CLASSIFICATION

PROJECT EVALUATION SUMMARY (PES) — PART I

Report Symbol U-447

1. PROJECT TITLE	2. PROJECT NUMBER	3. MISSION/AID/W OFFICE
Renewable/Improved Traditional Energy (698-0410.22)	698-0410.22	AID/Rwanda

4. EVALUATION NUMBER (Enter the number maintained by the reporting unit e.g., Country or AID/W Administrative Code, Fiscal Year, Serial No. beginning with No. 1 each FY)

☒ REGULAR EVALUATION ☐ SPECIAL EVALUATION

5. KEY PROJECT IMPLEMENTATION DATES			6. ESTIMATED PROJECT FUNDING	7. PERIOD COVERED BY EVALUATION
A. First PRO-AG or Equivalent FY 79	B. Final Obligation Expected FY 79	C. Final Input Delivery FY 83	A. Total $ 664,350 B. U.S. $ 487,500	From (month/yr.) 8/79 To (month/yr.) 3/82 Date of Evaluation Review March 18 - April 2, 1982

8. ACTION DECISIONS APPROVED BY MISSION OR AID/W OFFICE DIRECTOR

A. List decisions and/or unresolved issues; cite those items needing further study. (NOTE: Mission decisions which anticipate AID/W or regional office action should specify type of document, e.g., airgram, SPAR, PIO, which will present detailed request.)	B. NAME OF OFFICER RESPONSIBLE FOR ACTION	C. DATE ACTION TO BE COMPLETED

9. INVENTORY OF DOCUMENTS TO BE REVISED PER ABOVE DECISIONS

- ☐ Project Paper
- ☐ Financial Plan
- ☐ Logical Framework
- ☐ Project Agreement
- ☐ Implementation Plan e.g., CPI Network
- ☒ PIO/T
- ☒ PIO/C
- ☐ PIO/P
- ☐ Other (Specify) _____
- ☐ Other (Specify) _____

10. ALTERNATIVE DECISIONS ON FUTURE OF PROJECT

- A. ☒ Continue Project Without Change
- B. ☐ Change Project Design and/or ☐ Change Implementation Plan
- C. ☐ Discontinue Project

11. PROJECT OFFICER AND HOST COUNTRY OR OTHER RANKING PARTICIPANTS AS APPROPRIATE (Names and Titles)

Carolyn Barnes, REDSO/EA Social Analyst
Wes Fisher, REDSO/EA Energy Advisor
W. Brooke Stallsmith, AID/Rwanda, Asst. Program Officer
Prosper Mpawenayo, Director, CEAER

12. Mission/AID/W Office Director Approval

Signature: Eugene Chiavaroli

Typed Name: Eugene R. Chiavaroli

Date: June 29, 1982

AID 1330-15 (3-78)

EXECUTIVE SUMMARY:

Rwanda Renewable and Improved Traditional Energy Project
(698-0410.22)

Q.1. WHAT CONSTRAINTS DOES THIS PROJECT ATTEMPT TO OVERCOME AND WHOM DOES IT CONSTRAIN?

The purpose of this Accelerated Impact Program activity, approved August 28, 1979 for $488,000 is to help meet Rwanda's rural energy needs by overcoming institutional constraints to research, development, field testing and analysis of renewable and improved traditional energy technologies. The institution supported by this project is the Centre d'Etudes et d'Applications de l'Energie au Rwanda (CEAER - Rwandan Center for Energy Studies and Tests), a branch of the national university charged with (a) assessment of renewable energy potential, (b) development and construction of prototypes and the field testing of these to determine economic and sociocultural feasibility, and (c) assistance in the creation of at least one commercial society for the fabrication of a technology developed by the Center.

CEAER through this project addressed the problems of (a) depletion of woodstock, and (b) alternatives to current high costs of providing heat, light and power. One strategy for addressing the demand for woodfuel is the planting of more trees. This can reduce the amount of land available for other uses, and also requires a long period to show results. CEAER/s efforts to develop improved wood and charcoal stoves and more efficient charcoal production methods address these problems, which are faced by 880,000 farm families as well as the small minority of towns-people. The relatively high cost of using diesel-run engines and power from the main electrical grids affects institutions and commercial operations which serve rural and urban populations. High costs and fuel availability problems lead to an insufficient supply of hot water in hospitals, dispensaries and schools, and constraints the operation of productive enterprises in rural areas.

Q. II WHAT TECHNOLOGY DOES THE PROJECT PROMOTE TO RELIEVE THIS CONSTRAINT?

This project provides for the development and field-testing of alternative energy cookers, solar water heaters and solar distillation units for rural health care centers, a biogas unit to produce cooking fuel for an institution, a photovoltaic system to provide lighting and refrigeration for a rural health center, a small hydropower installation, a brick charcoal kiln as a potential substitute for charcoal earthen kilns, and other potentially economical renewable energy technologies which may be selected for CEAER research.

Q. III WHAT TECHNOLOGY DOES THE PROJECT ATTEMPT TO REPLACE?

The project attempts to increase the institutional capacity in Rwanda to identify feasible technologies as substitutes for current methods of using wood and as economical alternatives to relatively high cost electricity and petroleum fuel. For households, the project concentrates on alternatives to the current practice of cooking over a wood fire in a three-stone hearth. The project also focuses on providing substitutes for inefficient use of wood fuels by institutions and commercial enterprises and on providing economical alternatives to the use of petroleum products or costly electricity for lighting, water heating, mechanical drive and distillation of water. The projects also attempts to provide substitutes for current inefficient charcoal production practices using earth kilns.

Q. IV WHY DO PROJECT PLANNERS BELIEVE THAT INTENDED BENEFICIARIES WILL ADOPT THE PROPOSED TECHNOLOGY?

Under this project, most of the direct beneficiaries will be those benefiting from the field testing of technologies developed and adapted. Because of thes crucial step, technologies will not be extended until they have been determined to be economically, technically and socially feasible, as well as readily acceptable to potential consumers.

Q. V WHAT CHARACTERISTICS DO INTENDED BENEFICIARIES EXHIBIT THAT HAVE RELEVANCE TO THEIR ADOPTING THE PROPOSED TECHNOLOGY?

The most important shared characteristic of the intended beneficiaries - individuals, institutions and commercial enterprises - is that they are economically rational. They will only adopt devices developed by CEAER if these devices are economically and technically sound. The total cost of the installation, operation, maintenance and repair in terms of labor, money and other inputs will determine the attractiveness of a given technology against other competing demands on scarce resources and thereby influence adoption rates. Also, the purpose for which the technology will be used, (i.e., consumption, service or production) will affect its economic attractiveness. For example, in substituting improved stoves for open cooking fires the cost of the improved stove may be reasonable, but if it displaces other functions served by the open cooking fire, such as lighting, it may be uneconomical for potential users since the lighting function will have to be performed by another source.

Q. VI. WHAT ADOPTION RATE HAS THIS PROJECT OR PREVIOUS PROJECTS ACHIEVED IN TRANSFERRING THE PROPOSED TECHNOLOGY?

At this point in the project, most of the technologies are still at the stage of prototype development. However, experience from other projects of this type has shown that the diffusion of many renewable energy technologies proceeds at a slower pace than anticipated and that these technologies can be expected to make only a partial contribution to reducing rates of fuelwood consumption in rural areas or in displacing rural consumption of petroleum fuels. The primary consumption of petroleum products by rural populations is for transport, and lighting. Few economical, renewable energy alternatives exist for these uses. Rural institutions and enterprises largely depend on petroleum products for transport, heat-generation, lighting and mechanical power. Primary constraints have included:

1) an emphasis on design from locally available materials and an under-emphasis on field testing and modification of imported appropriate technologies from other developing countries,
2) the time required for determination of economic feasibility and social acceptability, and
3) the limited marketing and extension infrastructure as in most African countries.

Q. VII. WILL THE PROJECT SET IN MOTION FORCES THAT WILL INDUCE FURTHER EXPLORATION OF THE CONSTRAINT AND IMPROVEMENTS TO THE TECHNOLOGICAL PACKAGE PROPOSED TO OVERCOME IT?

Through continuing prototype development and field-testing, the project does promise the eventual identification of cost-effective, reliable and socially acceptable technologies. It will also enhance the skills of the CEAER staff in design and/or evaluation of cost-effective technologies, which will be useful well beyond the life of the project. The staff is highly motivated, and the national committment to the development of renewable energy alternatives by the Center is likely to continue. CEAER has well-established links with other similar research institutes and renewable energy projects, both through direct contacts and observational tours and through organizations such as Volunteers in Technical Assistance.

CEAER's non-project budget is determined through an annual review by the university of all research and teaching priorities. Both the university and CEAER are dedicated to development of technologies which will be of direct benefit to the Rwandan people. Both recognize that involvement in the manufacture, production or maintenance of these technologies would be inappropriate, and both are currently concerned by the number of requests they are receiving to build or repair solar water heaters and distillers. They do not view this activity as a legitimate role for a research institution, but are anxious to assist in the process of establishing manufacturing enterprises outside the university setting. This interest extends to such areas as the repair and maintenance of small hydrosystems, a CEAER priority not addressed in the original AIP project.

Q. VIII. DO PRIVATE INPUT SUPPLIERS HAVE AN INCENTIVE TO EXAMINE THE CONSTRAINT ADDRESSED BY THE PROJECT AND COME UP WITH SOLUTIONS?

The project addresses the research and development of feasible renewable and improved traditional energy technologies. This R and D function, which requires a financial investment in a long-term, risk-taking effort is unlikely to be addressed by private input supplies in Rwanda. Whereas govennments in developed countries assist in financing R and D functions, the Government of Rwanda is unable to devote many resources to this effort. When CEAER prototypes have reached the stage where they are economically and socially attractive, there is no reason to believe private input suppliers or private artisans and technicians would not take an active role in their production and dessemination.

However, effective marketing by input suppliers is constrained by the difficulty of reaching potential user markets, partly because of limited national transportation and communication infrastructure. Emphasis on strengthening national radio communication might help to open up rural markets for urban manufacturers and importers.

The limited availability of credit institutions in most African countries also constrains both the establishment of manufacturers and the ability of rural and urban users to purchase some technologies. Additionally, credit institutions must be assured that their investment does not involve an unacceptable level of risk. These institutions will have to be convinced that low-cost renewable technologies will provide measurable benefits at low risk before willingly extending credit for the manufacture or purchase of them.

. It is within the scope of this project to demonstrate the economic feasibility and social acceptability of renewable energy technologies and to provide for limited training of rural artisans and technicians who will build and disseminate a selected set of field-tested devices. The private input supplier constraints will have to be addressed through other, non-university based programs, which are outside this project's scope.

Q. IX. WHAT DELIVERY SYSTEM DOES THE PROJECT EMPLOY TO TRANSFER THE NEW TECHNOLOGY TO INTENDED BENEFICIARIES?

The project does not specifically aim at the transfer of technologies, but rather at the further development and refinement of technologies already available in Rwanda. The project paper envisaged that CEAER would train rural technicians to implement a number of field-tests, but this has not yet been done. The evaluation team recommends that when improved wood-burning stoves are field-tested, artisans and technicians be trained at each field-site. Once a feasible stove design has been identified, the project intends to train private artisans and technicians in construction of the stove. This strategy is appropriate for other low-level technologies, such as improved charcoal

kilns made of brick, when they are found feasible. For more complex technologies, once field testing has been performed to determine economic feasibility and financial and social acceptability, and after demand has been identified and precise costs and total system payback determined, CEAER intends to assist with the creation of a commercial operation for the manufacture, maintenance and repair of the devices. The transfer of these functions to commercial companies is one of CEAER's objectives, as listed in Q.1 above. The evaluation team recommends that the project assist CEAER in this transfer process for solar water heaters and solar water distillers by providing technical assistance to help it determine ways of reducing system costs. If a review shows a high payback per unit, the evaluation team also recommends that USAID provide technical assistance to carry out a feasibility study for the establishment of a manufacturing unit which would fabricate components and/or total systems. It is further recommended that this study identify potential sources of investment for manufacturing operations, which are economically attractive.

Q.X. WHAT TRAINING TECHNIQUES DOES THE PROJECT USE TO DEVELOP THE DELIVERY SYSTEM?

A delivery system has yet to be implemented under this project, and will be limited to:

1) Training of local artisans and technicians in mud and clay stove construction after field-testing has been successfully completed; and

2) Possible assistance in establishing a production unit for the fabrication of solar water heaters and solar distillation units. For the latter, attention must be paid to ensuring that the production unit has small enterprise management and marketing expertise, since this venture will be established with the aid of the university energy research and development staff who currently have limited experience in small enterprise operation.

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NO. 1

Recommendations

		Name of Office	Action Date
1.	Approve Nairobi visit for CEAER woodstove technician en route to West African training seminar and observational tour	AID/CEAER	5/82
2.	Record precise cost, labor and other resource inputs on all technologies under development by CEAER	CEAER	5/82 begin; ongoing
3.	Review current time allocation of staff to ensure that priority technologies receive necessary emphasis	CEAER	5/82 begin; ongoing
4.	Review amended scope of work for NRECA consultancy and provide to VITA	AID/CEAER	5/82
5.	Review scope of work for VITA assistance in solar water heating and solar distillation design and manufacture, and provide to VITA	AID/CEAER	5/82
6.	Review amended scope of work for VITA woodstove consultant and provide to VITA	AID/CEAER	5/82
7.	Approve CEAER requested ETMA assistance for Energy, Forestry and Environment seminar in Rwanda, provided ETMA has capability to organize Francophone program	AID	5/82
8.	Postpone solar fish drying consultancy	AID/CEAER	5/82
9.	Develop plan for maintenance and repair of small hydro power installations	CEAER/NRECA	10/82
10.	Prepare a report on the feasibility of establishing a small scale enterprise to manufacture and repair solar water heating and solar water distillation units.	CEAER/VITA	10/82
11.	Ensure that counterparts for training in small hydro power site assessment, design installation and repair are available full-time during NRECA consultancy	CEAER	6/82

		Name of Office	Action Date
12.	Limit AID support for biogas design and new field testing to current activity	AID	5/82
13.	Limit photovoltaic development and testing to the one present activity	AID	5/82
14.	Conduct laboratory tests of the current prototype wood-burning stove, with a top made from a used oil drum and with metal rings so different sized pots/pans can be used	CEAER/VITA	6/82
15.	Develop molds or other devices for assuring reliable measurement in construction of different parts of the prototype clay and sand wood-burning stove	CEAER/VITA	7/82
16.	Identify appropriate drying techniques to present cracking in the prototype clay and mud wood-burning stove	CEAER/VITA	7/82
17.	Limit initial field testing of the prototype clay and sand wood-burning stove to four communities and among a stratified sample of no more than 40 households	CEAER	7/82
18.	Conduct a study, based on households selected for field testing of the prototype wood-burning stove, covering current practices related to cooking; initial stove use by some households; and technical, social and economic feasibility of the stove from the view point of test households	CEAER/VITA	11/82
19.	Finance costs for the field test research of prototype clay and sand wood-burning stove	AID	10/82
20.	Delay AID financing of CEAER's proposed training program for artisans/ technicians in construction of different types of stoves, until prototypes are proven to be feasible through field tests.	AID	5/82

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13. SUMMARY

The purpose of the Rwanda Renewable and Improved Traditional Energy Project is to assist the Government of Rwanda (a) to support institutional mechanisms and activities to improve its understanding of the country's rural energy needs, and (b) to institutionalize the capacity to conduct research, development, field testing and analysis of renewable and improved traditional energy technologies to meet these needs. This project, financed in FY 1979 under the Accelerated Impact Program, with life-of-project contributions of $487,500 from AID and $176,850 from the GOR, is scheduled for completion in December 1982. At the time of the evaluation team's visit, approximately $130,000 remained for use in project implementation.

The institution supported by the project is the Centre d'Etudes et d'Applications de l'Energie au Rwanda (CEAER - Rwandan Center for Energy Studies and Tests), which is a branch of the national university. CEAER is currently staffed by seven researchers with advanced training in physics and engineering, and various craftsmen and laborers. The Center is divided into four departments: biomass development, solar technology, meteorological data, and micro-hydro power development.

The project paper of August 1979 called for the following inputs from AID and the GOR. First, AID was to finance training, technical assistance including a long-term scientific advisor, commodities, especially laboratory and field test equipment, and vehicles. Also, there was to be a Rural Energy Fund to support other organizations in field testing and disseminating improved energy technologies in rural areas. Finally, AID was to support CEAER in establishing an information exchange program. The GOR was to provide offices, laboratory and workshop space, and local salaries for researchers and other CEAER staff.

The project paper envisaged the following outputs: a baseline socioeconomic study and energy needs profile in three representative rural communities; trained Rural Energy Technicians from the three field-test communities; research and development and laboratory testing of imported, adapted or locally developed technologies with involvement of trained Rural Energy technicians; field tests conducted by CEAER and rural technicians in selected communities; and evaluation of field test in the three representative communities. The project paper also specified several technologies to be field tested, which CEAER is developing and testing. To date no Rural Energy Technicians have been trained, but some will be trained when improved wood-burning stoves are field-tested. Furthermore, CEAER is conducting field tests in more than three communities, an action supported by the evaluation team.

The experience gained to date by CEAER under the project indicates that the project's sub-purpose concerning institutional development will be met by the end of the project. The sub-purpose of improving an understanding of the country's rural energy needs will only partially be fulfilled. One reason for this is that the inputs and outputs to achieve this sub-purpose were superficially addressed in the project paper.

The inputs provided under the project - training, commodities and technical assistance - have helped to institutionalize this process. CEAER is already proposing a strategy for meeting the long-term demand for production, maintenance and repair of solar water heaters and distillers.

The Project Paper was to some extent contradictory in that it called for an energy needs profile and baseline socioeconomic study, thereby indicating the need for a prefeasibility stage. However, the PP also identified technologies to be field-tested and their intended beneficiaries. A more appropriate conceptual approach would have been to first collect socioeconomic data centered on key topics related to possible technologies. Second, identify those technologies and models which appeared most socially acceptable and economically feasible. Third, carry out research, development and field test those technologies, and finally, conduct a detailed evaluation of their technical and economic feasibility and social acceptability.

The evaluation team found CEAER staff to be highly motivated. Both the university and CEAER are dedicated to the development of technologies which will be of direct benefit to Rwandans. They do not see the manufacture, production, or maintenance of such technologies, as a legitimate role for a research institution, and are concerned by the number of requests they are receiving to build or repair solar water heaters and distillers. However, they are eager to assist in the establishment of independent manufacturing and commercial enterprises.

The most significant problems affecting project implementation have been:
1) Insufficient long-term technical assistance. While the Project Agreement was negotiated and signed in September 1979 and the PIO/T submitted in January 1980, AFR/RA encountered difficulty recruiting a U.S. trained specialist in renewable technologies with French language capability and was unable to identify a candidate until May 1981. AFR/RA requested Volunteers in Technical Assistance (VITA) to serve as the contractor for this individual who arrived in country in August 1981, but resigned six months later.

2) Changes in CEAER staff. Since August 1979, three Rwandan professionals have held the position of Director and the number of research associates has increased from three to seven.

3) Development of too wide a range of prototype technologies given CEAER's small staff, insufficient long-term technical assistance, changes in CEAER management and other CEAER teaching and research responsibilities. The number and type of prototypes developed goes beyond the long list originally identified in the PP and includes institutional and family biogas digesters; a brick charcoal kiln; cokefaction and gasification of wood; photovoltaics for lighting, pumping and possible medical refrigeration; a combination biogas/solar cooker; and development of clay and sand woodstoves, solar water heating and distillation units, and small hydro-installation(s).

4) Overemphasis on the technical feasibility of prototypes and underemphasis on developing information on cost and labor inputs.

5) Absence of laboratory equipment. Laboratory equipment ordered in December 1980, has yet to arrive on site.

6) Delay in establishment of the Rural Energy Fund.

7) Limited information exchange activity as envisioned in the PP.

CEAER is cognizant of these problems and is now placing priority on the development and field-testing of clay and sand woodstoves, efforts to reduce the costs for and commercialize solar water heating and distillation, and the development of a small hydropower program.

Given the project completion date of December 31, 1982 and limited remaining funds available under the project, the evaluation team supports the decision not to recruit further long-term technical assistance. The team also supports CEAER's focus on woodstoves, solar water heating and distillation, and small hydropower. Because of the funding limitations and the need to hold the initiation of new tasks to a minimum, the evaluation team also supports removing the Rural Energy Fund requirement from the project, and the use of these funds for support of other tasks.

Based on the above findings the evaluation team recommends:

1) Short-term technical assistance in clay and sand stoves, solar water heating and distillation, and small hydro program development.

2) Careful scheduling and allocation of CEAER staff time during the remaining life of project to ensure the priority activities above receive necessary attention. CEAER should include teaching committments and a percentage of unanticipated demand on time in budgeting manhours for the remaining tasks to be completed within the life of project.

3) Increased attention by CEAER staff to developing cost, labor and other inputs for prototypes technologies.

4) Increased emphasis on the information exchange elements of the project once field-testing of technologies has been completed.

5) CEAER be given the latitude to make other changes in the project scope of work, provided AID/Rwanda receives written justification for the proposed changes prior to their implementation.

14. EVALUATION METHODOLOGY

The purposes of this interim evaluation were to measure the progress achieved under this project, to review proposed plans for the expenditure of approximately $130,000 yet to be spent, and to provide CEAER and AID/Rwanda with recommendations on possible future renewable energy activities beyond the life of project. The PP provides a set of illustrative evaluation guideline questions which were taken into account by the evaluation team. The team suggests that the guideline questions be addressed by CEAER as part of its future activity in woodstove design and testing, more efficient charcoal production, and biogas development. Also, because no logical framework matrix was provided in the project paper, the team partially reconstructed one based on information contained in the Project Paper.

The evaluation team consisted of the REDSO/EA sociologist and energy advisor. The evaluation included preliminary meetings and debriefing with the AID/Rwanda AID Affairs Officer and Assistant Program Officer, and individual and joint interviews with key members of the CEAER staff and the National University of Rwanda. In addition, the team toured the CEAER workshop; made site visits to solar water heating; solar distillation and biogas demonstrations in and around Butare;visited the prototype brick charcoal kiln at the Gishamvu Blacksmith Cooperative; and examined potential microhydro sites at Kigembe, Ruhengeri, and Nkora River. A full list of site visits is provided in Annex I. Primary project documents reviewed are listed in Annex II and the names of individuals contacted during the course of the evaluation are provided in Annex III.

15. EXTERNAL FACTORS

No major changes in project setting, socioeconomic conditions or host government priorities have occurred during project implementation. Since PP preparation, there has been some shift in AID policy concerning the role of renewable energy technologies in rural development. The need for socially acceptable, economic and replicable renewable technologies is widely recognized. Exeperience has also shown that the diffusion of renewable technology often proceeds at a slower pace than anticipated and that these technologies can be expected to make only a partial contribution to reducing rates of fuelwood consumption in rural areas or in displacing rural consumption of petroleum fuels. Forestry/fuelwood projects are receiving increasing donor emphasis. There is growing recognition of the need to reduce the foreign exchange payments for petroleum fuels through improved energy efficiency in the commercial/industrial and transportation sectors and the application of renewable technologies in meeting urban energy requirements.

16. INPUTS

The PP stated inputs and illustrative budget are:

a)	In-country and foreign training	$33,000
b)	Technical assistance	162.500
c)	Commodities	190,000
d)	Rural Energy Fund	60,000
e)	Information exchange	26,000
f)	CEAER travel on official business	60,000
		$ 487,500

As of March 1982, the following funds had been committed by AID:

a)	Training	$ 19,995
b)	Technical Assistance	183,571
c)	Commodities	169,687
		$380,000

The Project Agreement was signed August 29, 1979. The Government of Rwanda contribution has been both timely and responsive, but inputs available to the project have differed from the original design.

Training

The PP calls for two full-time Bachelors-level research fellowships, one Masters and three Bachelors-level summer research fellowships, as well as several study tours. This component has been less ambitious than originally foreseen. Three CEAER researchers (including the current Director and current Secretary General of the University) have received training in the United States or attended third-country seminars. The three persons trained in the U.S. attended the centrally-funded training course in alternate energy technologies at the University of Florida. Two individuals took advantage of this opportunity to tour renewable and alternate energy research and development centers in the U.S., providing CEAER with a valuable network of professional contacts; this study tour was financed out of the project. The project also financed CEAER representation at the U.N. Conference on New and Renewable Sources of Energy (UNERG) and at the International Solar Energy Convention in August 1981. Future participant training is to include financing of travel, lodging and miscellaneous costs for participation of the CEAER woodstove technician (Mr. Jerome Nkinahoruli) as an observer at a CILSS regional woodstove seminar in Upper Volta. The CEAER woodstove project director (Mr. Camille Nzabonimana) is also expected to attend this seminar, and will take advantage of the trip to West Africa to observe woodstove extension activities in Senegal. The evaluation team recommends that Mr. Nzabonimana also review wood and charcoal stove testing and development in Nairobi as part of this observation tour.

Technical Assistance

USAID's contribution to the project has included six months of what was to have been 18 months of a long-term technical advisor's time. The following table provides a chronology of the major events to date related to the long-term technical assistance contract:

Action	Date
PP Approval	August 1979
Project Agreement Signed	September 1979
PIO/T Submitted	January 1980
Long-term Advisor Identified	May 1981
Long-term Advisor In-Country	August 1981
Long-term Advisor Resignation	February 1982

Prior to the arrival of the long-term technical advisor, AID provided two short-term advisors to CEAER, a consulting engineer for two months and a social scientist for two weeks. Two microhydro specialists were also provided by the centrally-funded grant with NRECA for a total of two person-months in November-December 1981.

Technical assistance problems have included:

- A two-year delay in recruitment of the long-term technical advisor for the project.
- Resignation of the long-term advisor in February 1982, six months after arrival in Rwanda.
- Changes in and expansion of the CEAER staff: at the time of PP development, the Director of CEAER was an expatriate under a CIDA contract with three Rwandan research associates; since then, three Rwandan professionals have held the position of Director and the number of research associates has increased to seven.

CEAER has asked for additional short-term technical assistance under the project, including a woodstove specialist (5 months), additional time of a small hydropower specialist (1 month), and a solar fish-drying expert (1 month). The evaluation team supports this request, but recommends additional short-term assistance in small hydropower development (1 month) and solar water heating (1 month). The team also suggests that the arrival of the solar fish-drying consultant be delayed to allow CEAER to first concentrate on these other technologies.

Commodities

AID funds have been used to purchase three vehicles: a small car for site visits, a four-wheel drive pick-up truck, and another pick-up truck for hauling materials. AID is also financing laboratory and workshop equipment. However, while the PIO/C for laboratory and workshop equipment was issued December 1980, the equipment, except for calculators, has yet to arrive on site. At the time of the evaluation team's visit, some of these materials were waiting for customs clearance in Kigali.

Rural Energy Fund

The PP calls for the establishment of rural energy fund projects in five or six communities providing a total energy output of 10 kilowatt hours per day. PP design assumed such technologies would be available for field-testing and dissemination. Sixty thousand dollars were tentatively set aside for this activity, whose use was to have been determined after review by the long-term technical advisor. The technical advisor's early resignation left CEAER without a plan for expenditure of the fund. At this stage in the project, the evaluation team believes the initiation of new tasks should be held to a minimum to ensure a focused effort by CEAER staff on the most promising technologies. The evaluation team, therefore, supports the use of these funds elsewhere in the project in such areas as short-term technical assistance in woodstove design and field-testing, small hydropower program development and solar water heating and distillation commercialization.

Information Exchange

AID has provided $1,800 worth of library materials to CEAER. This expenditure has been included in the commodities line-item of funds committed.

CEAER Travel on Official Business

The funds spent on this item have been subsumed under the participant-training lime-item of funds committed.

Additional Recommended Changes in Inputs

The evaluation team recommends that AID/Rwanda review financial commitments and deobligate funds where appropriate. It also recommends that funds be earmarked for research expenditures associated with the field-testing of the sand and clay stove. AID/Rwanda should also review, in light of the funds available, whether the Project Completion Date should be extended beyond December 31, 1982.

17. OUTPUTS

(1) Baseline socioeconomic study and energy needs profile in three representative rural communities.

An energy needs profile was conducted by CEAER in 1980 in two prefectures near the Center. The report mainly covers institutions and includes designs of possible prototypes. It is regrettable that a profile of current household practices is unavailable; however, the work carried out by F. Bart, National University of Rwanda, in 1978, provides some data. The CEAER should contact Mr. Bart to learn if he has done further work on the subject; the evaluation team was unable to contact him during its stay in Rwanda.

A socioeconomic baseline study was conducted in August-September 1981 by an economist and sociologist from the National University of Rwanda. The study was conducted in areas and at institutions designated by the CEAER, in two prefectures in relation to one or more specified technologies in each area or at each institution. (See Annex IV for a list.) It was envisaged that, before proceeding with the installation of prototypes or their use, baseline information be collected on economic viability and social acceptability of the technologies planned or being installed. The methodology employed was to interview key respondents, and in rural communities to combine these key interviews with group discussions involving farmers/livestock owners. Regrettably, in some cases important data points needed to evaluate the technology were omitted. The investigators tried to assess potential users' acceptance of certain prototypes through direct questioning. It is difficult to assess acceptability in a direct way when the persons interviewed are unfamiliar with the technology, but the investigators attempted to describe the model and, in some case, its estimated cost.

(2) Trained Rural Energy Technicians from three Field Test Communities

The project anticipated the training of persons in construction, maintenance and repair of prototypes in the three selected rural communities where field tests were to be conducted. As of the evaluation team's visit, this activity had not been carried out by CEAER. To date, the CEAER researchers, staff and/or hired laborers have been responsible for the building of field prototypes, with the exception of the Karubanda biogas digester which uses some prison laborers.

When CEAER reaches the stage of building and field testing improved wood stoves, it would be appropriate to train at least one technician in each test community. Also, it would be advantageous at this time to train people in maintenance and repair of those technologies which have been proven to be feasible, i.e., solar water heaters and distillers. During the development and field testing of other technologies, additional persons should be trained

where needed. (Discussed in Section 23.)

The CEAER proposes to train 20 artisans/technicians between May and November 1982 in fabrication of new and improved cookstoves as a means of extension of the technologies. There would be two training sessions, each of three months duration and for ten persons drawn from seven urban centers. Training would center on the following prototypes

	Estimated Cost
Metal and brick wood-burning stove	10,000 Frw
Metal charcoal stove	4,000
Clay wood-burning stove	2,000
Solar cooker	6,000
Clay methane cooker	100
Biogas digester (family size)	50,000

The evaluation team considers such a training program inappropriate at this time for the following reasons. First, none of the prototypes currently appear ready for dissemination, with the possible exception of the solar cooker. The family-size biogas digester is in the process of being field-tested, and CEAER should await the results. More feasible models of metal or brick wood-burning stoves and of charcoal cookers for urban areas should be tested, and the clay and sand wood-burning stove should undergo initial field-testing. Second, such a strategy should not be followed for field-testing. Field-testing should initially take place on a small-scale within a reasonable distance from CEAER, so that CEAER or its representatives can follow progress. Without controlled field-testing, CEAER runs the risk of creating a negative climate should the prototypes prove infeasible--which would constrain the extension of models which are eventually identified as being feasible. Third, if the initial field tests show good results, then further expansion of the program should be carried out, which would include not only the training of artisans/technicians but also a strategy whereby awareness and demand are stimulated, e.g., through involvement of persons at nutrition centers demonstrating the improved cook stove.

The evaluation team considers the approach of training artisans/technicians to become experts in the building of stoves and other low-level technologies to be an appropriate strategy, but only after prototypes have been identified as being socially, economically and technically feasible for the intended users.

(3) Research and Development and Laboratory Testing of Imported, Adapted or Locally developed Technologies with Involvement of Trained Rural Energy Technicians.

CEAER activity has for the most part been focused on prototype development with limited employment and training of technicians in prototype construction. Laboratory testing has centered on determining performance and efficiency of various technologies made from locally available materials, with little attention paid to cost. The evaluation team recommends that much greater attention be paid to developing detailed cost information on all future technologies to be designed and tested at CEAER.

(4) Field Tests Conducted by CEAER and Rural Technicians in Selected Communities.

- "150 families using alternative energy cookers and stoves.
- "3 dispensaries equipped with solar water heaters, water distillation devices or involved with other health-oriented pilot energy experiments.
- "2 eight-kilowatt biogas power systems installed to produce cooking heat, light and power for rural communities.
- "2 two-kilowatt photovoltaic power stations will be installed in rural communities.
- "1 five-kilowatt hydroelectric system in operation to serve rural needs.
- "various drying systems and increased-efficiency charcoal production units demonstrating fuel saving ways of carrying out traditional drying and baking activities.
- "Rural energy Fund Projects established in five to six communities providing a total alternative energy output of about 10 kilowatt hours/day.

The project design identifies the above technologies as being worthy of field-testing for feasibility and also tends to match the technologies with end-users. As mentioned elsewhere, this implies that such technologies have initially been found to be socially and financially feasible for the intended end-user.

The project design was overly ambitious for a two-year project. Yet, CEAER has been progressing well in spite of the problems it has encountered with three changes in leadership, no permanent technical advisor, delays in procurement of commodities ordered under the project and shortage of research staff during periods when persons have been absent for training. Rather than focusing on installation of prototypes to meet PP demands, the CEAER has, correctly in the view of the evaluation team, tried systematically to develop and test prototypes using locally available materials. However, in the future, CEAER should give greater attention to financial aspects and record separately those costs which are due to the experimental nature of the undertaking. For example, information should be obtained on the number of hours of labor input and the cost of such labor; if there are special labor inputs which would not be required during replication, these should be recorded separately. Also, the prototypes should be built of materials which CEAER considers to be the most likely used in extension of the technology; for example, used oil drums to provide metal parts rathe than new, more costly metal sheets. Furthermore, CEAER should carefully monitor field usage to assess efficiency and to identify problems in adapting to the use of the new technology.

To date, CEAER has installed or is in the process of installing the following prototypes for field testing:

Alternative Energy Cookers and Stoves

The CEAER is in the process of laboratory-testing a sand and clay wood-burning stove which the Center and the evaluation team consider potentially feasible and hence believe should be field-tested. Section 23 (1) contains a discussion related to these stoves and the team's recommendations on this prototype. The team also recommends that other designs be developed and tested, particularly portable wood-burning stoves suitable for rural households

and stoves for urban household use.

The team further recommends a concentrated, limited approach to field-testing which includes careful monitoring and evaluation. The PP indicator of 150 families using alternative energy cookers and stoves will most likely not be achieved during the life of the project, but CEAER should have completed the field-testing of one design which will provide them information on its feasibility and a strategy for field-testing stoves.

Solar Water Heating and Distillation

Using USAID project funds, CEAER installed a solar water heater at Kigeme Hospital in October 1981, and expects to have two additional installations in operation at the University Hospital in Butare for the pediatrics and maternity wards in April and May 1982, respectively. A distillation unit was also installed at Kigeme Hospital in October 1981. A second unit is to be placed at the Rusatira Dispensary on the road to Kigali; the unit was damaged during transport to the site in February 1982 and is currently being repaired. It is, therefore, anticipated that the PP objectively verifiable indicators for solar water heating and distillation will be achieved at project completion.

CEAER's work in solar water heating and distillation reflects considerable knowledge and experience with these technologies and the evaluation team believes activity in this area should be expanded and receive additional support. A strategy for moving prototype development toward commercialization is outlined under Section 23, Special Comments or Remarks.

Biogas Systems

The PP calls for the establishment of two biogas systems to produce cooking heat, light and power for rural communities. AID funding for biogas demonstration has been limited to a unit currently nearing completion at Karubanda Prison in Butare which will utilize human waste generated by the prison to produce gas for cooking. No detailed costs for this system are available from CEAER and cost estimates are complicated by the fact that free prison labor has been used in construction and no records have been maintained on total man-hours provided. The evaluation team does not recommend further AID support for biogas design and demonstration at this time,although it does consider biogas systems more feasible for institutions than for household use. It is suggested that future demonstrations concentrate on determining total installation costs and, if necessary, design modifications to reduce these costs to economically acceptable levels. Construction materials, water availability,quality and type of biomass and labor costs all affect economic feasibility.

The socioeconomic study indicates that biogas systems are currently not considered feasible at either the community or the household level. CEAER, with German support, is field-testing biogas systems for family use using a stratified sample of eight households.

Photovoltaic systems

CEAER staff are reviewing, but consider questionable, the technical feasibility of a 2 KW photovoltaic design to provide lighting and refrigeration for the Rukondo rural health center.

According to CEAER staff, the original design was developed by the since-departed long-term technical advisor, but CEAER has not been able to obtain a copy of the design study. The evaluation team recommends AID support for photovoltaic development be limited for the present to this single activity. Similar CEAER photovoltaic projects are receiving Government of Rwanda and other donor support.

Photovoltaic pumping from ponds or shallow wells may be worthy of investigation at a later date; however, it is recommended that CEAER experiment with packaged commercial photovoltaic pumps rather than assembling hybrid systems from components provided by different donors.

Small Hydropower Systems

As discussed in the Summary, the CEAER staff has identified small hydropower development and fuel-efficient stoves as the two renewable technologies with the greatest potential benefit to the rural population of Rwanda. The evaluation team concurs with CEAER's concentration on these two technologies.

At the request of AID/Rwanda, AID/Washington's Office of Energy (ST/EY) sponsored a site visit to Rwanda by a team from the International Programs Division of the National Rural Electric Cooperatives Association (NRECA) from November 26 to December 20, 1981. The NRECA team evaluated a small hydropower site at Kaviri, which CEAER had been in the process of developing, and rejected it on both technical and economic grounds. Subsequently, CEAER proposed to meet the original PP objective "to install one 5 KW hydro system... to serve rural needs through a $10,000 expenditure of AID project funds to restore an abandoned small hydropower site on Lake Kivu, north of Kayove on the Nkora River. CEAER has requested one month of NRECA follow-on assistance to identify equipment to rehabilitate this facility and to provide CEAER staff with a training seminar(s) in small hydropower load matching, startup, repair and maintenance. Problems of ownership of and access to the site, formerly operated by a coffee producers' cooperative, remain to be worked out.

NRECA team members were Bard Jackson and John Topik.

The evaluation team supports the concept of NRECA follow-on assistance, but believes that the original PP output indicator as stated above is too narrowly focused and should be: to assist in development of Rwandan capability to design, install, operate and maintain smallhydropower systems for rural development. The evaluation team believes meeting this revised indicator will require development of at least three elements:

1) training of professionals in site assessment and designing of small hydropower facilities,

2) training technicians in installation, operation, maintenance and repair of small hydropower facilities, and

3) developing a strategy to ensure adequate financial resources for training and employment of technicians, for purchase of equipment, and for future repair and maintenance costs.

Implementing this program will require more financial and technical resources than were anticipated during PP design as well as significant modifications to the scope of work as recently proposed by CEAER. The evaluation teams's recommended approach and proposed changes in CEAER responsibilities and the NRECA scope of work are outlined in Section 23, Special Comments or Remarks.

Drying Systems

CEAER has asked for a one-month AID-supported consultancy on solar fish drying to be identified through VITA. CEAER anticipated development of one or two prototypes for 200 kilo batches of tilapia or other small lake fish. Prototypes are to be tested at the Kigembe Fisheries Center. This technology was considered in the PP as a potential subject for investigation. Given limited CEAER staff and the recognized importance of focusing Center activity on woodstove development and field testing, small hydropower-program development, and solar water heating commercializat the evaluation team believes that this activity should be delayed.

It is recommended that CEAER restrict its activity for the time being to review experience with solar drying in other African countries (e.g., Senegal fish drying.)

Increased Charcoal Production Efficiency

CEAER has constructed a brick charcoal kiln to be used by the Gishamvu Blacksmiths' Cooperative near Butare. Given the widespread production and use of brick throughout Rwanda, the production of this type of kiln may have promise; however, CEAER should carefully develop construction cost and energy performance information. The evaluation should take into account costs and energy consumed for transporting wood to the charcoal kiln versus previous production of charcoal at the wood sites and transport of charcoal to the cooperative.

Rural Energy Fund

As discussed under Section 16 (Inputs), the Rural Energy Fund has not been used, and the evaluation team supports the reallocation of these funds to meet other project priorities.

Information Exchange

The PP calls for a series of research seminars on CEAER's work, open to the public, distribution of written materials with Governement assistance when equipment is ready for dissemination; hosting of visitors at field test sites; a national colloquium at the end of the first year, and one inter-African colloquium at the end of the second year; improvement of the CEAER library; a semi-annual technical journal; preparation and distribution of CEAER technical reports; and interim and end-of-project evaluation reports with recommendations.

CEAER staff have made a number of presentations to faculty and students on renewable energy topics, and have recently provided interviews on CEAER's work to the local radio station and newspaper. However, the evaluation team supports deferral of most information exchange activities until completion of field tests for selected technologies. CEAER has requested the AID sponsored Environmental Training and Management program (ETMA) to assist in organizing a national colloquium on the subjects of energy, forestry, and environment. The evaluation team supports this request, provided capability to help organize a French-speaking program is adequately demonstrated.

Library materials have been ordered which CEAER believes are useful, but additional assistance has been requested from VITA to select and provide other documents more directly applicable to CEAER research activity. The evaluation team supports this request. The semi-annual technical journal and various technical reports are in preparation.

(5) Evaluation of Field Tests in Three Representatives Communities.

It is anticipated that evaluation of all field tests will be carried out as a follow-up to the baseline information collected by the university economist and sociologist. However, the economist who participated in the initial data collection effort has been transferred from the university. It is recommended that CEAER give more attention to collecting of information on costs, including labor inputs, to facilitate evaluation of field tests, as mentioned in Output 5 above. Also, the team recommends that the consultant who is to design the wood-burning stove baseline, monitoring and evaluation data-collection effort also advise on the design of the final evaluation of field tests.

18. PURPOSE

"Assist the Government of Rwanda in support of institutional mechanisms and activities to improve its understanding of the country's rural energy needs and to institutionalize an ability to conduct research, development, field-testing and analysis of renewable and improved traditional energy technologies to meet these needs.

- "Recommendations and strategy as to options for meeting longer-term energy needs for rural development."

The project purpose assumes that identification of needs leads to identification of feasible designs of technologies to meet those needs. However, there is a wide gap between a perceived need and meeting that need through the selection and development of devices which are technically and financially feasible and socially acceptable. For example, the demand for cooking fuel by rural households might be met through introduction of conservation techniques (e.g., improved cooking devices), through alternative fuels or conversion technologies, or through an increase in the supply of the current fuel type.

The CEAER has been engaged in research and development of several renewable energy technologies, primarily using locally available materials. The center is currently in the process of field testing some of these technologies to assess their feasibility.

19. GOAL

Although the Project Paper does not contain a goal statement, it implies that the goal is to reduce depletion of woodstock and to provide more cost-effective means of providing energy to rural areas than currently available sources.

20. BENEFICIARIES

The project's intended direct beneficiaries were the CEAER staff, people served by devices installed in field-test rural communities and recepients of the Rural Energy Fund activities. The PP envisaged that the field-testing would be aimed at the rural population which exists on a low-cash subsistence level and maternal and child health services.

The PP focused primarily on the rural population as direct beneficiaries of field tests. However, since project design, it has become evident in several developing countries that many of the new and renewable energy technologies currently available are more likely to be feasible for dwellers, institutions and commercial facilities. When devices which conserve woodfuel or substitute a new

energy form for it are adopted by the town dwellers and urban institutions, they indirectly benefit the rural population by lessening the depletion rate of available woodstock. Moreover, institutions and more affluent households tend to consume more woodfuel per capita than do less affluent rural dwellers. Also, substitution by government institutions of new less costly energy forms for current sources can provide a net national economic benefit, often representing a savings in foreign exchange when the fuel type replaced is derived from petroleum-based products.

To date, the direct project beneficiaries have been CEAER staff, and some persons served by devices installed in field tests. By the end of project, the following are anticipated to directly benefit from field test:

a) at least 10 rural households and 10 urban households;

b) persons using the maternity and pediatric sections of the University Hospital in Butare, through the provision of solar-powered hot water systems (35 staff members, plus approximately 60 patients per day);

c) persons using the maternity, premature baby, laundry and operating room section of Kigeme hospital through provision of solar hot water and solar distilled water units;

d) persons using light and water provided by photovoltaic system at Rukoni dispensary, (8 staff members, plus approximately 85 patients per day);

e) the 11 blacksmith cooperative members at Gishamvu who will have an improved charcoal kiln;

f) some 1000 persons at Karubanda prison who will have a biogas digester providing cooking fuel.

21. UNPLANNED EFFECTS

No unplanned social, environmental, health, technical or economic effects were identified during the course of this evaluation.

22. LESSONS LEARNED

At the time of PP preparation,the development of renewable energy technologies for rural applications was a relatively new activity in developing countries, and little was known about the potential contribution these technologies might make as substitutes for fuelwood or commercial energy. Since that time, the range of potential technologies considered likely to undergo rapid diffusion has narrowed, as have the potential applications. Few technologies have emerged which directly affect rural family energy use and which are readily

transferable from one developing country to another. Solar water heating is more directly applicable to urban and commercial institutional uses; solar distillation (and to a lesser extent photovoltaics) may be economical for hospitals and rural health centers; solar fish drying is more likely to be adopted by cooperative organizations; and small hydropower installations require relatively large commercial or institutional users. The possible exception may be the fuel efficient woodstove which is being developed and promoted throughout Africa. However, it is still too early to judge the social acceptability of this technology or to gauge whether or not rapid diffusion will take place. This does not mean that renewable technologies should not be pursued, but rather that many of the most attractive applications only indirectly affect fuel use by rural populations.

Few technologies have emerged which promise to provide a significant substitute for fuelwood as a source of cooking fuel (e.g. fuel efficient stoves and improved charcoal production methods), and their development is proceeding slowly, to some extent because careful economic and social analysis takes time. For these reasons renewable energy technologies, should not be expected to play a major role in the near future in lowering fuelwood depletion rates. For the time being greater attention should be placed on tree planting and agroforestry to meet rural family needs, and the effects of population growth on the present and future natural resource base must be taken even more seriously, particularly where the planting of trees for fuel competes directly with crop production.

In hindsight, the PP scope for this project appears to have been too broad. A more concentrated effort on fewer technologies and on the development of methodology for field-testing, economic and social analysis and dissemination might have done more to strengthen CEAER's capability in selecting and field-testing appropriate technologies for rural applications. Had the methodology been mastered first, the project would now be in a position to take each promising new technology and carry it to the point where its social and economic attractiveness would spur replication and diffusion. Instead, after two years, none of the prototypes developed have reached the dissemination stage. This is also due in some degree to the delay in recruiting and the subsequent loss of the long-term technical advisor, and to the delay in arrival of laboratory equipment in-country. It is difficult to anticipate problems of this kind, although the qualification criteria for the renewable energy specialist might have been made less demanding and specification of laboratory equipment might have been done during PP design. (It shouod be noted, however, that the major commodity delay occurred after issuance of the PIO/C).

Another factor affecting projects of this kind is a tendency to emphasize research rather than commercialization. Few renewable energy projects, whether with universities or with separate centers, have had project managers with small enterprise management experience. The natural tendency therefore has been toward research and invention rather adaptation, marketing and extension of existing technologies and devices. It is strongly recommended that future projects of this type incorporate small enterprise expertise in the early stages of implementation, and that greater emphasis be placed on the adaptation of proven and marketable technologies from other countries. Increased attention should be paid to the needs of manufacturers and importers of appropriate technologies and their components such as:

- strengthening credit/loan programs for production or end-user purchase,
- developing national pricing and regulatory policies which encourage manufacture or importation of appropriate technologies,
- assistance in strenghthening transportation and communication infrastructure as an aid to marketing and advertising, and
- training in small commercial enterprise management.

Renewable energy projects are frequently focused on the development of energy alternatives for cooking, water pumping, lighting and cooling. As a result, a number of labor-saving technologies with considerable market potential may be excluded from consideration unless they are incorporated into agricultural or rural development projects. These include simple agricultural tools,grain grinders and shellers, animal drawn plows and cultivators, carts, bicycles, pedal power machinery, handpumps and foot-pumps. The possibility of developing a strategy for more rapid diffusion of these technologies may exist by working directly with the manufacturers, importers and distributors of these technologies.

23. SPECIAL COMMENTS OR REMARKS:

ELABORATION ON CERTAIN TECHNOLOGIES AND FUTURE WORK

A. Development and Field Testing of Alternative Energy Cookers and Stoves

The CEAER is in the process of laboratory testing an improved charcoal stove and an improved wood-burning stove. The improved charcoal stove, made of metal, has a chimney, and is estimated to cost some RWF 4,000. Charcoal stove designs being developed and tested in other countries should also be considered by CEAER: in particular, the portable clay stoves and portable metal stoves with clay liners being tested in Kenya. It is recommended that the CEAER woodstove project manager spend three or four days in Kenya, in connection with his forthcoming trip to West Africa, to talk with appropriate individuals, and to review alternative designs and test results. This information should be passed on to the CEAER wood stove technician who is responsible for charcoal stove design and testing. The information obtained may also be of use in identifying designs which could be adapted for wood use. The evaluation team considers that the emphasis given to wood rather than charcoal burning stoves is appropriate, since it is estimated that less than five percent of Rwandan households use charcoal and most rural households use wood as the primary fuel source.

CEAER is currently testing a wood-burning stove in the workshop. Based on a VITA design, the stove is made primarily of clay, and has a metal top, two cooking places, a clay chimney, a clay damper and a small combustion chamber. The metal parts cost approximately 6,000 FRW when made of new metal

and are expected to cost some 1,500 FRW if made of used oil drums. Currently CEAER proposes to place about five improved stoves in houses around Butare to obtain feedback on performance. They then plan to install some 150 of these in rural households and in households on the outskirts of two towns. Local artisans would be trained in construction at the CEAER workshop and users (women) would be given instruction in stove use. Later, an evaluation by the University consultants (sociologist and economist) would be conducted.

The evaluation team recommends a more concentrated and limited approach to the field testing of the prototype stove, based on its members' knowledge of similar experiences; consideration of various aspects related to stove construction; and the lack of information on critical aspects of current practices, which relate to stove design. From both boiling and simmering tests, the prototype being tested shows a high level of efficiency. However, such a stove design eliminates other potential uses of the presently used open hearth fire, such as space heating, lighting and drying of crops. The prototype is stationary and must be installed inside the house or in a shelter to protect it from deterioration from the weather. Information is needed on: the extent to which the current cooking fire actually serves multiple functions in Rwandan households; the main location of cooking and seasonal variations in it; and the size and type of fuel currently used in most households, and any seasonal variations in these. It is expected that patterns will vary between households in one area and between areas, but certain common patterns in each area can be expected to emerge.

The construction of clay and sand wood-burning stoves with chimneys should be done systematically if success is to be achieved. CEAER currently has a mold for the stove exterior; however, the fabricators also need molds and appropriate measuring equipment to achieve reliable construction of pan holes, chimney holes and tunnels between the different parts of the stoves. Second, assessments need to be conducted of available materials. This require consultation with local brickmakers and potters during the process of selecting test communities in order to identify the best sites for suitable clay. It also requires assessment of the availability of used oil drums in these communities which would facilitate extension of the stove-building if the field-tests are successful. Third, attention must be given to construction of the chimney. It is unknown if the height of the prototype's chimney is suitable for most households, and any alteration in its height would effect quantity of air supplied to the combustion chamber. Fourth, after the stove is built it needs to be cured carefully. Different parts of the stove will dry at different rates, a main cause of cracking. Thus, special drying techniques need to be developed, such as covering those parts that are likely to dry too fast with a wet cloth. Fifth, before a stove is used, it should be test-fired to make sure that it works as intended; test procedures should be specified. Sixth, it may be appropriate to identify and train at least one rural artisan at each field test site. This may consist of some training at the workshop as well as on-the-job training. This artisan would be responsible for seeing that the proper drying techniques are followed

and for test-firing the stove before it is used by the household.

The evaluation team recommends that the following steps be undertaken to test the current prototype wood-burning stove made of clay:

1) The testing in the workshop of a model with used oil drum tops and with metal rings so different sized pots - clay and aluminum - can be used; and the testing of different drying techniques which lessen the possibility of cracks. Also molds or other appropriate devices should be developed for reliable measurement when constructing different parts of the stove, i.e. chimney, pot holes and rings, combustion chamber, and tunnels between different parts.

2) The selection of test communities - two rural and two peri-urban - taking into consideration availability of good quality clay, used oil drums, and other criteria deemed important.

3) In each of the selected sites:
   a) selection of a non-random sample of households (6-10) based on differences in main type and size of wood used for cooking, and indicators of economic status,

   b) construction of prototype stoves in the selected households,

   c) after step (b) and before stoves are used, collection of critical information on current practices related to cooking

4) The monitoring of stove use during the first two or three weeks in half of the test households(since the presence of a monitor will probably influence stove use, only half of the households should receive such an input. Because only a few stoves will be installed at each site, it appears more feasible to do half the sites than half the total number of households.)

5) At least two months after stoves have been installed, evaluate their acceptability and identify problems.

The evaluation team recommends that VITA provide a short-term consultant to assist with the workshop testing and design of measuring devices and to be responsible for the data design, collection and analysis effort. (See Annex V for terms of reference.) If feasible the short-term consultant should identify a university researcher to carry out this effort. Field data collectors should be hired with project funds. The study results should lead CEAER to determine if the design should be modified or abandoned. They may also allow CEAER to match this prototype more closely with the characteristics of potential users. In addition, the results should also help determine whether further training of artisans at the selected sites is justified for extension of the model, and whether further training and extension at other sites can be undertaken.

B. Solar Water Heating and Distillation

Using government, private and other donor funds, CEAER has completed several solar water heating installations using a standard design and patented collector developed by CEAER over the last six years. CEAER currently fabricates the collectors by welding together steel tubing and sheets purchased in Rwanda. The tanks are also individually welded at the CEAER workshop from steel sheet, making the production of the tank the most expensive component in the system. CEAER has also incorporated a heat exchange loop into the system, believing that without such a system the high mineral content of local water would cause rapid buildup of solids in the non-galvanized steel collector tubing. Installed systems have been operating for over four years without significant maintenance problems. Total purchase cost of the smallest units produced (350 liters capacity) have not been precisely estimated, but are roughly on the order of $1000, with $300 for the panel, $200 for the heat exchanger and $500 for the tank. Installation costs vary, but may average as much as $400.

According to CEAER, the Government of Rwanda is currently prohibiting importation of solar water heaters into the country in an attempt to stimulate creation of a local solar water heating industry. CEAER would like to see a cooperative company, autonomous of the University and other government of Rwanda agencies, established to manufacture, maintain and repair the CEAER designed solar water heating and distillation equipment. They believe that they are already receiving sufficient demand for the equipment to justify a small production unit away from the university and that current involvement of the Center in manufacture and repair of this equipment is not an appropriate university function. CEAER has provided AID/Rwanda with a preliminary cost proposal for the establishment of a such a production facility, although there are not sufficient funds available in the current project to support such a venture.

CEAER Responsibilities

The evaluation team believes the evolution in the CEAER solar water heater design reflects considerable knowledge of solar water heating principles and the team supports the concept of separating local solar water heating and solar water distillation manufacturing capability from the university. The university's demonstrated experience with solar water heating, and the potential for production of a high payback system and economical alternative to electrical power in the urban centers, make this an important activity for further investigation. However, it is strongly recommended that CEAER first determine:

1) precise costs for total installed systems,

2) total energy savings and equivalent kWh cost savings for typical Rwandan installations based on current and projected price for electricity,

3) total system payback,

4) whether design features can be further modified to reduce total purchase and installation costs, and

5) a realistic survey of estimated demand, expected annual orders (including for solar water heating) and the total number of electric water heaters in Rwanda present and projected.

Such analysis is necessary if financial support is to be secured for a production facility. It will also give prospective purchasers the information needed to decide whether the kWh cost savings will justify their investment in the solar system. Although, manufacture and repair of solar distillation will be primarily limited to demand for such units by hospitals and dispensaries, it is strongly recommended that the same strategy outlined for the solar water heater also be followed for the distillation unit.

Recommended Joint CEAER/VITA Responsibilities

CEAER has sufficient operating, test, and solar insolation data to quickly develop accurate system payback information. Assuming this information is provided by CEAER, it is recommended that VITA assist CEAER in identifying modifications to the design of the solar water heater and solar distillation unit which could reduce total installed costs. It is suggested that detailed drawings, specifications, local water quality information, costs and detailed payback calculations be provided to VITA for review by specialists in thermosyphon solar water heating systems and solar distillation. The solar water heater system review should include:

1) an evaluation of the feasibility of hot dip galvanizing of components and tanks in Rwanda and the potential impact on system design and manufacturing costs, (e.g., to determine whether the heat exchanger could be eliminated.); and

2) alternatives to current local single unit fabrication and welding of tanks, (e.g., whether it would be technically and economically feasible to recondition and galvanize locally available oil drums.)

Assuming system review of the solar water heater and/or solar distillation unit demonstrates that high payback units could be manufactured in Rwanda, it is recommended that a manufacturing specialist be identified by VITA and provided to CEAER on a short-term consultancy (a) to assist CEAER in conducting a manufacturing feasibility study for fabrication of components and/or total systems and identify requirements for management, ordering and inventory, marketing, installation, servicing and repair, (b) to prepare a preliminary proposal for potential investors in a venture of this sort; and (c) to identify local entrepreneurs who could be interested in undertaking this activity. A draft scope of work follows, prepared by the evaluation team for consideration by AID, CEAER and VITA.

It is suggested that cooperative involvement with installers of residential/ commercial electric water heating systems be explored.

Scope of Work for Technical Assistance in Solar Water Heating and Distillation

Dates: VITA initiate review of CEAER thermosyphon and solar distillation unit designs upon receipt of information from CEAER. Short-term consultancy to CEAER estimated September 1982, pending result of VITA technical review.

Duration:
VITA technical review, 3 months short-term consultancy, 1 month.

Qualifications:
VITA review should involve specialists with experience in the design and manufacture of thermosyphon solar water heaters, and of solar distillation units (for hospital and rural health applications). The short-term consultant should be a manufacturing specialist with at least three years experience in small enterprise operation, preferably with a degree in business administration. Fluency in French highly desirable.

Duties: VITA with CEAER participation will:

1. Review solar water heating and distillation section of Rwanda Renewable Energy Project Evaluation Summary (PES).
2. Initiate and coordinate specialist review of CEAER thermosyphon solar water heater and solar distillation unit design as recommended in PES.
3. Summarize findings of specialist review.
4. Identify and provide manufacturing consultant, pending outcome of VITA specialist review. Duties of the consultant shall include:
   a) assist CEAER in determing technical and economic feasibility of manufacturing components and/or total systems;
   b) assess market demand for units,
   c) identify requirements for management, ordering and inventory, marketing; installation and servicing,
   d) explore possibility of cooperative arrangement with existing small manufacturer(s) in Rwanda for production of solar water heating and distillation units;
   e) explore possibility of cooperative arrangements with installers of residential/commercial electric water heating systems in Rwanda for marketing, distribution, installation and servicing of solar water heaters;
   f) if the establishment of manufacturing operations is determined to be feasible, prepare preliminary proposal for consideration by potential investors, outlining personnel, materials and manufacturing requirements and costs, estimated market demand, and strategy for manufacturing, marketing, installation and servicing;

g) provide final report to CEAER/USAID Mission prior to departure from Rwanda.

C. Small Hydropower Systems

Training of Professionals in Site Assessment and Design of Small Hydro Facilities

Before engaging NRECA for further technical assistance CEAER must identify counterparts to the NRECA consultant who are to receive training in site assessment and design on a full-time basis during these individual(s) stay in-country. Training in site assessment and design may proceed as soon as this assignment has been accomplished.

Training of Technicians in Installation, Operation, Maintenance and Repair of Small Hydro Facilities

The maintenance and repair of small hydro facilities installed in Rwanda will be a crucial element in a program to expand the use of small hydro in Rwanda. While it is anticipated that local individuals at each site will have responsibility for operation and basic maintenance of the systems, individuals with specialized experience will be required for ordering, replacement and repair of equipment. It is expected that CEAER staff will have this kind of experience upon completion of NRECA training; however, the role of CEAER as a research and development center precludes it from becoming heavily involved in providing for the continuous servicing of small hydro facilities.

Rehabilitation of existing plants or installation of new facilities without concurrently establishing an adequate servicing program could be detrimental to any national program directed at expanding small hydro use. It is recommended that CEAER examine (with NRECA assistance) the feasibility of establishing such a national servicing unit, outside the university, but initially under the supervision of CEAER small hydro specialists.

Ideally, financial and manpower committments for such a small hydro facilities servicing unit should be obtained prior to purchase of equipment. It is therefore recommended that, in addition to the proposed selection, development and/or rehabilitation of a selected small hydro facility as training experience for CEAER staff (and other individuals from appropriate Ministries), the NRECA team assist CEAER in preparing a preliminary proposal for the establishment of a national small hydro program including manpower levels, vehicles, tools, and small hydro equipment, training and the estimated costs associated with each element.

It is recommended that the feasibility be examined of making the servicing unit self-supporting through the application of KWH user charges for repair and maintenance at each small hydro site to be developed.

It is also recomended that the servicing unit begin with a small group of no more than two or three technicians and that their duties be expanded to include siting, design, installation (and technical advice in operation), in addition to repair and maintenance. Starting with a small unit would help to ensure that services would be effectively matched with demand. It is suggested that the feasibility of establishing such a unit include an examination of management of

small hydro services in other countries, including possible third country observational tours. Attention should also be paid to the administrative needs for such a unit, including business manager, administrative assistant, bookkeeper/ accountant and secretary.

Financial Resources to Provide Training, Purchase Equipment and Cover Maintenance and Repair of Small Hydro Facilities

Early financial commitments must be sought from donors, the private sector and the government. USAID may be able to support limited equipment purchases of up to $100,000 under the IRT program, but only after manpower and training commitments have been secured. Alternatively, an AID/Rwanda project or the AID proposed Energy Initiatives for Africa program could be considered as future sources of support for both training and equipment.

CEAER Short-Term Responsibilities

The evaluation team has reviewed the small hydro study prepared by NRECA as a result of the November 26 - December 20, 1981, visit to Rwanda. The evaluation team finds the majority of recommendations contained in this study to be sound and strongly endorses CEAER follow-up action on these recommendations, especially those related to carrying out a more detailed inventory of potential sites and conducting a review of the Swiss inventory prior to selecting new sites for potential development. CEAER must also identify professional counterparts who will work full-time with the NRECA consultants during their visits.

In addition, CEAER should begin to discuss with the government, private sector and donors the establishment of a national technical servicing unit for maintenance and repair of small hydro facilities, so as to obtain commitments to such an effort prior to major purchases of materials and equipment.

Joint CEAER/NRECA Site Selection Responsibilities

The evaluation team visited the two most favorable existing abandoned small hydro facilities identified in the NRECA report (the Rwanda Flour and Coffee Mill and the Nkora Site) as well as a proposed new site at the AID-supported Kigembe Fisheries Center. The selection of any or all of these sites for development should be based on their potential value in training professionals and technicians. It is recommended that none of these sites be selected until CEAER and the NRECA consultant have completed more detailed evaluation of each site as well as other favorable sites which may be proposed in the Swiss inventory. The NRECA consultant(s) should therefore not restrict their review to the Nkora site alone. Existing operating small hydro facilities in Rwanda should also be considered as sites to be included in a training program for both CEAER professionals and the proposed technical services unit. The evaluation team recommends the NRECA consultant(s) assist CEAER in performing more detailed site analysis at the Rwanda Flour and Coffee Mill, the Nkora site and the Kigembe Fisheries Center. Tasks should include, but not be limited to, the following:

Rwanda Flour and Coffee Mill [1]

1. Compare the economic and technical feasibility of supplying power from the Rwanda Flour and Coffee Mill with other alternatives such as the nearby 13,800 kW Mukungwa hydroelectric plant.

2. Clearly identify the reason for abandonment of the site.

3. Specify in detail the costs for rehabilitation, operation and repair. The NRECA team estimated it would cost $5,000 to $10,000 to restore the mill to operating condition and $10,000 to $20,000 to restore the electric plant. CEAER believes rehabilitation would cost $25,000 - $30,000 and an additional $15,000 to purchase the site from the present owner. While NRECA favors this site because of its proximity to the main Kigali-Ruhengeri road and potential usefulness as a training center, CEAER believes it would cost $15,000 - $20,000 more to reopen than the Nkora facility.

4. Re-examine the assumption by NRECA that this site would be ideal for training and R & D development. Factors to be considered include:
   -- distance from CEAER staff of other professionals (trained in small hydro siting, design, installation, operation, maintenance and repair) from technical services staff;
   -- ability to attract technicians who would live and work in Ruhengeri.
   -- need for staff offices and classroom space;
   -- need for vehicle maintenance and storage of tools and equipment.

5. Determine the degree to which work at this site would be directly transferable to other sites in Rwanda.

6. Determine realistic timing for receipt of equipment needed for rehabilitation.

7. Determine feasibility of applying user charges for future maintenance and repair of the facility and the appropriate level for such charges.

Nkora [2]

1. Determine the potential use of power produced at the site. The NRECA report suggests possible uses for the power such as coffee milling, a fishing center, or a resort hotel. However, the NRECA report also cites a World Bank study estimate of $100,000 to restore the entire coffee processing operation to functioning condition. Government or donor commitments to ensure demand for the power should be obtained before proceeding with rehabilitation.

2. Determine costs for rehabilitation, operation, maintenance and repair. This site was identified in the UNDP report (Block 1980) as the most favorable of the abandoned facilities visited. It is also identified

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[1] The NRECA report places the location of the Rwanda Flour and Coffee Mill on the Nyamutera River (p.46). The actual location is south of Ruhengeri, just to the east of the main Kigali-Ruhengeri road near Rwaza.

[2] On Lake Kivu north of Kayove on the Nkora River. Presently accessible with non-four wheel drive vehicle only during dry weather.

in the Development Program of the Kagera Basin Final Report (February 1982) [1] as a facility with 100 kW of guaranteed power which could be rehabilitated at a cost of $15,000. Although the NRECA team was unable to view the inside of the powerhouse they concluded the power plant could be rehabilitated for about $25,000. CEAER favors this site over the Rwanda Flour and Coffee Mill, believing it could be restored for no more than $10,000. The evaluation team found this site to be remote and virtually inaccessible by road. Rehabilitation would provide valuable training experience, but the estimated low cost to rehabilitate the facility may be deceptive, given the need to ensure future uses for the power generated.

3. Determine feasibility of applying user charges for future maintenance and repair of the facility and the appropriate level for such charges.
4. Determine the degree to which experience gained from rehabilitation of this site would be directly transferable to other sites in Rwanda.
5. Determine realistic timing for receipt of equipment.

Kigembe[2]

1. Obtain site information developed and held by former long-term technical advisor, Branson, and no longer available to CEAER.
2. Determine whether the 17 kW of estimated power production could be fully utilized by the fisheries and staff housing.
3. Provide more detailed estimates of total installation, operation, maintenance and repair costs. The NRECA team estimated a cost of $18,000 for installation. CEAER believes the cost would be closer to $180,000.
4. Determine degree to which experience gained through development of this site would be directly transferable to other sites in Rwanda.
5. Determine realistic timing for receipt of equipment.
6. Determine feasibility of applying user charges for future maintencance and repair of the facility and the appropriate level for such charges.
7. Measure the benefits and costs of installation of a new small hydro facility at the Kigembe fisheries against rehabilitation of the Rwanda Flour and Coffee Mill and the Nkora site or other sites identified in the Swiss inventory.

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1. Volume III, p.100

2. Located at the Kigembe Fisheries, south of Butare.

Further Action

Assuming this analysis results in favorable selection of a site or sites, the NRECA consultant(s) should assist CEAER in prioritizing sites for future development or rehabilitation, in specifying materials and equipment, and in providing detailed cost estimates.

These joint CEAER/NRECA responsibilities differ significantly from the proposed task assignments identified by CEAER/VITA, and should be provided to NRECA via VITA in a revised scope of work prior to the return visit of the NRECA consultant(s). The evaluation team believes 2 person months of effort may be required initially for this consultancy. NRECA should be requested to provide a more precise estimate of the level of effort necessary to carry out these tasks.

The installation of one small hydro system as called for in the PP should not be expected prior to the Project Agreement Completion Date and should be viewed as secondary in importance to accomplishing the tasks recommended herein by the evaluation team. A revised scope of work follows which has been prepared for consideration by CEAER/AID and NRECA.

Revised Scope of Work For Small Hydro Consultant(s)

Dates:	Consultancy to begin after July 10, 1982, contingent on CEAER provision of full-time counterparts during consultant(s) visit.
Duration:	Estimated 2 months.
Qualifications:	MS Degree Electrical Engineer with at least 2 years experience in small hydro. Fluency in French highly desirable.
Duties:	The consultant(s) with CEAER participation will: 1. Review small hydro section of Rwanda Renewable Energy Project Project Evaluation Summary (PES) prior to arrival in-country. 2. Obtain additional information on Rwanda Flour and Coffee Mill, Nkora and Kigembe sites as suggested in PES. 3. For Gisenyi (Nkora) site, 150 kW small hydro installation, analyze entire system including control panel and electrical distribution. 4. Identify reason(s) for failure of Nkora plant and prepare parts list needed for repair. If imported parts are not required, consultant should oversee and assist with repair/startup procedures. 5. Train CEAER staff (and other individuals from appropriate organizations) through site visits and seminar in practical aspects of small hydro systems including siting, load matching, design, equipment specification and ordering, installation, operation maintenance and repair.

6. Review with CEAER, the potential use of existing small hydro systems in Rwanda for observational training of professionals and technicians.
7. Prioritize sites for installation or rehabilitation, specify equipment for most favorable site(s) and prepare detailed cost estimates.
8. Assist CEAER in preparing proposal for small hydro services unit as suggested in PES.
9. Provide final report to CEAER/VITA prior to departure from Rwanda.

ANNEX I

Site Visits

Activity	Institution	Location
1. Workshop and offices	Centre d'Etudes et d'Applications de l'Energie au Rwanda (CEAER)	Butare
2. Fishdryers, potential small hydropower site	Centre Piscicole du Rwanda, Kigembe	Kigembe (Butare Prefecture
3. Biogas Unit	Karubanda Prison	Butare
4. Solar water heating unit (pediatrics)	Hôpital Universitaire	Butare
5. Brick charcoal kiln	Gishamvu Blacksmith Cooperative	Gishamvu (Butare Prefecture)
6. Biogas unit, solar water heater, solar distillation	Ecole Technique Agricole de Butare (ETAB)	Butare
7. Pyrethrum drying with peat	Pyrethrum drying operation	Ruhengeri [1]
8. Small hydropower site	Rwanda Flour & Coffee Mill	Ruhengeri [2]
9. Small hydropower site	Nkora Coffee Cooperative	Nkora River [3] (Gisenyi Prefect

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[1] Near Parc National des Volcans headquarters

[2] East off main Kigali-Ruhengeri road

[3] Nkora river on Lake Kivu, north of Kayove

ANNEX II

PRIMARY DOCUMENT SOURCES

1. Bart, François, "Le Paysan Rwandais et l'Energie."

2. Graham, T., Memorandum to AAO/Rwanda on Renewable and Improved Energy Project, 21 August 1980.

3. Hirsch, Steve. Memorandum on "Short-term Consultancies for USAID Renewable Energy Project" to Prosper Mpawenayo, CEAER acting Director, February 27, 1982.

4. Jackson, B. and J. Topik. Small Decentralized Hydropower in Rwanda, Small Decentralized Hydropower (SDH) Program, NRECA, January 1982.

5. Klock, T.E. Study of the Potential for Developing Nine Small Hydropower Schemes in Rwanda, UNDP and Kagera Basin Organization, July 1980.

6. Ntaganira, J.J.A., Eugene Uwimana, R. Berkhardt and G. Simbiyobewe. Identification des Besoins dans le Cadre du Développement Energétique du Rwanda, Vol. No. 1, CEAER.

7. Reintsma, Mary, "Energy in Rwanda--A Synopsis," prepared for USAID/Rwanda, August 1981.

8. Twagiramutara, P. and T. Mhatswenumugabo. "Etude de Factibilité des appareils utilisant les Energies Renouvelables et Traditionnelles Améliorées en Milieu Rwandais." CEAER, December 1981.

9. CEAER proposal "Formation d'Artisans à la Fabrication de Cuisinières Améliorées ou Utilisant les Sources Non-Conventionnelles d'Enérgie."

10. CEAER, Rapport d'Activités pour l'Année Académique 1980-1981.

11. Development Program of the Kagera Basin, Final Report, Volume 3, Energy, UNDP, February 1982.

12. Renewable/Improved Traditional Energy Project Paper (698-0410.22) (In Accelerated Impact Program Format), AID/Rwanda, 13 August 1979.

13. Rwanda Country Development Strategy Statement, FY 83, AID/Rwanda, January 1981.

14. Rwanda Renewable Energy Project Status Report. AID/Rwanda cable: KIGALI 03305, 12 December 1981.

15. Rwanda Renewable Energy. Technical Consultancies in support of CEAER/Rwanda, AID/Rwanda cable: Kigali, 1 March 1982.

16. Tableau Synthétique d'Activités de Recherche et d'Installation du CEAER pour l'Année Académique 1981-1982, CEAER, September 1981.

ANNEX III

Persons Contacted

- Eugene R. Chiavaroli, AID Affairs Officer/Rwanda
- Norman Olsen, Program Officer, AID/Rwanda
- Brooke Stallsmith, Assistant Program Officer, AID/Rwanda
- Venant Ntabomvura, Rector, National University of Rwanda
- Charles Ntakirutinka, Secretary General, National University of Rwanda (former Director CEAER)
- Prosper Mpawenayo, Acting Director, CEAER[1]
- Camille Nzabonimana, CEAER
- Eugene Uwimana, CEAER
- Alphonse Karangwa, Project Director
  Projet National de Pisciculture, Kigembe
- J.J. Athanase Ntaganira, Engineer, Electrogaz, former biogas specialist and Director of CEAER
- Richard Haavisto, Instructor in Sociology, National University of Rwanda, Butare, Peace Corps Volunteer.
- Straton Gasigwa, Chef de Service Technique Electricité, Electrogaz National Power and Water Company)

[1] Centre d'Etudes et d'Applications de l'Energie au Rwanda.

ANNEX IV

Sites and Technologies Covered by the Socioeconomic Feasibility Study[1]

1. University Hospital, Butare: solar water heating
2. Kigeme Hospital: solar water heating and solar water distillation
3. Rukondo Dispensary: photovoltaic system for light and water pumping
4. Gishamvu Blacksmith Cooperative: improved charcoal kiln
5. Kigembe Fisheries Center: solar drying
6. Kavili Water Falls (Karama community 5 km from the falls): electricity from a small hydropower installation
7. Karubanda Prison: biogas digester to provide cooking fuel
8. Muyaga rural commune: biogas for cooking and an improved wood-burning stove
9. Rwamiko rural commune: biogas for cooking and an improved wood-burning stove
10. Huye rural commune: biogas for cooking and an improved wood-burning stove
11. Kinyamakara rural commune: biogas for cooking and an improved wood-burning stove
12. Maraba rural commune: biogas for cooking and an improved wood-burning stove
13. Ngoma rural commune: biogas for cooking and an improved wood-burning stove

[1] These sites and technologies were included in the Energy Needs Assessment conducted by CEAER in 1980.

ANNEX V

Terms of Reference for Short-Term Stove Consultant

1. Advise and assist CEAER in developing molds and other devices for field construction of prototype sand and clay wood-burning stoves.

2. Advise and assist CEAER on making necessary modifications in sand and clay wood-burning prototype stove; on identification of suitable drying techniques; on criteria to be used in test-firing of stoves.

3. Advise and assist CEAER in selection of field test sites and households in each site based on criteria set out in this evaluation report.

4. Advise and assist CEAER on design of other models of wood-burning stoves suitable for rural households and wood and charcoal stoves suitable for urban/town household use.

5. Assist CEAER in establishing a system for collecting cost data on all prototypes.

6. Be responsible for the design, collection and analyses of baseline, monitoring and evaluation data on the sand and clay wood-burning stove field tests.[1]

7. Advise on the information needed in the final socioeconomic evaluation of field tests.[1]

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[1] The final instruments for data collection should be approved by REDSO/EA prior to their use.

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Evaluates project to strengthen the capacity of the Rwandan Center for Energy Studies and Tests (CEAER) to develop and field test renewable and improved traditional energy technologies. Evaluation covers the period 8/79-3/82 and is based on site visits, document review, and interviews with personnel from USAID/R, CEAER, and the National University of Rwanda.

The project is progressing well despite an overly ambitious design and many implementation problems, e.g., three changes in leadership, no permanent long-term technical assistance (TA), delays in procuring equipment, and shortage of research staff. However, institutional development of CEAER is more likely to be achieved than is the subpurpose of increasing understanding of Rwanda's rural energy needs.

CEAER has focused on developing and testing prototype technologies based on ~~made from~~ locally available materials. It has installed a solar water heater and distiller at a hospital and constructed a brick charcoal kiln for a blacksmith cooperative. In addition, CEAER is testing a sand and clay woodburning stove and providing a biogas system for a prison; it is planning to install a photovoltaic system at a rural health center and develop small hydropower and solar fish drying systems. An energy needs profile and a socioeconomic survey were conducted in local areas.

Employment and training of rural technicians in prototype construction has been limited and training of technicians to implement field-tests has not begun. Planned rural energy fund projects were not implemented due to the lack of long-term TA. In addition, training of CEAER staff has fallen short of target.

Key recommendations are: (1) give priority to developing clay and sand stoves, solar water heaters and distillers, and small hydropower systems; (2) provide short-term TA in these areas and carefully schedule CEAER staff time to ensure that these activities receive necessary attention; (3) develop cost and other input data on prototype development; (4) emphasize information exchange activities when field-testing is completed; (5) allow CEAER to make changes in project scope, provided USAID/R receives prior written justification; (6) postpone the solar fish drying component; (7) limit support for biogas and photovoltaic design and testing to current activities; and (8) delay training technicians to construct stoves until prototypes are proven feasible. Other recommendations relate primarily to specific tasks to be done in the above priority areas.

!DESCR /Energy research/ /Ren energy tech/ /Alternat energy/ /Conventnl energy/ /Rwanda/ - /Biogas energy/ /Instit building/ /Solar energy/ /Alt energy trng/ /Photovol energy/ /Small hydroelec/ /Tech training/

!IDENT /Indepth eval/ /Evaluation team/ /Onsite eval/