15 February
Task: Development of Residential Sector Energy Use Model

Name: Norman Hamlin
Date: 2-15 February
Task: Second Stage Audit of Compagnie Tunisienne de Navigation

Name: Glenn Bauer
Date: 2-15 February
Task: Second Stage Audit of Compagnie Tunisienne de Navigation

Training Trips to U.S.

Name: M. Nouri-Ammar
Date: 16-30 March
Task: Energy Technology Conference/Project Review

Name: M. ben Abdallah
Date: 16-30 March
Task: Energy Technology Conference/Project Review

Quarter 13

Name: Jack Huddleston
Date: 10-29 March
Task: Integration of Sectoral Models
Status: In Progress

Name: To be identified
Date: April/May
Task: Energy Forecasting and Policy Analysis Workshop
Status: Requested by RMA

Name: Coplay Cement
Date: March/April
Task: Audit of Cimenterie Oum Khelil
Status: Being Proposed by RMA

Name: To be identified
Date: April/May
Task: Audit of Societe de Distribution Petroliere
Status: Requested by SME

AID Project No. 664-0326
CUMULATIVE PROJECT EXPENDITURES

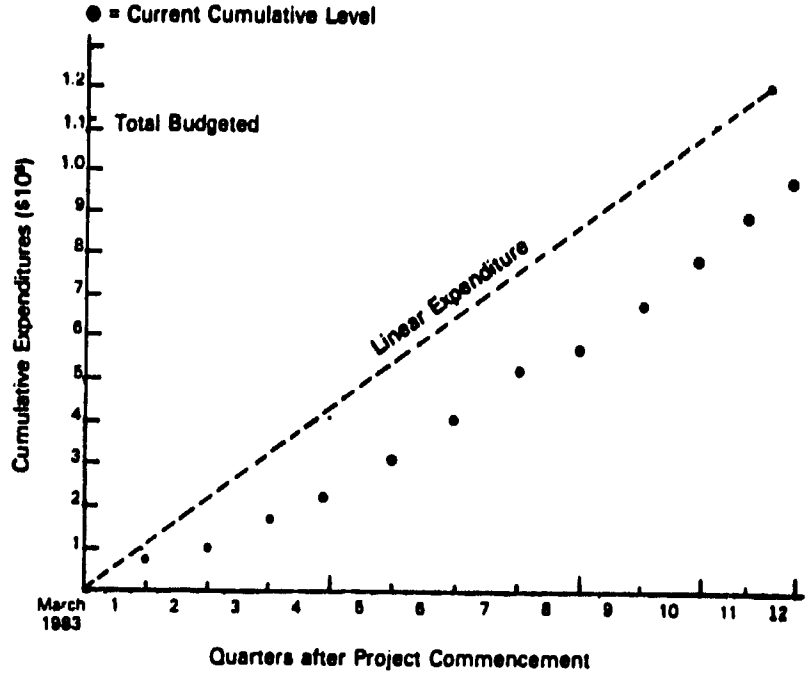

Table 3
FINANCIAL EXPENDITURES

Level of Effort	1	2	3	4	5	6	7	8	9	10	11	12
(10^6\$)												
Total in Quarter	.059	.055	.053	.062	.079	.096	.105	.044	.094	.142	.107	.060
Cumulative	.059	.114	.167	.229	.308	.404	.509	.553	.647	.789	.896	.956

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5. Distribution List

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