SUDAN RENEWABLE ENERGY PROJECT

(SREP I)

Project No. 650-0041

Final Report

by

William C. Larson

July 15, 1987

Prepared for

U. S. Agency for International Development

Box 119, American Embassy
APO New York, 09668-0001

AID Contract No. 650-0041-C-00-3002-00
October 19, 1982 to July 15, 1987

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GTRI

July 15, 1987

Mr. John W. Koehring
Director
USAID/Sudan/SREP I
Box 119, American Embassy
APO New York 09668-0001

RE: Project #650-0041
AID Contract No. 650-0041-C-00-3002-00

Dear Mr. Koehring:

Four copies of the Final Report for the Sudan Renewable Energy Project I (SREP I) are herewith submitted in accordance with the provisions of the above contract. The report covers the 57-month life of the project from October 19, 1982 to July 15, 1987.

Georgia Tech regards the SREP I as a successful project that has more than fulfilled its contractual and programmatic expectations. We wish you every success in the implementation of SREP II.

Sincerely,

William C. Larson
Project Director

WCL/vae

cc: J. Kryschtal, Contracting Officer, USAID (w/3 copies of report)
K. Rikard, Project Officer, USAID
Dr. El Tayeb Idris Eisa (courtesy of K. Rikard)
Gaafar El Faki (courtesy of K. Rikard)

ACKNOWLEDGEMENTS

The author wishes to express his sincere appreciation to Dr. El Tayeb Idris Eisa, SREP I Coordinator, and to Mr. Gaafar El Faki, Assistant Coordinator, for their support and assistance. Without their valuable help, this report might not have been completed. A special thanks must be extended to Mr. Bradley Tyndall, ex-Peace Corps Volunteer, who spent many, many hours of off-duty time diligently collecting data, conducting interviews, and writing up notes related to the priority technologies. Mr. Donald B. Peterson also deserves a commendation for donating his time and efforts to reviewing and contributing to the final draft of the report. Ms. Vivian Edwards' uncomplaining and diligent work in the compilation and final typing of the report is also gratefully acknowledged and appreciated. Finally, most sincere thanks are gratefully extended to Ms. Clara Galleshaw for her unfailing support and assistance over the life of the project.

SREP I FINAL REPORT

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I. INTRODUCTION AND SUMMARY

A. Setting

An energy assessment by the National Energy Administration (NEA) of the Government of Sudan (GOS) in 1980 indicated that wood and charcoal provide about 78 percent of Sudan's total energy consumption. About 75 percent of these fuel sources were used in the household sector, primarily for cooking. Over 14 million tons of wood were estimated to be removed from Sudan's forests annually. This consumption was growing at 2.2 percent per year. This dependence on biomass as a primary source of energy has contributed to major deforestation and desertification.

In seeking solutions to the growing problem of providing sufficient energy for its population, the GOS has mounted a many-pronged effort to find alternative sources of energy. Among others, renewable energy sources were considered to have potential for alleviating some portion of Sudan's energy problems.

In its Renewable Energy Assessment for Sudan carried out in 1982, the NEA identified several constraints to carrying out renewable energy policies. These included the lack of institutions and human resources needed to identify, develop, manufacture, install, and maintain renewable energy technologies which would be technically, economically, and socially appropriate for Sudan. The benefits of renewable energy were little known and there was little technology transfer in renewables between industrialized countries and Sudan. Neither the GOS nor the private sector was very interested in renewables and there was not much known about costs and the reliability of renewable energy technologies. The financing needed to carry out research and development and to demonstrate renewable energy technologies was lacking.

The Sudan Renewable Energy Project (SREP) was jointly designed and undertaken by the GOS and the U. S. Agency for International Development (USAID) to respond to the GOS's desire for a viable and innovative renewable energy program. The project would address itself to the constraints identified by the

NEA in its Assessment and emphasize the development of an institutional capacity in Sudan to deal broadly with renewable energy. In the process the project would undertake to develop, field test, and encourage the widespread dissemination of renewable energy technologies. In the original design, the project focus was on the rural and poor; the project was initially titled Rural Renewable Energy Project (RREP). Later, because of the impact of fuel consumption in cities, the urban poor were also included and "Sudan" was substituted for "Rural" in the project title.

B. Georgia Tech and SREP I

In October 1982 Georgia Tech was competitively awarded a contract for $2.6 million (subsequently amended twice to $3.1 million) to provide both long- and short-term technical assistance; conduct training programs; and procure vehicles, equipment, and materials to carry out the project objectives. The project's objectives were to:

- o Institutionalize the Government of Sudan's Renewable Energy Research Institute (RERI), and
- o Develop, adapt, and disseminate renewable energy technologies (RET's) which are economically, socially, and evironmentally appropriate for Sudan.

Georgia Tech, assisted by its subcontractors -- Energy/Development International (E/DI) and the TransCentury Corporation, both of Washington, D.C. -- began work in Sudan in November 1982. In May 1983 the USAID/Sudan Mission, the Energy Advisor for the AID Regional Economic Development Service Organization in Nairobi, Kenya (REDSO/EA), and several interested Government of Sudan agencies selected five priority technologies. These were:

- o Fuelwood/Forestry
- o Charcoal Stoves
- o Wood Stoves
- o Charcoal Production
- o Photovoltaics

During the several years of its implementation, SREP I has revised its emphasis to include:

- o Fuelwood/Forestry/Mechanized Farming
- o Charcoal Stoves
- o Briquetting
- o Water Pumping

Wood stoves, as a technology for development, was considered less attractive in terms of the potential gains that could be realized from development, or improvement, than other areas and was dropped from the priority selections. Photovoltaics, after several demonstrations and studies, are considered generally uneconomic (except in unusual circumstances) for application in Sudan. That technology has been subsumed under the water pumping area and will receive attention as a possible source of energy for water pumping during SREP II.

Of the total of 86 grants awarded during the period of SREP I, 70 were awarded for over LS 900,000* to demonstrate a variety of afforestation activities ranging from shelterbelt planting on large agricultural projects to small village woodlots for fuelwood, building-pole and aesthetic purposes. The original charcoal stove designed at the University of Khartoum has undergone considerable development and improvement and has been rather widely disseminated in the Khartoum area. The project's latest emphasis in charcoal stoves is being focussed on the metal-clad ceramic "El Jiko" stove. The development of the briquetting process and briquetting machines has been given priority emphasis by SREP I since early 1985, and it appears that the activity will continue to receive priority attention in SREP II.

Georgia Tech's contract was completed on July 15, 1987. In the 57-month life of the SREP I contract, Georgia Tech and its subcontractors, E/DI and TransCentury, have furnished long-term a Chief of Party (52 pms), a Project

*During the life of SREP I, from October 1982 to June 1987, the market exchange rate went from approximately $1.00 = LS1.35 to $1.00 = LS6.00.

Economist (36 pms), and 5 Peace Corps Volunteers (PCVs); over 49 person-months of short-term consultancies; have provided 47 off-shore (U.S. and third-country) short-term training courses to 30 Sudanese counterpart personnel; and have procured over $280 thousand worth of vehicles, equipment and materials for SREP.

The Renewable Energy Research Institute (RERI) has been institutionally strengthened. It started in 1981 as an embryonic organization of approximately 8 professionals, chartered to do renewable energy research. Through the implementation of SREP I over the past four and a half years, it has grown into an operating organization of over 50 staff members. Many of the staff are engaged in the extension work so necessary to disseminate the results of the applied research work into practical and affordable renewable energy technology applications for the end-users. The RERI has achieved recognition and some stature during the progress of the project as the center of renewable energy applied research and dissemination for Sudan. It is now looking forward to continuing the work started in SREP I with additional technical assistance, training, and procurement to be provided through USAID dollar-funding in SREP II. USAID/Sudan was to begin the process for awarding a two-year contract for a new US technical assistance contractor for SREP II in the latter half of calendar year 1987.

C. U.S. Evacuation from Sudan

The American staff of SREP I (Georgia Tech's Chief of Party, Donald Peterson, and five American Peace Corps Volunteers (PCVs)) were evacuated from Sudan in April 1986. During their evacuation to the United States, SREP I activities in Sudan were continued under the direction and leadership of Dr. El Tayeb Idris Eisa (SREP Coordinator) and Gaafar El Faki (SREP Assistant Coordinator).

During the evacuation period, Donald Peterson and three of the PCVs continued work on SREP I activities at Georgia Tech in Atlanta. A conceptual design for a charcoal briquetter was drawn up and documented, and the Charcoal Stove Book was completed and published in July 1986. A short-term (two weeks) general

marketing training course was also conducted in Atlanta for 6 staff members of RERI/SREP I, and 3 individuals from the National Energy Administration. There was no participation in SREP I by the PCVs beyond publication of the Charcoal Stove Book, and no PCVs returned to Sudan when the evacuation order was lifted.

Donald Peterson returned to Sudan in mid-September 1986 to resume his duties as Georgia Tech's Chief of Party. He left Sudan in late January 1987 to become the Peace Corps Director in Asuncion, Paraguay.

The evacuation order for American personnel was lifted October 15, 1986, and USAID personnel returned to Khartoum. Some continuity between SREP I and USAID was lost during the evacuation. However, during his absence from Sudan, the USAID SREP I Project Officer, with inputs from the RERI/SREP staff, was able to prepare the draft documentation which was required to secure dollar funding authorization for SREP II.

The early departure of Donald Peterson as the Georgia Tech Chief of Party made it necessary for the Georgia Tech Project Director, William Larson, to fulfill Georgia Tech's contractual obligations from Atlanta. He made two short-term visits to SREP I. In March/April 1987 he assisted in preparing the Fifth Annual Work Plan for SREP I. In May/June 1987 he terminated Georgia Tech's contract activities in Sudan as of June 30, 1987, and collected data for the final report for SREP I.

II. INSTITUTIONAL DEVELOPMENT

As SREP I comes to an end in July 1987, the ERC/RERI has become widely recognized as the primary Government of Sudan (GOS) organization for applied research and development as well as the dissemination/commercialization of renewable energy technologies. Further development and solidifying of this relatively new but going organization will occur as project and institutional management skills are strengthened. These skills will be strengthened in conjunction with the expansion and enhancement of technical capability in the priority renewable energy technology areas. SREP I has developed and instituted management practices and procedures for project implementation which had not been used previously in the ERC/RERI. The project is making use of management tools such as annual work plans, budgets, periodic project reviews, and monthly financial reporting. These project implementation/management techniques have been judged successful in RERI/SREP and are being replicated in other councils of the National Council for Research.

RERI's institutional development will further progress from planned training activities and from additional experience gained from the day-to-day implementation of the SREP II activities planned to follow SREP I.

A. Organizational Structure

The Sudan Renewable Energy Project (SREP) is a project jointly sponsored by the Government of Sudan (GOS) and the United States Agency for International Development Mission in Sudan (USAID/Sudan). The Energy Research Council (ERC) is the counterpart organization for the Georgia Institute of Technology (GIT), the technical assistance contractor for SREP I (October 1982 through mid-July 1987). The Director of the ERC is the designated Coordinator of the SREP for the GOS and the direct counterpart of GIT's Chief of Party (COP). The COP is responsible for implementing the technical assistance contract in Sudan. The Coordinator and COP report to the ERC Board of Directors through the ERC Technical Committee which oversees general program policy and direction.

Figure 1 on the next page provides a graphic illustration of SREP organizational relationships.

The ERC/SREP cooperates with other Sudanese government organizations as well as with private sector entities which are involved in renewable energy activities in Sudan. For example, the SREP has developed good working relationships with the Forest Administration, the National Water Corporation, and the National Electricity Corporation. SREP has also cooperated with the UN's Food and Agriculture Organization (FAO) and with private voluntary organizations such as PLAN/Sudan and CARE in carrying out activities under the priority renewable energy technology areas.

B. Staffing and Technical Assistance

1. RERI/SREP I Personnel

Most of the Sudanese staff required to implement SREP I has come from the ERC's Renewable Energy Research Institute (RERI). Other staff/personnel needed to implement SREP I have been seconded from Sudanese Government agencies or have been retained as consultants under personal services contracts. The RERI had a staff of 8 professionals when SREP I started. At the end of SREP I on June 30, 1987, RERI/SREP I had a working staff of 45 government employees and 8 long-term consultants.

As the Energy Research Council Director, Dr. El Tayeb Idris Eisa is the SREP I Coordinator. He succeeded Dr. Hassan Wardi in this position in December 1984. Mr. Gaafar El Faki became the Assistant Coordinator for SREP I in December 1984; he is also concurrently head of the Dissemination Unit and project leader for the charcoal stoves project.

2. Technical Assistance Contractor Personnel

Under its direct contract with USAID/Sudan, Georgia Tech was responsible for furnishing both long- and short-term expatriate technical assistance personnel. Georgia Tech furnished the Chief of Party:

SREP I ORGANIZATIONAL RELATIONSHIPS

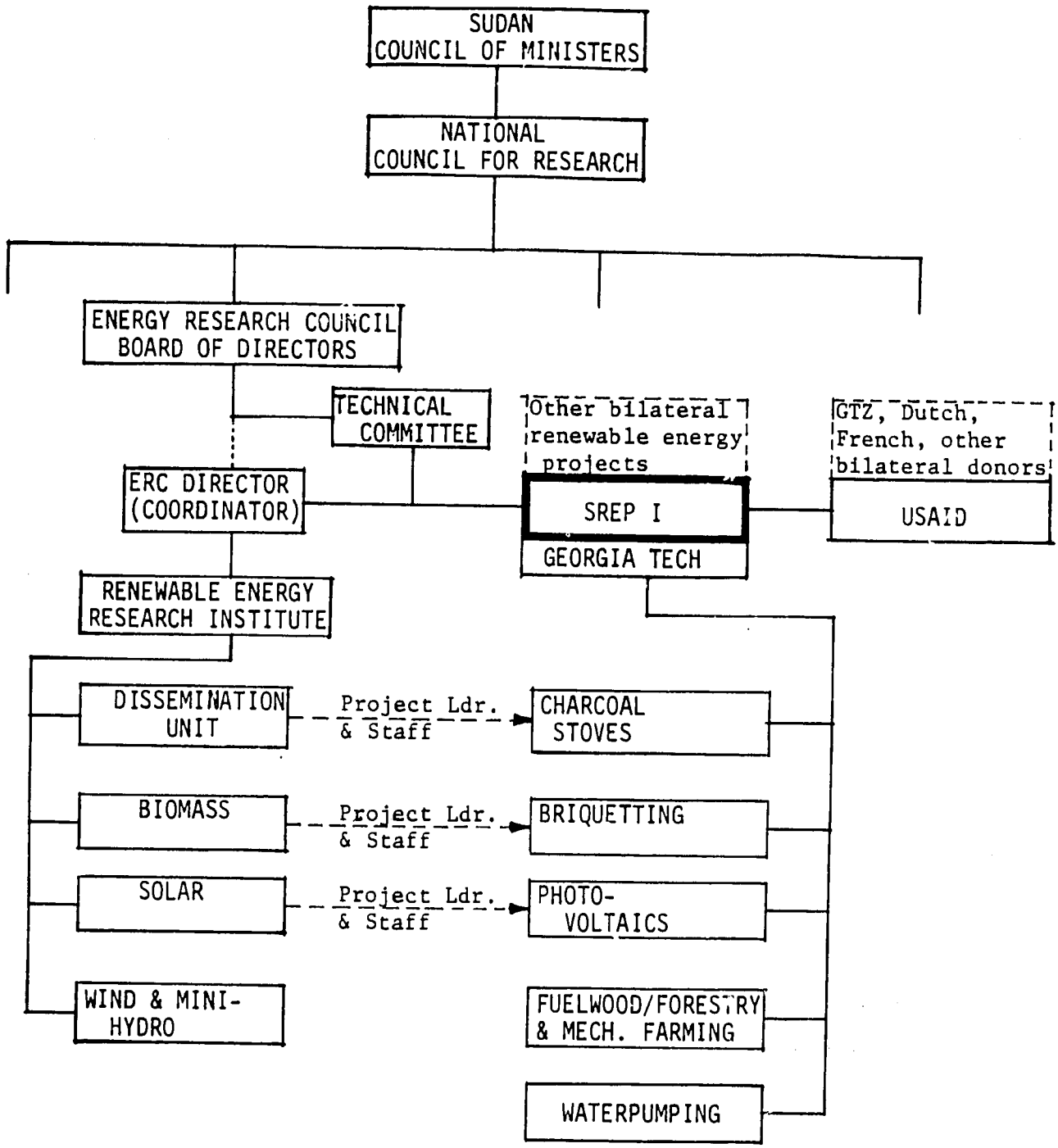

FIG. 1

- o Dr. Ronal W. Larson from October 1982 through October 1983
- o Mr. Donald B. Peterson from November 1983 through January 1987
- o Mr. William C. Larson, Georgia Tech/Atlanta-based Project Director, served as the Acting Chief of Party from February through June 1987.

E/DI, under subcontract to Georgia Tech, furnished the long-term Project Economist, Mr. Matthew Gamser from October 1982 through October 1985. Under a contract amendment, five U.S. Peace Corps Volunteers (PCVs) served in Sudan as staff of the Dissemination Unit from November 1984 until the U.S. evacuation in April 1986. The PCVs and their technical assignments were:

- o Kevin McNally — Charcoal Stoves (assigned to CARE)
- o John Dorre — Charcoal Production/Briquetting
- o James Adams — Forestry
- o Mary Clarkin — Dissemination
- o Bradley Tyndall — Dissemination

Following the evacuation, Adams and McNally were terminated from the project. Dorre worked at Georgia Tech until June 1986 and developed the conceptual design of a manual charcoal briquetter. Clarkin and Tyndall worked at Georgia Tech through July, 1986 and completed the drafting and publication of the SREP charcoal stove manual: "Improved Charcoal Stoves for the Sudan; a Guide for Introducing Technologies." The evacuation prevented the PCVs from completing a full two years of activities on SREP I as originally intended. Despite this, it should be noted that the ERC was well satisfied with the PCVs involvement in SREP I and has formally requested PCV involvement in SREP II.

3. Expatriate Short-Term Consultants

Short-term technical assistance (expert consultants) have played an important role in the implementation of SREP I. The short-term consultants, both local and expatriate, have come out of developed and identified needs of the project during its progress. SREP I has been flexible and responsive to these needs as they have surfaced, and terms of reference and consultancy tasks have been specifically written to meet those needs. Often the short-term consultancies have been scheduled to complement short-term training arranged for SREP I. In most

expatriate consultancies, the terms of reference required the presentation of one or more seminars in the subject matter of the consultancy. Also, SREP policy required expatriate consultants to work with one or more Sudanese staff and/or consultants of SREP I. This was to provide on-the-job training benefits as well as to assure continuity in the subject matter after the departure of the expatriate consultant.

During the 57-month life of the SREP I, a total of nearly 50 person-months of short-term consultancies was furnished to the project under the Georgia Tech dollar-funded contract. This was somewhat more than the original 32 person-months plus the 10 person-months added by contract amendment that were contemplated in the contract. These consultancies were carried out by 21 individual consultants, 11 from Georgia Tech providing 17.73 person-months, 7 from TransCentury providing 17.26 person-months, and 3 from E/DI providing 14.80 person-months. A complete listing of the consultants and the subject of their consultancies is given in Appendix 1.

4. Local Consultants

From the beginning of the project, SREP I has relied on Sudanese professionals retained as either long- or short-term expert consultants to help in the implementation of the project. These have been private sector individuals, and in some cases, have been retired government employees with many years of experience. These individuals are retained under personal services contract with the ERC and they are compensated with funds from the Project Account. SREP I has found the use of local consultants to be an effective way to quickly mobilize the needed human resources to carry out project activities. A listing of the consultants and the subject of their consultancies is provided in Appendix 2.

C. Training

Training has been an important component of SREP I, and has consisted of:

- o Local short-term training .
- o Long-term training (local & U. S.)

o Short-term training (U.S. & third country)

Local training has consisted of on-the-job training (OJT) for the SREP I staff, academic training for Sudanese university and college students, and other short-term training for SREP staff.

It is ERC/RERI policy for SREP staff personnel to work with both foreign and local short-term expert consultants. This is to provide OJT and experience in the SREP I priority technology areas to individuals and institutions with limited knowledge and experience in those specialties. In many cases it was a part of the expert consultant's terms of reference to present seminars/workshops in his/her subject specialty for RERI/SREP staff and other interested individuals.

SREP has presented month-long academic training programs covering many aspects of renewable energy subject matter to students of the University of Khartoum Faculty of Engineering and Architecture and the Khartoum Polytechnic Colleges. These courses were offered in May 1983 and again in May 1984 with positive and encouraging results.

From time to time a variety of other short-term training has been carried out and/or provided to SREP staff, such as the training in "Canun El Duga" stove production given to three of the Peace Corps Volunteers during the initial charcoal stove producers workshops conducted by SREP. Other examples are Shadia Nasr el Din's attendance at the Nursery Training Workshop, and Maha Hassan Osman's attendance at the FAO-sponsored workshop on forestry extension techniques.

1. Long-Term Training

Under the Georgia Tech contract, a dollar-funded two-year joint University of Khartoum/University of New Mexico (UKh/UNM) MSc degree program in Renewable Energy Technologies was organized and started in January 1984. Eight students were accommodated, six of whom qualified for the U.S. portion of the program. Five of the six attended UNM and the sixth, a forestry student, attended Texas A & I. The other two students completed a shorter program and

were awarded a Diploma by UKh in January 1985. One of these two students received support from SREP to continue working on his MSc at UKh.

The program was completed in December 1985 and six MSc degrees were awarded to members of the RERI and the Forestry Research Center. The six students and their theses are:

- o Hisham Mohy El Din — Solar Passive Tracking
- o Ibrahim Ahmed El Zein — Generating Electricity from Wind
- o Siddig Adam Omer — Solar Heating for a Soft Drink Company
- o Belgiz Suliman — Charcoal Production from Cotton Stalks
- o Hassan Abdalla Mohamed — Photovoltaic Applications for Pumping
- o Mohamed Ahmed El Fadel — Fuelwood Production

A continuation of the Renewable Energy Technology MSc program for ten students is planned under the SREP II. That program will not have a U.S. university component. All academic work will be done at the University of Khartoum, with an expatriate visiting professor providing technical advisory assistance in curriculum development and implementation.

2. Short-Term Training

In SREP I short-term training was identified and arranged to respond to developed and felt needs as the project progressed. This training was specially tailored to meet individual staff and project needs. In many cases, short-term training and short-term expert consultancies complemented each other. For example, following the work of the Georgia Tech marketing consultant in Sudan, a two-week marketing course was developed and given at Georgia Tech for 9 Sudanese counterparts. Similarly, following the work of the Georgia Tech briquetting consultant, a three-week training program was conducted at Georgia Tech for the SREP briquetting team. The training has focussed on the priority technology areas and has been effective in contributing to or advancing SREP I objectives. U.S. and third-country short-term training has also been instrumental in attracting staff to work on the project, and has been helpful in the professional development of the SREP staff.

Short-term training outside of Sudan is dollar-funded from the technical assistance contractor's funds. An annual training plan is prepared in December of each year and presented to the Institutional Committee of the ERC and to USAID for review and approval. To maintain the continuity of U.S. and third-country short-term training, preparation of an annual training plan will be one of the first action items requiring immediate attention by the new technical assistance contractor.

During the 57-month life of SREP I, 47 short-term training courses in the U.S. and third countries has been provided to 30 Sudanese staff involved in the implementation of the project. This training has ranged from several days to several months in some cases, and has focussed on the enhancement of technical and managerial skills within the RERI/SREP I. A detailed listing of the individuals benefitting from this training and their course subject matter is provided in Appendix 3 of this report.

D. Dissemination

One of the unique components of SREP is its emphasis on the dissemination of the renewable energy technologies (RETs) it develops. Unlike other research and development projects, SREP I has followed up the development work with active commercialization of its RETs.

The RERI established the Dissemination Unit in January 1984 to promote the extension and commercialization of RETS developed through the SREP. Commercialization is required to disseminate the benefits of applied research and development of RETs to the largest possible number of end-users. Widespread dissemination or commercialization will not occur unless it is profitable for an entreprenuer or beneficial for a government agency to produce and market RETs. The RETs must also meet an expressed need of the end-user. SREP's approach to commercialization is to seek participation of both the private and public sector in its dissemination activities. The primary vehicle for involving such outside participants, who often lack skills and funds, is the Renewable Energy Development Grants (REDG) program explained further below.

The concept is to demonstrate a usable RET with a grant, with the hope that others would then replicate the RET. Grants are used to financially assist the demonstration, marketing, and/or the production of the RET.

Through both grants and technical assistance, SREP I has helped groups such as Khartoum's Forestry Department, Shendi's Education Center, CARE, and PLAN/Sudan in carrying out dissemination activities. The Dissemination Unit itself has helped about 15 grantees in improved charcoal stoves. Except for charcoal stoves and cooperative activities with the SREP Fuelwood/Forestry project, the Dissemination Unit has had few activities with other SREP RETs because these RETs were not ready for commercialization. However, the Unit has participated in two charcoal briquette acceptance surveys in 1985 and 1986, and has monitored charcoal stove production and charcoal prices on a monthly basis.

The Dissemination Unit has benefitted from expatriate consultancies on publicity, training workshops, and stove marketing. Also, five of the Unit's staff attended a two-week marketing training course at Georgia Tech in Atlanta. The Unit's skills have grown during the project, and it has become one of the RERI/SREP's most active and visible divisions.

Working with other RERI units, the Dissemination Unit has put on over 20 training workshops, primarily for stove makers. It conducted a major agroforestry seminar/conference in Khartoum entitled AFTAH (Agro Forestry Toward an Abundant Harvest). This brought high level government forestry officials and influential agriculturists in the public and private sector together for a one-day working conference. A compilation of the technical papers given at the conference was published under the AFTAH title. The Unit has produced over 20 technical reports along with several pamphlets, posters, training manuals, and articles for local newspapers and magazines. It has participated in radio and television programs. The Unit conducted a survey of 1000 charcoal stover users to assess user acceptance and buying habits in order to help stove producers market their products. As part of its effort to commercialize improved charcoal stoves, the unit has conducted over 15 market demonstrations/sales with the participation of the stove producers. With the active participation of two Peace

Corps Volunteers (during their evacuation to the U.S.), the Unit published "Improved Charcoal "Improved Charcoal Stoves for the Sudan; a Guide for Introducing Technologies."

From the Unit's experience in promoting and commercializing charcoal stoves, it is well positioned to commercialize other RETs as they become ready for dissemination. Through the Unit's activities in SREP I, the RERI has moved from being primarily a research organization into being an operational organization carrying out applied research, field tests and market surveys, and promoting the commercialization of RETs to end-users. Through its activities and interaction with the other RERI/SREP units, the Dissemination Unit now sees itself responsible for:

- o Field surveys and identifying parameters for RET modifications.
- o Assisting in the formulation of REDG proposals.
- o Publicizing and disseminating RETs.

1. Renewable Energy Development Grants (REDG) Program

An REDG is a financial grant to a public sector organization or private sector entity to carry out agreed-upon activities related to the development, field testing, or dissemination of a renewable energy technology. REDGs enable groups or individuals to undertake renewable energy activities who otherwise would be unable to because of lack of funding. REDGs are awarded based on careful review of written proposals submitted to SREP in a prescribed format. The criteria for individual grants and procedures and requirements for submitting proposals is as shown on the "Grants Program" published by SREP and reproduced in this report as Appendix 4. Grant proposals are reviewed and decided upon within six weeks after receiving a grant application.

The REDG program has been a unique, active, and successful component of SREP I. The judicious award of REDGs has enabled RERI/SREP to mobilize the support of other government organizations, community groups, and individual entrepreneurs in carrying out renewable energy activities and project objectives.

The success of the REDG program can be attributed, among other things, to:

- o Clear, simple, and objective criteria and procedures for awarding grants.
- o Expeditious review and approval of grant proposals submitted.
- o Effective financial management.
- o Availability of technical assistance from SREP for grantees.
- o Flexibility and willingness of the Grant Committee to accept some degree of risk in awarding grants.

Physical monitoring and evaluation of approved grant activities is carried out by the staffs or teams of the priority technology projects, and in some cases by short-term consultants. For example, the Fuelwood/Forestry area has received the largest number of REDGs. In this area an expatriate expert, Dr. Hosni El Lakani of Egypt, was retained to technically evaluate the forestry grants. In his evaluation, which was generally positive, he recommended that the grants also be subjected to economic assessment. Dr. B. William Riall, in January 1987 developed cost benefit analysis models for the RERI/SREP staff to apply to forestry grants. These did not include a model for evaluation of relatively small village forestry grants. Economic appraisal of these smaller grants may ultimately be impractical.

A grants administrator, Ms. Nahid Hassein, ensures that grant projects are followed up and monitored on a timely basis. She also coordinates the review of new grant proposals using established SREP guidelines. Table 1 on the next page summarizes the REDG awards and disbursements during the life of SREP I.

2. Energy Information Center

An important component of the Dissemination Unit is the Renewable Energy Information Center. The objectives of the Center are to:

- o Provide technical information on the applications of renewable energy technologies for Sudan. (A bibliographical service of documents available has been established.)

Table 1

RENEWABLE ENERGY DEVELOPMENT GRANTS (REDG)

Awards & Disbursements in LS For SREP I

Priority Technology Area	1st & 2nd Year		3rd Year		4th Year		TOTAL	
	Awds	LS	Awds	LS	Awds	LS	Awds	LS
Fuelwood/Fuelwood	35	376,508	24	473,836	11	57,760	70	908,104
Charcoal Stoves	6	154,284	1	57,400	1	500	8	212,184
Charcoal Production	1	9,150	-	-	-	-	1	9,150
Woodfuel Combustion	1	33,725	-	-	-	-	1	33,725
Photovoltaics	1 4	7,200 50,500	1	800	-	- -	2 4	8,000 50,500
Technical Journal, University of Khartoum	-	-	1	7,000	-	-	1	7,000
TOTAL AWARDS	44 4	580,867 50,500	27	539,036	12	58,260	83 4	1,178,163 50,500
TOTAL DISBURSEMENTS		446,315 47,925		415,929		$114,473		976,717 47,925

NOTE: 1st and 2nd Year: November, 1983* through June 30, 1985
3rd Year : July 1, 1985 through June 30, 1986
4th Year : July 1, 1986 through June 30, 1987

***First REDG awarded to Seleit Agricultural Scheme in November, 1987**

- o Establish a renewable energy technology network in Sudan. (This includes maintaining a directory of organizations involved in renewable energy technology applications and a listing of projects by technology.)
- o Establish communications with organizations in Africa and the Middle East that are involved in similar activities.

The Center is becoming the focal point for most renewable energy technology studies. It has strengthened the RERI capability to research applications of renewable energy technologies.

The Center is located at the RERI/SREP offices in the NCR building and is staffed with 2 information managers and 2 librarians. It is equipped with 2 MacIntosh and 2 Osborne computers with attendant peripheral equipment and 3 microfiche readers. It has a collection of 1271 books, 16 journals, and 109 microfiches on water/sanitation, dissemination, and on major renewable energy subjects including biomass, solar, wind, and hydro. From February 1986 through March 1987, the Center had 206 registered users: 117 from the RERI/SREP I staff and 89 from external organizations (e.g., the University of Khartoum).

III. TECHNOLOGY DEVELOPMENT

The ERC/RERI had traditionally considered technology development to be the design and testing of renewable energy technologies under controlled laboratory conditions to improve their performance. Researchers believed that once they had developed an efficient working prototype, their work as researchers was completed. The SREP approach to RET development demonstrated how all types of technology users, including artisan producers, retailers, and household consumers, can contribute to improving and refining the design and development of new products. The development of the charcoal stove was the first technology which considered the end-user's preferences in the design of the technology. Also, ease and practicability of production were taken into consideration when modifying the design. The ERC/RERI learned through this process that technology adaptation for Sudan must include consumer preferences and production limitations in the criteria for designing RETs. This expansion in the concept and scope of applied research allows the ERC/RERI to more effectively and positively impact the development of Sudan.

Originally, the SREP was intended to promote the development of a variety of RETs in Sudan. This included wind energy conversion systems, solar photovoltaic technologies, biomass biodigesters, gasifiers, and small hydro electric power systems. During the first year of SREP I, however, it became apparent that the scope of the project should be narrowed. First, about 80 percent of the total Sudan energy consumption comes from biomass sources such as fuelwood and charcoal; therefore, the project should address those energy sources and systems most common to Sudan. Second, some of the RETs originally considered were not yet commercially viable and, for Sudanese, were extremely expensive and inappropriate from a practical use standpoint. Third, the project's human and financial resources were limited and therefore SREP could not hope to give proper attention to a large array of RETs.

In May 1983, therefore, a joint GOS/USAID/REDSO/Georgia Tech conference in Khartoum resulted in a decision to limit the project's activities to five priority technology areas, primarily in low-cost and low-tech biomass energy applications

envisioned to have potential for immediate beneficial impact for Sudan. These were:

- o Charcoal Stoves
- o Fuelwood Production
- o Charcoal Production
- o Wood stoves
- o Photovoltaic Applications

Over the ensuing four years of SREP I, in line with the AID mid-term evaluation recommendations, the priority technology areas were further narrowed to four basic technology areas:

- o Fuelwood/Forestry/Mechanized Farming
- o Charcoal Stoves
- o Charcoal Production/Briquetting
- o Water Pumping

As a technology for SREP development and dissemination, wood stoves were considered to have comparatively less to offer in potential gains that could be realized than the other areas selected. It was therefore eliminated from the priority list and no work was done by SREP I in this area. After approximately 3 1/2 years of demonstrations, testing, and studies, photovoltaic applications were considered uneconomic and generally inappropriate (primarily because of the high cost). That technology area has been included under the water pumping project. Photovoltaics will be considered as a possible source of energy for water pumping applications in SREP II, in comparison with other renewable energy sources as well as with the more traditional diesel and electrical power sources.

A. Charcoal Stoves

Charcoal Stoves was selected as one of the priority projects for SREP I because significant reductions in energy consumption could be gained by improving the traditional Sudanese charcoal stove. Over 75 percent of Sudan's energy consumption is from biomass sources. Of that, over 90 percent is used in the home, with food preparation being the largest component.

The first stove made to save energy in the domestic area was the Canun El Duga (a stove capable of burning charcoal fines) designed at the University of Khartoum. SREP conducted a small field test which rendered promising results. Even though more development and improvements to this first stove would follow, SREP established the Dissemination Unit to promote and commercialize its first technology. The Dissemination Unit hired an engineer and sent four RERI/SREP staff to Kenya to examine the successful stove project there. In addition, a stove consultant from Kenya visited Sudan three times to help locate Sudanese artisans and to assess the potential of the Kenyan stove, the El Jiko (a metal clad ceramic stove), in Sudan.

The Dissemination Unit conducted a contest to attract potential stove makers and to publicize improved stoves. By the end of March 1984 there were 28 contestants from different economic sectors of industry. Prizes and stove-production contracts were awarded to producers from each of the three industrial sectors: traditional stove producers working out of abandoned cars and shacks, entrepreneurs working out of metal workshops, and factories.

With time it became evident that only the traditional stove producers found it profitable to continue the production of stoves. Entrepreneurs in workshops and factories would only work with new metal, and this made their stoves too expensive for the market. Also, considerable labor time was needed to construct the stoves. These two groups found that making simpler products was more suitable for mass production and more profitable. But to the traditional stove makers, the El Duga stove was profitable. By October 1984, 14 traditional stove makers had begun producing the stove that their prize-winning colleague was making. These producers made two types of El Duga stoves, the original model and a second version with a draft door (developed by one of the stove contestants). Each stove would sell for between LS 10 and LS 15. This compared to the LS 2 to LS 4 for a traditional stove.

It was important to coordinate production activities with publicity and marketing in order to promote the stoves. The stove team coupled training workshops with market demonstrations/sales and other dissemination activities. To increase its

outreach SREP awarded seven grants and provided technical assistance to organizations such as FAO, CARE, ADRA (Adventist Development and Relief Agency), and the Adult Education Center of Shendi so they could pursue similar activities outside the Khartoum area.

In all, over 15 stove workshops were conducted, training over 245 people in towns from Port Sudan to Juba and to El Nuhud in Southern Kordofan. The majority of the trainees were traditional stove makers or those with similar skills. Most learned how to make the El Duga stove, and a few learned how to make the ceramic/metal El Jiko stove. Over 90 percent of the trainees began to produce improved stoves, although many have now discontinued production, largely because of the increased scarcity and price of suitable scrap metal.

As stove-producer numbers increased, stove production peaked at approximately 10,000 per year. In the Khartoum area in 1985, improved stoves totaled about 6,600 for a 4.5% share of the Greater Khartoum market.

As training activities continued, SREP kept promoting commercialization of the stoves. SREP conducted over 15 market demonstrations where new producers could sell their stoves and gain encouragement for their new enterprises. The eight Sudanese staff and two Peace Corps Volunteers in the Dissemination Unit also provided much publicity and marketing assistance.

In 1985 it became evident that stove production was leveling off. The high price of the heavy metal required for the El Duga stoves made them less profitable. In some areas metal was not even available. SREP then began to promote the El Jiko stove, following an SREP consultant's advice and CARE-Sudan's lead. CARE had been successful, with an SREP grant and some technical assistance, in promoting the ceramic/metal stove in Western Sudan. At the end of 1985, SREP also retained two consultants to address production and marketing problems.

During the production consultancy, the stove team designed a new El Duga stove model and several other metal and ceramic variations using the following criteria

for stove design:

- o Efficiency
- o Low cost/Superior performance
- o Producibility
- o Availability of materials
- o Appearance

The third El Duga stove was designed to eliminate problems the earlier El Duga versions had with air draft control. The other stove variations addressed the need to reduce the high cost of the stoves.

As a result of the marketing consultancy, the stove team conducted a survey of 1000 stove consumers to better assess the performance of three different stoves and their acceptance by consumers. After placing the original El Duga (the open-draft), the third El Duga model (the sleeve), and the El Jiko stoves in 1000 homes, the unit found that all the stoves were well received. Over 90 percent of the survey users decided to buy their stoves at slightly reduced prices at the end of the survey. The survey showed that rapid charcoal starting, not energy-savings, was a more important criterion for buying a stove. Following the survey indications and the trend of metal prices and availability, SREP decided to refocus its stove program more on the El Jiko stove. This stove requires less and thinner metal while providing for a more efficient, easier-to-use, and faster-starting stove.

Although stove production dropped during late 1986 and early 1987, the stove team hopes to increase stove production during 1987 through active promotion and commercialization of the El Jiko.

RERI/SREP I staff feel that the charcoal stove activities were successful not only in the replication (production) that resulted, but in the lessons they provided for the dissemination and commercialization of renewable energy technologies in general. These lessons are well documented in the team's 119-page stove manual, "Improved Charcoal Stoves for the Sudan; A Guide for Introducing Technologies".

B. Fuelwood/Forestry

The increasing consumption of wood from Sudan's forests and problems of deforestation and desertification dictated the selection of fuelwood/forestry as one of the original five priority renewable energy technologies for SREP I. There is great potential for wood energy in Sudan. For example, if only 5 percent of all arable land (not the 10 percent to 15 percent required by law) were under forestry reserved for fuelwood and charcoal, it would provide 35 percent of all the energy needed for the Gezira, Blue Nile, and Khartoum provinces (per 1983 National Energy Plan demand estimates).

SREP's forestry team was made up of two or three local consultants, a Peace Corps Volunteer, and an RERI forester. They implemented a wide range of fuelwood/forestry activities. With the assistance of an expatriate forestry consultant, SREP used grants to set up model projects for many of these activities so that others might replicate them. The 70 grants issued for forestry/fuelwood served as the unit's primary dissemination tool. The RERI/SREP Dissemination Unit contributed to these activities by conducting a nursery management workshop and an agro-forestry seminar.

The forestry team's first focus was to rehabilitate nurseries and to plant trees in woodlots, shelterbelts, and along irrigation canals on small individual farms. For example, SREP increased Khartoum and Soba government nurseries capacities from about 30,000 seedlings to over 250,000 seedlings per year. For individual farms, SREP awarded 20 grants, primarily in the Khartoum area. Because of the drought in Sudan and the low water level in the Nile, almost half of these grantees either never started planting or had poor survival rates for the trees they planted.

To avoid problems with water supplies and to expand its scope, the forestry team then shifted its focus to village forestry and to agroforestry activities on the large irrigated agricultural schemes. SREP also introduced a few projects in more remote areas of the West, assisting in water-supply needs by awarding grants for water well drilling and/or repairs. This was done because of the great need and potential for fuelwood in that area.

SREP achieved particular success at the irrigated agricultural scheme of Seleit about 10 kilometers North of Khartoum. Over 200 feddans (1 feddan is approximately 1 acre) of eucalyptus woodlots have been planted there in addition to six-and-a-half kilometers of shelberbelts with five rows of trees. And Seleit has established a tree nursery producing 100,000 seedlings per year and has been successful inter-planting trees with karkadeh (hibiscus). The profits from the karkadeh crop has paid for the tree planting costs. Profit estimates at schemes such as Seleit show woodlots for fuelwoods and poles to be profitable. At Seleit, for example, one feddan should yield LS 12,000 each rotation, the first being eight years and the following ones at shorter intervals. Considering that these trees could be planted in otherwise unused, cut-out, or marginal lands and that trees require little maintenance in terms of fertilizer and weeding, profits comparable to agricultural crops should be possible.

Wanting to increase the number of Seleit-type successes, the forestry team and the SREP Dissemination Unit organized a major agroforestry seminar, AFTAH (Agro Forestry Towards an Abundant Harvest) in Khartoum in 1985. The seminar brought together agricultural scheme directors and senior government foresters in a one-day working conference. The conference resulted in a bound collection of technical papers and several grants -- most notably the White Nile, Blue Nile, Nile, Rahad, and Gezira schemes. These first two schemes hired foresters as permanent staff following the AFTAH conference.

The forestry team has effectively applied the REDG program to promote commercialization of fuelwood/forestry. The 70 grants awarded in this area include 7 to irrigated agricultural schemes, 12 to old or new nurseries, 9 to villages, 20 to small farms, 4 to mechanized farms in rain fed schemes, and 18 for other miscellaneous fuelwood/forestry activities.

Promoting fuelwood/forestry in the rain-fed mechanized farms has become a strong SREP focus only recently, although an early consultancy (by Derek Earl) indicated the potential in this area. Currently the mechanized farms burn the trees obtained from clearing land for agriculture. Hundred of feddans of wood energy are lost each year without leaving shelterbelts, woodlots, or trees

along canals. The forestry team has been working with two large mechanized farming companies and two smaller individual farms. Plans for late 1987 are to reforest some cleared areas through direct sowing of seeds and seedling planting. Planting experiments in the area near Damazine, conducted in 1985, brought positive results that SREP hopes to replicate. The forestry team has made additional plans, with the two major mechanized schemes to produce charcoal from the trees cleared from forested lands during their next land-clearing activity in late 1987.

During the four-and-a-half years of SREP I, the forestry team has been actively establishing and monitoring model demonstration projects. The team has had many successes but has learned, according to the Project Leader, that it could have been more successful if it had focussed on fewer but better monitored and more carefully selected projects. Three of the team's staff have attended desertification and/or agroforestry training, and the team has worked with a Georgia Tech consultant on forestry economics. It now is better equipped to evaluate existing and potential forestry grants. The forestry team is anticipating further progress in fuelwood/forestry for the Sudan in SREP II.

C. Charcoal Production/Briquetting

In Northern Sudan where few forests still exist, much of the population relies on charcoal brought from the south for its cooking needs, its greatest energy use. Charcoal is the preferred fuel, especially in urban centers, because it is cleaner and provides more energy by volume than does fuelwood. It is thus more economic to transport over long distances. Since charcoal is a major energy source for the Sudan, SREP began to investigate ways of improving or increasing charcoal production. (SREP is continuing this effort by getting two major agricultural corporations to agree to charcoal production field tests when clearing forested land for crop farming. These large mechanized agricultural companies ordinarily burn the trees cleared from forested lands simply to dispose of them.)

Originally SREP intended to improve charcoal carbonizing efficiencies in Sudanese earth-covered kilns, but discovered through studies that the kilns were,

indeed, efficient. It was concluded that traditional kilns, running at about 30 percent efficiency, equalled the worldwide average efficiency for improved brick kilns, even when the kiln shape and size or the diameters of the tree stand varied. Discovering that only small efficiency gains could be made at relatively high costs by improving charcoal kilns, SREP began to focus on charcoal briquetting. A local SREP consultant found that an abundant supply of charcoal fines, available at depots as waste, might be used in briquettes. But SREP's briquetting team, formed in March 1985, discovered that these fines were hard and difficult to crush and process into briquettes. From this and other experiences, the team learned that only finely crushed charcoal made sturdy briquettes.

With Sudan's large production of cotton, the carbonization of cotton stalks for charcoal briquettes evidenced some potential. Many thousand feddans of cotton stalks are burned annually to prepare the fields for the following year's crop. These stalks are not used as a fuel because by law they must be destroyed after the cotton harvest to prevent the spreading of diseases or viruses to following crops. SREP considered carbonizing stalks without briquetting, but soon realized that this charcoal burned too quickly and was too fragile to be transported. However, brittle carbonized cotton stalks were ideal for crushing and forming into briquettes. In March 1986, SREP and the ERC began the construction and testing of portable kilns for carbonized cotton stalks. By the end of SREP I twenty-four such kilns were being used (each 2.71 meters in diameter) for tests at the Rahad Agricultural Scheme.

When the briquetting team began its work in March 1985, a Georgia Tech consultant helped SREP to test a new fiber-binding technique that Georgia Tech had developed. To develop its knowledge and skills in this and other briquetting processes, the briquetting team participated in a training program at Georgia Tech in Atlanta, consisting primarily of further laboratory experiments with the fiber-binding technique in making charcoal briquettes.

The team designed a briquetting machine that it believed could produce a briquette meeting at least four criteria:

- o It would be suitable for Sudanese cooking needs.
- o It would have a high calorific value.
- o It would be sturdy and well bound internally.
- o It would be commercially feasible in Sudan.

Back in Sudan, the briquetting team developed an air cylinder device to extrude briquettes out of a paper-fiber and charcoal fines slurry. The complete briquetting system consisted of a steel plate grinding mill for crushing charcoal, a tank with a mixer for the charcoal fines and binder slurry, a circulating pump, an air compressor, and the briquetting machine itself. Carbonized cotton stalks were crushed and added to the mixing tank of paper-fiber solution. Once mixed, the slurry was poured into a hopper that fed into the briquetter that extruded briquettes through its cylindrical orifice. After additional design assistance from a Georgia Tech consultant, the briquetting team field tested the extruder in Sudan's second largest government agricultural operation, the Rahad Blue Nile Scheme.

The Rahad Scheme is comprised of about 320,000 feddans and 13,700 tenant families. The briquetting team, along with an ERC/RERI team responsible for testing portable charcoal kilns, produced a supply of briquettes to test with a 5 percent population sample in 5 of Rahad's 40 villages. From March until the end of May 1986 the team carbonized and briquetted stalks at a rate of 1000 briquettes per day. These briquettes were composed of 95 percent charcoal fines and 5 percent binding materials with no other additives. Although the briquettes were found preferable to regular charcoal by the 100 housewives involved in the survey, the extruding device itself was judged too slow, because of excessive friction in the extruder. In addition, the supply of waste paper for fiber was found to be relatively non-existent and difficult to obtain.

The briquetting team then began to investigate other binding materials and ways to improve the briquetter design. Of gum Arabic, molasses, and second-grade starch, the starch proved to be the best binder. Whereas gum Arabic made briquettes that crumbled and molasses caused a smoky flame, starch made sturdy

clean-burning briquettes. And the supply of second-grade starch appears to be plentiful and economic.

The extruder itself was altered to use a hydraulic pump (capable of 70 pounds per square inch of pressure) and a stainless steel extrusion cylinder to reduce friction and increase the speed of production. Although the hydraulic pump consumed more energy than the air cylinder device, the increased output and improved quality may justify the hydraulic system. This hydraulic briquetter was tested by producing briquettes for a May 1987 consumer survey in the Rahad Scheme. The preliminary results were encouraging because the briquette supply could not meet initial demands. Also, interested entreprenuers inquired about becoming involved in selling briquettes.

The prototype for briquetting appears promising for the market although it would require a capital investment too large for small entrepreneurs to undertake. However, to a large enterprise that could mobilize and manage the labor needed during the different stages of carbonization and preparation of the charcoal/binder mixture, the potential for success appears promising. The briquetting team anticipates further development/improvement in both the briquetter and briquettes early in SREP II, and plans to begin dissemination of this technology in mid-1988.

D. Photovoltaic Applications

The original intent of the photovoltaic (PV) applications project was to determine whether small businesses could be assisted with grants to defer the initial costs of buying an inventory of PV systems. The assumption of some entrepreneurs was that markets could be stimulated if subsidized models could be demonstrated as useful.

Following this approach, SREP field tested the marketability and practicality of four different PV systems. For each type of PV system a grantee/entrepreneur was responsible for locating interested customers representing different markets/locations and for installing and helping to monitor the system. Also the

grantee was to assist SREP in an economic and social assessment of the PV technology in use.

All of the PV systems encountered problems with delivery, equipment preparation, site selection, and field testing. To date, because of these delays, only the economic analysis for the portable lantern system has been completed while the other three systems are still being analyzed.

The portable PV lanterns with self-contained solar cells was distributed over a wide area of Sudan to both the public and private sector. The grantee began selling these lanterns at a 40 percent discount in September 1984. Eighty solar lanterns were sold and were compared with dry-cell battery and kerosene lantern operations.

Another SREP grantee was responsible for selling three systems of a centralized PV recharging unit with 24 lamps. A lantern, charged from the central solar unit located near the users of the 24 lamps, would provide light for an average of 10 to 12 hours. Current results indicate that this PV system is less expensive for the user whose initial investment is simply a regular lamp with rechargeable batteries. But the user must pay a recharging fee after every few hours of use, depending on the condition of the lamp's batteries. Each recharging costs about LS 3 to LS 4, which is comparable to the price of dry-cell batteries. Thus for the user, the initial and running costs are comparable to dry-cell battery lanterns, but more expensive than kerosene, when kerosene is available. But for the village retailer who pays the high cost for the recharger, the initial investment is prohibitive. Only with long-term financing might such a venture become more feasible.

Based on a two-year return on initial investment and a 20 percent discount rate, economic comparisons were made. Kerosene lamps were the cheapest to buy and to run where kerosene was readily available, but this availability often does not exist, or consumers are forced to purchase kerosene on the black market. Black market prices make kerosene lanterns economically comparable to the self-contained solar lanterns.

These solar units, were less expensive to operate than the dry-cell battery lanterns, but had a high initial cost. While a kerosene lantern could be bought for LS 15, a PV lantern could be loaned to a user against a deposit of at least LS 100. The PV project leader concluded that if a credit system could be established so that users could pay for their lanterns over a period of two to four years, the PV lantern would become more economical than the kerosene lamp.

A third grantee was responsible, under SREP guidance, for locating buyers for 10 street lamps recharged by solar cells. These units were also expensive. The greatest potential for these solar lamps would be with large public or private groups having available funds and needing an isolated light source or lighting in an area where fuels for generators were not available.

A fourth grantee was responsible for testing a PV refrigerator for medical vaccines with a solar recharging system. The refrigerator, which encountered several mechanical problems, was installed in a medical refugee camp in the hot and dusty town of Tokar in the Eastern part of Sudan. The apparatus did poorly under conditions of decreased light (the Tokar area is often dusty). Under such conditions the unit would need to have one or two additional PV modules in order to operate properly. The cost of this system was high, but where other forms of energy are not suitable, or available, the cost could possibly be justified where human life is at issue. For Sudan, the World Health Organization estimated a need of about 350 such refrigerators. The PV project leader has concluded, and recommended, that this system be field tested at other locations in Sudan.

As part of its SREP work, the PV team conducted an assessment of water pumps. The team compared solar pumps with those run by diesel and electricity at the SREP testing site at Soba, near Khartoum. For small scale applications (about 10 to 15 cubic meters of water per day), preliminary indications are that solar pumps may be comparable to conventional pumps in cost and performance, depending on location and the availability of diesel fuel or electricity. To test this hypothesis, the water pumping team plans to test solar pumps at various sites and under

different conditions and to compare them to electrical and diesel-fuel operated pumping systems.

During SREP I PV activities, the PV team of about five people, received extensive training. Three members of RERI participated in the MSc program, jointly conducted by the University of Khartoum and the Unversity of New Mexico in the U. S. Two of the three students joined the SREP PV team upon their return to Sudan from the U.S. in 1985. In addition, the PV project leader received PV training in Kenya and marketing training in Atlanta at Georgia Tech.

From SREP I PV activities, SREP has concluded that small scale photovoltaic applications are very expensive and comparable to other available technologies only under unusual conditions, such as the unavailability of kerosene or where human life is at stake. Also, SREP concluded that PV's will only compare in price to other sources of energy when reasonable long-term credit financing becomes more available in the Sudan. Thus, PV application activities will be discontinued under SREP II, although photovoltaic pumps will be tested under the water pumping project.

E. Water Pumping

When the project began, water pumping was not envisioned as one of the priority technology areas to be selected for SREP development and dissemination. However, water plays an important role in all aspects of Sudanese life, particularly in rural areas where only 40 percent of overall water requirements are met. Because solutions to Sudan's water supply problems began to surface as a national priority, renewable energy technology applications for water pumping was adopted as a priority activity by SREP I during its fourth year of implementation. The long-term study on renewable energy technology applications for water pumping is planned to continue under SREP II..

SREP water pumping activities began with the consultancy of Dr. Vaughn Nelson, of West Texas State University, in March/April 1986. This consultancy laid the groundwork for a long-term study on renewable energy techn .ogy (RET)

applications for water pumping in Sudan. Among other things, Dr. Nelson recommended:

- o The formation of a central steering committee on renewable energy pumping systems.
- o The collection of all available data related to:
  - -water requirements, domestic and agricultural.
  - -water resources availability, ground and surface.
  - -renewable energy resources potential.
- o The establishment of field evaluations of long-term operations of pumping systems.
- o The commercialization of pumping systems which can be manufactured and/or assembled in Sudan.

A four-person team (Seddig Adam, Nuralla Yassin, Nahid Yagoub, and Ibrahim Mohamed Zein) of applied researchers/engineers was appointed by SREP to implement the Nelson recommendations and carry out water pumping sub-project activities. These individuals comprised the counterpart team that worked with expatriate consultants Rick McGowan and Russell deLucia in January 1987. McGowan and deLucia, following up on and reinforcing the Nelson recommendations, assisted in laying out a long-term work plan for water pumping for SREP. The work plan included:

- o An extensive secondary data assimilation of water and energy resources, local infrastracture, existing equipment, and pumping system costs.
- o The installation, monitoring, and evaluation of a variety of pumping systems.
- o The collection of primary data related to the secondary data collected on the resource and infrastructure data base above, as well as that generated by the on-going testing and evaluation of pumping systems.
- o The dissemination of data generated by SREP to assist users in making more informed choices of pumping sytems.

Following the McGowan/deLucia consultancy in January 1987, the SREP water pumping team completed the compilation of reports on the "Petroleum and

Electrical Energy Potential" and "Renewable Energy Potential" in Sudan. In addition, SREP commissioned a local consultant to compile a report on the "Water Supply Potential" in Sudan. Also, a local consultant (geographer) was retained by SREP to compile basic data charts and maps for water supply which would show infrastructure, geographic features, and demographic information with the data from the above three reports superimposed. This compilation was to be completed by July 1987.

In addition to SREP's activities in water pumping, both the Netherlands (Dutch SWD) and the German (GTZ) governments are also involved in water pumping activities. Both donors have agreed with ERC/RERI to cooperate in the implementation of the SREP pumping project. The SREP pumping team is collecting primary basic data by monitoring and testing RET water pumping installations consisting of:

- Twelve wind pumps provided by the Dutch (SWD), which are geographically dispersed, including an installation in the Red Sea area which is being monitored and tested by the staff of the Sudan Oceanography Institute of the NRC.
- Four solar pumps and four river turbines provided by the German (GTZ) Special Energy Project (SEP).

It is now Government of Sudan policy that all external donors involved in RET water pumping coordinate their assistance through the SREP water pumping project.

Through June 1987 the SREP I Coordinator, Dr. El Tayeb Idris Eisa, has served as the temporary SREP project leader for the water pumping project. SREP plans were for Mohamed El Hassan El Tayeb to be seconded at the beginning of the GOS fiscal year 1987/1988 (July 1, 1987) from the National Water Corporation to be the water pumping project leader for SREP II.

As stated in the Fifth Annual Work Plan, the SREP water pumping team will:

- Develop design improvements in RET pumping systems,

- o Develop RET pumping system prototypes for manufacture using locally available materials,
- o Determine local manufacturing capability for RET pumps, and
- o Study the socio-economic acceptability of RET pumps (wind and solar pumps, river turbines, gasifiers, and animal traction) as compared to diesel-powered pumping systems of the same size and capacities.

If the water pumping project of SREP can successfully achieve its intended goals, it could have significant positive impact in helping solve Sudan's water supply problems and it could serve as a model for replication in other areas of Africa.

IV. PROCUREMENT

Procurement of locally available equipment, materials, and supplies required for project implementation was handled by the SREP staff. It included local purchases from both USAID-provided Trust Funds for contractor support and/or from Project Account funds provided by the Government of Sudan. Procurement of major commodities such as vehicles or computers was limited to U.S. sources and was financed from Georgia Tech's contract dollar funds.

TransCentury Corporation, as Georgia Tech's subcontractor responsible for providing the logistic support for SREP I, carried out all the U.S. commodity procurement and shipping. They also arranged for and financed all U. S. and third-country training, and provided certain short-term expatriate consultants for the project. In addition, TransCentury provided the administrative and logistic support for the five Peace Corps Volunteers who served in SREP I.

TransCentury's records indicate a total of $282,396.64 was expended in procuring vehicles, equipment, and materials for SREP I. The following is a summarized listing of the major items procured for SREP I from U. S. and local sources. A more detailed listing is available from TransCentury, Inc. files and/or from SREP I files in Khartoum:

A. Vehicles
   - o 6 Jeep station wagons
   - o 2 Jeep pick-ups
   - o 1 Celebrity (Chevrolet) Station Wagon
   - o Spare parts for all of above (about 50 percent of initial spare parts inventory was still available in June 1987)

B. Computer and Related Equipment
   - o 3 Osborne portable personal computers
   - o 2 McIntosh personal computers
   - o 2 IBM personal computers
   - o 3 Printers (2 NEC and 1 Epson)

- o 3 Uninterruptible power supplies (UPS)
- o 1 Alphaplus word processor (purchased with local currency Trust Funds)

C. Office Equipment

- o 4 IBM electric typewriters (3 English and 1 Arabic)
- o 3 Photocopiers, one with a sorter (two photocopiers purchased with local currency Trust Funds)
- o 2 Microfiche readers w/500 microfiche sheets
- o 2 HP 12C hand-held calculators
- o 1 25 KVA emergency generator for SREP office power supply (Trust Funds contributed half the cost of this locally procured item)

D. Audio Visual Equipment

- o 1 Overhead projector
- o 3 Slide projectors
- o 1 Tripod and screen
- o 1 Complete dark room unit for developing and printing photos
- o 1 35mm SLR camera with 50 and 135 mm lenses
- o 2 35mm Konica cameras
- o 1 Polaroid camera
- o 1 VCR camera
- o 1 20" monitor for VCR

E. Laboratory Equipment

- o Various, including anemometers, altimeters, therometers, oxygen bomb calorimeter, crucibles, 60-minute timer, ph meters, strip chart recorders, precision pyranometers, electronic integrator, laboratory balance.

F. Field Testing Equipment

- o Various, including moisture meters, compasses, band saws, measuring rods, transit and tripod, tree measuring chain, tree

height measurer, calipers for tree diameters, portable air compressor, hydraulic jacks, series sieves, conductivity meter, dessicator, stop watches.

V. BUDGETS AND EXPENDITURES

SREP I was financed from three different funding sources:

- o USAID/Sudan U. S. dollar funding for the Georgia Tech technical assistance contract
- o USAID/Sudan Sudanese pound (LS) funding for contractor support in Sudan
- o Government of Sudan Sudanese pound (LS) funding for all RERI support and most of the funding for the REDG program

(NOTE: The market exchange rate deteriorated from $1.00 = LS1.35 in November 1982 to $1.00 = LS6.00 in June, 1987 during the 57-month life of SREP I.)

A. Georgia Tech U. S. Dollar Contract

The $3,094,570 contract between Georgia Tech and USAID/Sudan was the source of funding for all long- and short-term technical assistance, long- and short-term U. S. and third-country training, and all U. S. commodity procurement. The subcontracts of TransCentury Corporation and E/DI were funded from this source. Some U. S. dollar Peace Corp support costs were also covered by these funds.

Dollar expenditures through the end date, July 15, 1987, of the Georgia Tech contract total approximately $3,085.000. This is necessarily only an estimate since all accrued costs, invoices, and actual disbursements will not be received and completely processed by Georgia Tech for 30 to 60 days beyond the contract end date.

A breakdown of the budget for Georgia Tech's U. S. $ contract and estimated cumulative expenditures is shown in Table 2 on page 41.

B. USAID Trust Funds

The Trust Fund was a USAID local currency (LS) account established to provide local support for the technical assistance contractor. This account covered costs associated with housing for Georgia Tech's long-term personnel assigned to Sudan, local travel, communications, office materials and supplies, and local support costs for Peace Corps Volunteers.

See Table 3 on page 42 for details of the budget and cumulative expenditures for the Trust Fund account.

C. GOS Project Account Funds

Project Account funds were local currency (LS) funds allocated as agreed upon between the Sudan Ministry of Finance and Economic Planning, the National Council for Research, and USAID/Sudan to implement SREP I. The funds covered the priority technology project activities including field testing, materials, equipment, local consultancies, and training costs. These funds also covered RERI operational costs such as staff incentives and travel costs and local currency (LS) costs of REDG's.

See Table 4 on page 43 for details of the budget and cumulative expenditures for the Project Account.

Table 2

Sudan Renewable Energy Project (SREP I)

Georgia Tech U. S. Dollar Contract

Budget and Expenditures

AID Contract No. 650-0041-C-00-3002-00 (through Modification #11)

Georgia Tech Project #A-3392

	Line Item		Budget Oct '87 to Jul '87	Cumulative Expenditures to June 30, '87
I.	Personal Services		$ 472,400	$ 475,481
II.	Fringe Benefits		97,400	98,016
III.	Materials and Supplies		107,400	109,636
IV.	Sub-Contracts		1,870,400	
	A. TransCentury	$1,347,577		1,338,248
	B. E/DI	525,356		488,885
V.	Travel		100,200	94,953
VI.	Other Direct Cost		9,550	23,260
VII.	**Sub-Total**		**$2,657,350**	**$2,628,479**
VIII.	Overhead		437,400	427,528
IX.	**Total**		**$3,094,750**	**$3,056,007***

*This does not include expenditures during the period June 30 to July 15, 1987, nor other expenditures accrued but not invoiced in the Georgia Tech June, 1987 invoice. Total expenditures are expected to be well within the budgeted amount.

Table 3

Sudan Renewable Energy Project (SREP I)

USAID Trust Funds (LS)

Budget and Expenditures

AID Contract No. 650-0041-C-00-3002-00 (through Modification #6)

Georgia Tech Project # A-3392

	Cost Category		Budget Oct '82 to Jun '87	Cumulative Expenditures to June 30, '87
1.	Office Support		LS 173,000	LS 169,386
2.	Local Travel:	SREP	51,000	48,683
		USAID		11,760 (a)
3.	Miscellaneous		81,000	81,910
4.	Housing:	SREP	321,000	72,868
		USAID		243,536 (b)
5.	Communications		52,000	49,110
6.	Peace Corps Volunteers Support		455,440	356,130
7.	**TOTALS**		**LS 1,133,440**	**LS 1,033,383** (c)

NOTE: (a) Expenditures for chartered aircraft and vehicle rentals were paid directly by USAID.

(b) Expenditures for certain housing rental, repairs and maintenance and guard services were paid directly by USAID.

(c) Expenditure amounts are estimates based on incomplete information available at time the final report was published.

Table 4

Sudan Renewable Energy Project (SREP I)

GOS Project Account (LS)

Budget and Expenditures

AID Contract No. 650-0041-C-00-3002-00

Georgia Tech Project #A-3392

	Cost Category	Allocations to June 30, '87	Cumulative Expenditures to June 30, 1987
I.	Consultancies/Subcontracts	LS 000,000	LS 000,000
II.	Field Test Support	000,000	000,000
III.	Materials and Equipment	000,000	000,000
IV.	Training Activities	000,000	000,000
V.	**Sub-Total**	**LS 0,000,000**	**LS 0,000,000**
VI.	Other Costs		
	A. Incentives	000,000	000,000
	B. Travel	000,000	000,000
	C. Miscellaneous	000,000	000,000
VII.	**Grants**	**0,000,000**	**0,000,000**
VIII.	**TOTALS**	**LS 0,000,000**	**LS 2,629,520***

*Total expenditures is an estimated figure based on incomplete information available at the time the final report was published.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. USAID Mid-Term Evaluation

In September 1984, approximately two years after the project began, USAID conducted a mid-term evaluation of the SREP I.

The evaluators were impressed with the project's emphasis on action, rather than studies. They recommended that more effort be spent in developing dissemination strategies and documenting the rationale behind some of the project's activities. They suggested a reconsideration of wood stoves as one of the priority technologies for SREP attention, as well as a careful review of photovoltaic applications for possible elimination as a priority technology. The evaluators stressed the need for greater SREP attention to RET dissemination strategies for the priority technologies, with emphasis on post-project replicability.

The evaluation was generally positive and laudatory about the project and its progress to that point. The evaluation summary has been excerpted from the full report and is included as Appendix 5 to this report.

B. Conclusions and Recommendations

The representatives of the Government of Sudan most closely associated with SREP I, the ERC Coordinator and Assistant Coordinator, consider the project successful (see Appendix 6, Coordinator's letter of June 10, 1987). Georgia Tech also believes that the project has more than achieved its objectives as called for under its contract with USAID. Among other things, the following ingredients have contributed to the overall success of SREP I:

- The limiting of project attention to relatively few priority technology areas, thereby avoiding a dilution and dissipation of effort and resources with little overall impact.

- o The focus on relatively low-tech activities having an immediate beneficial impact; eschewing the more sophisticated and expensive, and therefore less widely applicable in Sudan, high-tech RET research and development.
- o The cooperative spirit between the Sudanese project staff and the contractor's long- and short-term technical assistance advisors, with equal participation in decisions relating to project planning and implementation. USAID's flexibility, pragmatism, and consistent support contributed greatly to this aspect.
- o The emphasis throughout the project on the application of effective management techniques and procedures, the recognition of which has made SREP I the model for other research organizations of the National Council for Research.
- o The effective use of Peace Corps Volunteers and their Sudanese counterparts to initiate and carry out extension and dissemination activities which are not traditional activities of research engineers and scientists, thereby allowing consumers and production people to contribute to the design and development of RET's.
- o The effectiveness of the Renewable Energy Development Grants (REDG) program in mobilizing resources outside the RERI/SREP to be involved in both RET development and dissemination.

Following are specific conclusions drawn and recommendations offered as a result of lessons learned during implementation of SREP I:

1. **Institutional Strengthening of RERI.** The Dissemination Unit has been an important organizational addition to the RERI -- it has been the bridge, or has provided the linkage, between researchers and end users of RETs. This has been a departure from the traditional organizational/operational norms for research organizations in Sudan. While the Dissemination Unit has been in existence for less than three years, it is carrying out significant responsibilities that are new to the RERI but necessary to the dissemination/commercialization of RETs in Sudan. To maintain and increase the success enjoyed by SREP I, it is

therefore important to continue to provide training and technical assistance in SREP II designed to further strengthen the RERI as an institution. While other areas of demand may become evident during SREP II, it is specifically recommended that both training and technical assistance be provided in:

- o Market analysis
- o Economic analysis/project evaluation
- o RET applications and production techniques
- o Organizational management

2. **Training and Technical Assistance.** The SREP I has been successful in planning and applying technical assistance and short-term training resources. Most of the training and technical assistance (short-term expert consultancies) has been carried out to meet needs of the project identified during the course of its implementation. Terms of reference for short-term consultants were discussed and developed with the Sudanese project leaders and scheduled so that local counterparts could participate in and contribute to the consultancies as well as to learn from them. Full participation by Sudanese counterparts also assured continuity in the subject matter after the departure of the expatriate consultant. Short-term training was also tailored to project, as well as individual needs and where possible, to complement short-term technical assistance. Maximizing the participation of Sudanese project leaders and staff is important to the pertinence and relevancy of short-term consultancies and training in meeting project needs and objectives.

It is therefore recommended that similiar procedures be continued in SREP II. Specifically, annual short-term training and technical assistance plans should be developed jointly with the RERI/SREP staff. In the case of the annual training plan, it must be formally presented to the Institutional Committee of the ERC and to USAID for approval. Individual short-term consultancies must also be approved by USAID.

3. **Peace Corps Volunteer Participation.** The participation of Peace Corps Volunteers (PCVs) was an important contribution to the successful completion of SREP I. Four of the five PCVs assisted in the promotion and dissemination of

RETs. The PCVs were experienced in journalism, community organization, and forestry extension and were willing to work directly with consumers and producers. RERI researchers had not traditionally worked with consumers or producers. The PCVs and their counterparts therefore established a new area of organizational activity for the RERI. Since continued development of the Dissemination Unit is planned for SREP II, it would be desirable for another group of PCVs to be assigned to this project. To accomplish this, negotiations must be undertaken and agreement achieved with the Peace Corps prior to USAID's selection of the new technical assistance contractor. This will enable the Peace Corps to begin recruitment of the PCVs so that their arrival in Sudan will be as soon after the contractor's mobilization date as possible. The PCV group should be made up of 2 foresters, 1 engineer with water pumping experience, and 2 PCVs experienced in dissemination/marketing.

It is therefore recommended that arrangements be concluded with the Peace Corps as soon as possible to identify, recruit, train, and assign PCVs to SREP II, and that USAID/Sudan support and facilitate such arrangements.

APPENDICES

SREP I - Appendix 1

Expatriate Short-Term Consultancies

October, 1982, - June, 1987

	Name	Consultancy And Date	Person-Months
A.	**Georgia Tech**		
1.	Arthur Thivierge	Initial Work Plan Apr/May, 1983	0.65
2.	Donald Peterson	Acting Chief of Party Nov/Dec, 1983	2.00
3.	Claudia Huff	Dissemination (Charcoal Stoves) Sep/Dec, 1984	3.53
4.	Grant Curtis	Briquetting Mar/Apr, 1985	1.75
5.	Arthur Brown	Marketing Sep/Oct, 1985	1.64
6.	Ben James	Stove Production & Briquetter Development, Oct/Nov, 1985	1.78
7.	Dr. Hosni Lakani	Fuelwood/Forestry Evaluation Feb/Mar, 1986	1.00
9.	Dr. William Riall	Agroforestry Economics Dec, 1986/Jan, 1987	1.64
10.	Dr. Russell deLucia	Water Pumping Nov, 1986/Feb, 1987	1.43
11.	Richard McGowan	Water Pumping Nov, 1986/Feb, 1987	1.31
		Sub-Total	**17.73**
B.	**TransCentury Corporation**		
1.	Pamela Parmer	Procurement Training Jun/July, 1983	1.08
2.	James Lehman	Manpower Study Jul/Sep, 1983	0.90

3.	Anis Aclimandos	Manpower Study Aug/Sep, 1983	0.40
4.	Dr. William Gross	UKh/UNM Academic program Sep/Dec, 1983/Jan, 1984 Mar/Oct, 1984 Jan/Aug, 1985 & Feb, 1986	3.58
5.	Paul Chakroff	Peace Corps Program Feb/May, 1984	1.54
6.	Carolyn Huskey	Dissemination & Info. Center Mar/Jun, 1984, Jul, 1985 Jan/Apr, 1986	8.28
7.	James Winslow	Vehicle Maintenance Jan/Mar, 1986	1.48
		Sub-Total	**14.80**

C. Energy/Development, International (E/DI)

1.	Lester Bradford	Fuelwood/Forestry Dec, 1983/Aug, 1984	8.50
2.	Derek Earl	Charcoal Production Feb;Mar, 1984 & Jan, 1985	4.90
3.	Maxwell Kinyangui	Charcoal Stoves Feb/Apr & Nov, 1984	1.40
		Sub-Total	14.80
		TOTAL	**49.79**

SREP I - Appendix 2

Local Long- & Short-Term Consultancies

	Name	Consultancy	LT/ST
1.	Hamaza Hamoudi	Forestry Advisor	LT
2.	Khalafalla Sid Ahmed	Forestry Advisor	LT
3.	Somaya Suliman	Dissemination	LT
4.	Abdel Aziz Bayoumi Ali Saliim Kamal Osman Khalifa	Agroforestry-Northern Region	ST ST ST
5.	Hassan Osman Abdel Nour	Charcoal Production-Blue Nile	ST
6.	Dr. Taj el Din Nasroun	Metal Charcoal Kiln Trials	ST
7.	William Ibrahim Assad	Wood/Charcoal Energy Analysis	ST
8.	Jamal Shabaak	Charcoal Stove Production	ST
9.	Hanafi Obeid	Mechanized Farming Study	LT
10.	Mohamed Ali Hamid	Photovoltaic Field Testing	LT
11.	Ibrahim Abdalla Suliman	Photovoltaic Field Testing	LT
12.	Endi Amin	Charcoal Stove Production	LT
13.	Dr. Harbi	Mechanized Farming Charcoal Production	ST
14.	William Ibrahim Assad	Fuelwood Combustion	ST
15.	Ali Mohamed Hassan	Charcoal Production	ST
16.	Omer A/El Karim	Agroforestry	LT
17.	Ali Khalid Ali	Mechanized Farming	LT
18.	Ali Beheiry	Information Center	LT
19.	Dr. Hamid Ibrahim	Conventional Energy (Pumping)	ST

20	Ustaz Khiralla Magoub	Hydrogeology (Pumping)	ST
21.	Ustaz Amin Sabry	Conventional Energy (Pumping)	ST
22.	Dr. Abbas Shasha Musa	Geography (Pumping)	ST

SREP I - Appendix 3

U. S. & Third-Country Short-Term Training

Shadia Nasr Eldin	Charcoal Stove	Kenya Dissemination Seminar
Shomo Sha'a El Din	Charcoal Stove Dissemination Seminar	Kenya
Dr. Ahmed Hassan Hood	Bioenergy Seminar	Sweden
Dr. Mohamed Osman	Research Project Management	U. S.
El Tayeb El Bashir	Charcoal Stove Study Tour	Kenya
Awatif Mahmoud	Charcoal Stove Study Tour	Kenya
Dr. El Tayeb Idris Eisa	Renewable Energy Tour	U. S.
Dr. Hassan O. Abd El Nour	Biomass Production	U. S.
Dr. Elsheikh El Magzoub	Renewable Energy Course	U. S.
Abdel Rahman Ahmed Gebril	Solar Equipment Maintenance	Egypt
Dr. Ahmed Ibrahim Elhag	Minihydro	Swaziland
Ibrahim El Zein	Minihydro	Swaziland
Gaafar El Faki	Study Tour on RET Commercialization	U. S.
	Plantation Species & Management	U. S.
Somaya Suliman	Study Tour on RET Commercialization	U. S.
Dr. El Tayeb Idris Eisa	R & D institutional Management	U. S.
Dr. Hassan Wardi Hassan	R & D Institutional Management	U. S.
Hamza Hamoudi	Irrigated Agriculture and Forestry Integration Techniques	Egypt
Dr. Elsheikh El Magzoub	Briquetting of Agricultural Residues	U. S.

Asma El Amin Ahamed	Briquetting of Agricultural Residues	U. S.
Gumma Ibrahim Gulfan	Computer Application in Developing Countries	U. S.
Maha Hassan Osman	Agroforestry Field Visit	Egypt
Khalafalla Sid Ahmed	Agroforestry Field Visit	Eygpt
Dr. El Tayeb Idris Eisa	Water Pumping Biomass Energy Applications	Botswana Kenya
Dr. Azmi Zein El Abdin	Photovoltaic Applications in Rural Areas	Kenya
Dr. Elsheikh El Magzoub Shadia Nasr Eldin Somaya Mohamed Suliman Amin Kamil Mohd. Awatif Mahmoud Maha Hassan Osman	Marketing Course	U. S.
Gaafar El Faki	R & D Institutional Management	U. S.
Dr. Mohamed Osman	Renewable Energy Applications Seminar	Egypt
Ibrahim Saad	Information System Management	U. S.
Fethie Mohd. Salih	Information System Management	U. S.
Dr. El Tayeb Idris Eisa	Water Pumping Conference Observation Tour	Botswana Lesotho
Seddig Adam Omer	Water Pumping Conference	Botswana
Nuralla Yassin	Water Pumping Conference	Botswana
Sana's Saad	Secretarial & Computer Training	Egypt
Hawa Makawi	Secretarial & Computer Training	Egypt
Ali Khalid	Agroforestry Seminar	Kenya
Bedar El Dien Ismail	Agroforestry Seminar	Kenya

Shomo Sha'a El Din	R & D Institutional Management	U.S.
Gaafar El Faki	Regional Charcoal Stove Workshop	Kenya
Ishraga Mohd. Taha	Dissemination & Stove Testing Field Visit	Kenya
Amin Kamil Mohd.	Dissemination & Stove Testing Field Visit	Kenya
Dr. El Tayeb Idris Eisa	Arid Land Management	Egypt

Sudan Renewable Energy Project - Appendix 4
Grants Program

The Sudan Renewable Energy Program (SREP), supported by the U.S. Agency for International Development, has organized a Grants Program to promote the use of renewable energy technologies. The grants are intended to help commercialize these technologies through dissemination and outreach activities. Grants are available to public and private institutions, entrepreneurs and community groups that can assist in this work.

Program Activities

Grants will be used for such activities as:

- Planting.
- Pilot production and/or test marketing.
- Extension activities by grantee which may include:
  - Production of promotional material.
  - Distribution and outreach.
  - Short courses or training.
  - Partial support (seed money) for entrepreneurial activities.

Program Focus

Proposals should focus on one of the five priority technologies under the SREP. These technologies are:

- Fuelwood production through individual or community plots, agroforestry combinations, and fuelwood/management activities.
- Charcoal production to demonstrate new and improved techniques to increase overall efficiency.
- Promotion of photovoltaic systems for small scale use in rural areas such as systems to recharge batteries in rural areas.
- Promotion of new and improved wood stoves for domestic and commerical use and improved manufacturing and marketing techniques.
- Promotion of photovoltaic systems for small scale use in rural areas such a systems to recharge batteries in rural areas.

Grants will be given for activities which assist in promoting the use of the above five technologies. Higher priority will be given to proposals which demonstrate a greater return on investment.

Grant Procedures

- Grant proposals can be submitted to the SREP office (University Barracks). Each proposal should contain the following information:
  1. Project objectives
  2. Implementation plan, including an outline of activities or tasks, the schedule for accomplishing these activities, and the person or institution responsible for each task.
  3. Budget describing portion of costs to be supported by the proposer and that to be supported by the grant.
  4. Geographic area involved.
  5. Training and/or technical assistance monitoring required.
  6. Nature of the market for technology.
  7. Projected outputs from project.
  8. How project will be self-sustaining.
- Proposals will be reviewed by the SREP staff and selected experts in the specific program field.
- The review will be based on the following criteria:
  1. Technical and Economic Soundness of the proposal.
  2. Extent of planned technology dissemination.
  3. Social soundness and benefits of proposal.
  4. Environmental impact.
- If modification to budget and/or work program are required, they will be negotiated and resolved before final approval is given.

Progress and Financial Reporting Procedures

Consistent with the submitted proposal, the Grantee will submit quarterly cash needs and status of expenditure reports to SREP on special forms provided for this purpose.

In addition, the Grantee will be required to submit quarterly progress reports.

Appendix 5

Evaluation of the Sudan Renewable Energy Project (650-0041)

September 1984

SUDAN RENEWABLE ENERGY PROJECT (SREP)

EVALUATION

TABLE OF CONTENTS

I. Summary

The Sudan Renewable Energy Project (SREP) was approved in August 1981. The contract for the project was signed in October 1982, and the contractor arrived on site shortly thereafter. The purpose of the project is to assist the Government of Sudan (GOS) to develop an applied research and dissemination capability in renewable energy technology, with verification through the application and dissemination of results in town and village projects. The five priority areas the project is focusing on are (1) fuelwood production (2) charcoal stoves (3) charcoal production (4) wood stoves and (5) photovoltaics.

The Sudan Renewable Energy Project has evolved substantially from the original Project Paper and the Amplified Project Description in the Project Agreement, due to changing external factors and a willingness on the part of USAID, the GOS and the contractor to correct certain problems inherent in the original project design.

Unlike most other renewable energy projects funded by AID in Africa, SREP has not over emphasized studies. The increasing emphasis on action, and on getting project staff, equipment, and funds into the field is admirable and should avoid some of the problems normally encountered during the implementation of such projects. However, the Evaluation Team recommends that more effort be spent on developing dissemination strategies, producing hypotheses and documenting the rationale behind certain project activities. We believe that the project has an opportunity to initiate, document and replicate approaches that can effectively disseminate and market improved stoves, as well as promote the increased production of firewood. However, if care is not taken, it is likely that many of the project's outputs will be relatively isolated and insignificant. SREP is a small project, and the funding for small pilot activities is not, in the opinion of the Evaluation Team, sufficient if the project is to be replicated.

In our opinion, the project should direct most of its attention to testing and promoting strategies that can and will be expanded and supported after the PACD. We believe that the project should be evaluated primarily on the basis of its ability to put in place governmental, non-governmental, and private sector mechanisms that will replicate the project's activities. The primary dissemination concept incorporated in the PP--that the demonstration of improved energy technologies will lead to their rapid construction or purchase by peasants--has proven to be faulty in other similarly designed projects. SREP should not, therefore, be expected to achieve outputs based on this original concept. SREP will not meet the project's purpose if the present outputs and End-of-Project status are adhered to. Therefore, the original Project Paper and outputs should be revised to reflect a greater emphasis on process and replicability than on objects.

We recommend that the Project Agreement be amended, that the Amplified Project Description be amended through a PIL, that the Contract be amended, and that the Logical Framework presented in the Project Paper be revised. Of these changes, only the first will require negotiating and signing an amended USAID/GOS document.

Assuming that the above changes are made, the project should substantially meet its project purpose and outputs by the PACD, January 1987.

The following specific recommendations and conclusions are discussed in more detail in later sections.

Relevance of SREP to Sudan's Energy Problems and USAID's Development Program (See Section II)

1. The project as now constructed and focused is addressing key energy related problem areas in Sudan, i.e. fuelwood and improved stoves.

2. SREP should be viewed as a test of low-cost methods to reach individual consumers in ways which will be replicable without significant recurrent costs.

3. SREP's challenge is to develop a diffusion strategy to avoid concluding the project with only a string of isolated efforts.

Technical Programs (See Section III)

4. Forestry/Fuelwood
Much progress has been made in fuelwood production, but considerable effort is still required in dissemination/outreach as well as in relating specific project activities to a broader strategy.

Charcoal Production

5. It is recommended that the charcoal production efficiency study carried out by SREP be checked. All activities in the charcoal production area are based on this one study, the results of which differ by a large factor from what was previously believed to be correct and from experience in charcoal production (wood conversion) efficiencies in other countries.

6. It is recommended that SREP collaborate with the National Energy Administration (NEA) and FAO on a charcoal fines 1/ resource base study. This recommendation should be carried out before the arrival of the charcoal technical consultant.

Charcoal Stoves

7. The charcoal stove program has progressed well, although an effort should be made to promote innovation and the continued development and extension of a variety of stove designs. While non-governmental organization (NGO)-supported stove programs outside of Khartoum can be assisted and encouraged, the majority of effort should be centered on Khartoum.

1/ As used throughout this report, charcoal fines refer to charcoal bits, not dust.

8. Woodstoves
We suggest that SREP review the inclusion of rural household woodstoves as one of the five priorities because there is no example of a successful woodstove program in Africa, with the possible exception of Botswana. In general, those people who use wood rather than charcoal cannot afford to invest in a stove, and in most countries extension services are too weak to diffuse stationary stoves widely. We doubt that Sudan is different.

9. Focusing on wood use by small local industries is probably a more logical step. The team supports the survey to be conducted by the NEA of industrial wood users in the Khartoum area. We recommend that additional technical assistance be allocated should the survey prove it to be necessary.

Photovoltaics

10. We have some concern that this component as originally identified is too hardware-oriented. This priority should be carefully reviewed for possible revision or elimination by the end of 1985.

Dissemination

11. Dissemination strategies should be developed for each project area, with an emphasis on post-project replicability. This may entail further technical assistance and staff time, and should be a major consideration in the selection of future renewable energy development grants (REDGs). This should be done in coordination with the NEA.

Technical Assistance (See Section IV)

Long-term

12. The quality of present long-term staff is excellent.

Short-term (Foreign TA)

13. Short-term consultants have been of very high quality and are in large part responsible for the significant progress made in certain areas.

14. Certain consultancies should not be undertaken prior to the completion of studies on resource availability and alternative technologies. This applies in particular to the planned pelletization consultancy.

Local TA

15. The use of local consultants under this project has been extensive and effective, particularly in the forestry component.

16. The continued and expanded use of local consultants is encouraged in areas of local expertise, i.e. forestry, while still using foreign technical assistance to fill in gaps as needed.

Renewable Energy Development Grants (REDGs) (See Section V)

17. The REDG system has proven to be quite effective for funding small-scale development activities in terms of their turn-around time for funding and their ability to reach a wide variety of organizations and individuals.

18. While the present SREP team can effectively handle the current level of REDGs, any expansion in the grants area may require additional monitoring, possibly through use of local currency to hire more Sudanese staff.

19. The bulk of approved grants are in the area of fuelwood production. The Evaluation Team recommends at this point that more REDGs should be used to fund studies on how the economics and strategies of the five priority areas can be developed to meet the objectives of the project.

Training (See Section VI)

20. The long-term training program must be made more practical, with a mandatory course on project evaluation after the upcoming field work.

21. Additional regional site visits should be supported, funds permitting.

22. A manpower assessment related to each priority area should be prepared in order to guide further local training.

Management (See Section VII)

Home Office

23. Considering that the prime contractor has two subcontractors, the Evaluation Team was impressed by the smooth home office management.

SREP

24. The team was impressed by the management skills of both the contractor and the GOS. The strengthening of the Renewable Energy Research Institute (RERI), as well as the establishing of the Technical Committee, have reinforced the development of a professional, cooperative environment.

25. TransCentury, one of the subcontractors, will be responsible for the administrative/logistical support of the Peace Corps Volunteers (PCVs). As integral components of the project, the PCVs will be guided technically by the SREP staff, including the COP, the RERI Coordinator, and the relevant Project Managers. The COP and the Coordinator should represent the Volunteers in official dealings with the GOS, USAID, and the Embassy.

USAID (See Section VIII)

26. A better level of information exchange should be established among offices at USAID in order to utilize available technical expertise in forestry--for example, as related to agriculture. Also, USAID and the contractor should establish linkages with similar AID and regional activities to benefit from work being done in other countries.

27. Project management should improve with the addition of administrative support. USAID support and technical advice have been useful and at key times have had a significant impact. Until a natural resource/forestry specialist has been added to the USAID/Sudan staff, however, USAID should continue to draw upon REDSO at regular intervals for technical advice on energy, social science, and forestry.

28. Given the importance of marketing, extension, and dissemination, the Evaluation Team regrets USAID's decision to exclude from the evaluation a specialist in the dissemination of stoves and fuelwood. To get the most out of the project, USAID should consider an additional informal technical review in early 1985 to reexamine the project's dissemination strategies as recommended in this evaluation.

Government of Sudan - Institutionalization of SREP (See Section IX)

29. After initial problems among GOS institutions in terms of a base for this project, a good working relationship seems to have developed between the Institute, SREP, and the Energy Research Council (ERC). In large measure, this relationship has improved because of the skill and technical expertise of the ERC Director and the work of the ERC's Technical Committee.

Other Donors (See Section X)

FAO

30. Given the complementarity and overlap between the FAO/Dutch project and SREP, the dissemination strategies recommended above should be developed in close collaboration with the FAO team.

CARE

31. The REDG for stoves in El Obeid appears to be a good investment. Future collaboration should include activities in Gedaref.

German Agency for Technical Cooperation (GTZ)

32. SREP and the GTZ should continue to keep each other informed of progress being made in project activities.

World Bank

33. Future USAID support of activities initiated under SREP should take into account the results of the World Bank forestry assessment. The inclusion of SREP staff in the assessment, as recommended by USAID, would be highly desirable.

Project Design (See Section XI)

34 The Project Purpose in the Project Agreement should be revised by deleting from Section 2.1 the words "for use in rural areas of Sudan" and replacing them with "as defined by the project."

35. The contractor and USAID should work together to modify the scope of work of the contract to ensure that it accurately reflects the project's present focus and priority activities.

36. The contractor, USAID and the GOS should be commended for focusing and restructuring a potentially unwieldy project. It is doubtful that the Project Purpose would have been achieved if the decision had not been taken to concentrate all activity on five specific areas.

Appendix 6

THE DEMOCRATIC REPUBLIC OF THE SUDAN
THE NATIONAL COUNCIL FOR RESEARCH
ENERGY RESEARCH COUNCIL
P. O. Box 4032 Khartoum Centre.
Tels : 70701 - 76691
Telegraphic Address " Buhuth "
Telex No. 22342 ILMI SD

جمهورية السودان الديمقراطية
المجلس القومي للبحوث
مجلس أبحاث الطاقة
الخرطوم. ص.ب ٤٠٣٢ - الخرطوم وسط
تليفون : ٧٠٧٠١ - ٧٦٦٩١
العنوان التلغرافي : " بحوث "
رقم التلكس : ٢٢٣٤٢ "علمي" سودان

(In Your Reply Please Refer To Our) E. R. C. ملف رقم : ر م أ ط / ــــــــــــــــــــــــ

Date ..... June 10, 1987 التاريخ : ــــــــــــــــــــــــ

Dr. Henry C. Bourne, Jr.
Acting President,
Georgia Institute of Technology,
Atlanta, Georgia 30332,
U . S. A

Dear Dr. Bourne:

As you know, the Georgia Tech Research Institute has worked for the past four and a half years with the Renewable Energy Research Institute (RERI) of the Energy Research Council under Sudan's National Council for Research. This was in the Sudan Renewable Energy Project (SREP I) from October, 1982 until July 15, 1987. The project was sponsored under a direct contract with the U.S Agency for International Development Mission (USAID) in Khartoum.

Your participation in the project is now nearing the end. I want to express, on behalf of the Energy Research Council, our appreciation for Georgia Tech's help in strengthening the RERI institutions. With Georgia Tech's active participation, much useful progress has been made in the development and dissemination of five of the five renewable energy technologies selected as subprojects under the SREP I. Our staff has benefitted much from the training programs arranged and/or conducted by Georgia Tech.

Throughout the project, the long term staff and short term consultants assigned to SREP I by Georgia Tech have been concerned professionals with a real commitment to helping Sudan. They have worked well with us and we have developed personal as well as professional relationships with them which we will cherish. The Georgia Tech long term Chief of Party, Don Peterson,

deserves special commendation for the outstanding job he did here. He earned the respect and admiration of all those with whom he had contact, Sudanese and expatriates alike. We also appreciate Bill Larson's work with us here and in Atlanta.

We regret the decision by Georgia Tech to not compete for the prime contract for technical assistance for SREP II. For our part, we would welcome Georgia Tech's involvement in the follow-on project also.

Again, we thank you for a job well done.

Sincerely yours,

Dr. El Tayeb Idris Eisa,
Coordinator, SREP I
Director, ERC

cc. Director J. Koehring, USAID
Dr. Donald Grace, GTRI