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TRIP REPORT

SENEGAL RENEWABLE ENERGY PROJECT

by

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I - INTRODUCTION

The Government of Senegal (GOS) is placing a high priority on seeking alternative sources of energy for accomplishing the following tasks:

- drawing water for domestic use, irrigation, and watering livestock;
- conserving food, including improved drying techniques and refrigeration;
- cooking.

Work is currently underway in several Senegalese organizations to develop and perfect technologies which use renewable sources of energy. The Institut de Physique Météorologique (IPM), the Institut Universitaire de Technologie (IUT), and the Ecole Polytechnique de Thiès are experimenting with ways to pump water using energy from the sun and wind. This work is heavily supported by the French. Experimental solar collectors, photovoltaic systems and windmills have been installed and are in operation in a number of sites in Senegal. Caritas, a private voluntary organization, has developed a hand pump which has been successfully installed in several villages. In the area of food preservation, IPM is working closely with the Institut de Technologie Alimentaire (ITA) to perfect a prototype of a solar dryer. And IUT is experimenting with cooling systems (refrigeration) using solar cells. (See Table 1, chart fold-out.)

With regard to cooking, the major source of energy in rural areas is firewood and charcoal. The rapid rate of deforestation in recent years has caused the government to encourage the use of butane for cooking through subsidizing the importation of butane and butane burners. In addition, it has placed strong limitations on the production of charcoal, which is considered a wasteful use of forest resources. It is too early to assess the impact of these policies on the consumption of firewood and charcoal. However, people still apparently prefer to prepare their meals using traditional energy sources. And it is still cheaper to cook with firewood and charcoal as opposed to butane. Some experimental work is being done by Caritas to produce methane for cooking and lighting. And IPM is in the process of constructing a prototype for a solar cooker.

In response to GOS interest and U.S. Congressional support, the Agency for International Development (AID) has approved a proposal, drafted by the Overseas Development Council in close cooperation with the GOS, to provide financial and technical assistance to Senegal in the field of renewable energy. The purpose of the project, as stated in the proposal, is to

> "strengthen Senegalese capability to conduct a five year test program designed to help them learn whether small scale renewable energy technologies and improved traditional techniques can provide affordable, reliable, sustainable and environmentally, culturally and socially acceptable alternatives (or supplements)

to fossil fuel energy technologies on one hand, and traditional energy technologies on the other (e.g., firewood and human muscle power) for rural development purposes."*

As proposed, the project would consist of the following elements:

- support to R&D organizations in Senegal to enable them to further develop renewable energy technologies which meet local needs;
- village level surveys to collect information on present energy uses, perceived village needs, and on local availability of renewable energy sources;
- installation of renewable energy devices in a number of selected sites to determine their technical feasibility and social acceptability;
- project evaluation for the purpose of determining which alternative energy technologies hold the most promise for meeting local energy requirements.

AID has contracted with the Center for Research and Economic Development of the University of Michigan to formulate a project paper for a Renewable Energy Project in Senegal. Members of the design team include Charles Steedman, design officer and team leader; Clarence Kooi, energy technologist; Sheila Walker, anthropologist; and Moustapha Kassé, economist. (See Appendix 1 for biodata on the team members.) Clark Spooner from REDSO/WA is the civil engineer on the team.

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*Overseas Development Council, Operation Energie Renouvelable, Proposed Project Identification Document for consideration by USAID Mission to Senegal (Washington, D.C.: Overseas Development Council, March 30, 1978).

Best Available Document

TABLE 1. EXPERIMENTAL ACTIVITIES IN THE DEVELOPMENT OF RENEWABLE ENERGY, SENEGAL

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ENERGY TECHNOLOGY	RESPONSIBLE ORGANIZATIONS	SIZE OF INSTALLATION	DATE OF INSTALLATION	OUTPUT	POWER	OTHER PROPERTIES	COST (RATE OF EXCHANGE: $1 = 215 CFA)	SOURCE OF FINANCING	REMARKS
1. FLAT PLATE COLLECTORS	Institut de Physique Météorologique (IPM)	I.P.M. - Prototypes (SORUR, SECRA, ITTA)	1957 - 1966						
		I.P.M. Prototype (Nadje)	1966						
		I.P.M. Prototype (Segal)	1968	5-6 M^3/hour Depth of 25 m.	1 KW	88 M^2 collectors	17 m. CFA $79,069	GOS Ministry of Agriculture	Still in Operation
		I.P.M. Prototype	1975		1 KW	70 M^2 collectors	8-9 m. CFA $39,534	UNIDO	
	Institut Universitaire de Technologie (IUT)	I.U.T.	1976		1 KW				Uses: Training engineering students
	SOFRETES (manufacture) SINAES (installation)	Mecina - Dakhar (Thies)	1976	8-10M^3/hour from 20 m.	1 KW			FAC	Uses: Domestic water
		Meouane (Thies)	1976	8-10M^3/hour from 20 m.	1 KW			FAC	Uses: Domestic water
		Niakhene (Thies)	1976	8-10M^3/hour from 20 m.	1 KW			FAC	Uses: Domestic water
		Diagle (Fleuve)	1976	8-10M^3/hour from 20 m.	1 KW			FAC	Uses: Domestic water
	SOFRETES, SINAES & THERMO-ELECTRON	Bakel	Proposed for 1979		80 KW		300 m. CFA	FAC, US	Uses: Water for irrigation; generation of electricity
	SOFRETES & SINAES	Sine - Saloum	Proposed for 1979					Caisse Central (France)	Uses: Generation of electricity
		Kanel (Fleuve)	Proposed		2 KW				
		Dahra	Proposed		10 KW				
2. PHOTOVOLTAICS	Laboratoire des Semi-Conducteurs	Laboratoire des Semi-Conducteurs	1975 - 1976	20 M^3/day at 12 metres					
	Institut Universitaire de Technologie (IUT)	I.U.T.							
	Pompes Guinard & CARITAS	CARA, Bambey	February 1978	100 M^3/day at 10 metres	900 Watts	RTC solar cells	7.5 m. CFA $34,900	FAC	RTC solar cells replaced twice in one year. Solarex panels now being used instead.
		Babek	February 1978	65 M^3/day at 20 metres	1,300 Watts	Solarex panels	7.5 m. CFA $34,900	Pompes Guinard, Private Sources	Drip Irrigation
		Toki	November 1978	45 M^3/day at 18 metres	900 Watts			Pompes Guinard, Private Sources	Villages took initiative and constructed three small reservoirs, each 3 M^3. One is used to supply water to Babek; a second for all other neighboring villages; and the third for irrigating one large experimental vegetable garden
3. WINDMILLS	I.U.T.	I.U.T.							Domestic water, irrigation
	SINAES	Diagle							Sevanius prototype
	SINAES & CARITAS	L'Oull	Proposed for January 1979	15-20 M^3/hr.					Sevanius
								FED	Aerowatt windmill; Anemometer installed at L'Oull in Septem[illegible] 1978
	Ecole Polytechnique de Thies		About 1978					Canada	Imported from Austria; testing under village conditions.
4. BIOGAS	CARITAS Pere Picard Mr. Reichmuth Kilometre 11 DAKAR	Nianing - Centre de Formation Agricole Adjloukh Fissel		4-6 cubic metres					Uses: Cooking and lighting. Special cookers and lamps imported from India. Primary source material: animal dung.
5. SOLAR DRYERS	I.P.M.	I.P.M.	1976	250 kilos fresh fish in 48 hours		8 M^2 collectors			I.P.M collaborating with I.T.A. to perfect prototype; experimenting with cheaper construction materials (i.e., fibrocement).
	Institut de Technologie Alimentaire (I.T.A.)	I.T.A.							
6. SOLAR WATER HEATERS	I.P.M.	I.P.M.		capacity: 340 litres					
	SINAES	St. Louis (Hotel La Residence)	1978	4 cubic metres (or 4,000 litres)		36 M^2 collectors	5-6 m. CFA $23,255 - $27,900		Experimental construction using cheap, lightweight materials such as polyester
	SINAES	Factory for Mass Production - Dakar	Proposed for 1979						Heats water to 45-50° C. Supplies 36 rooms and kitchen.
7. SOLAR DISTILLERS	I.P.M.	I.P.M.	1975 - 1976	3 litres per M^2/day					SINAES negotiating with GOS for preferential treatment and guaranteed market
8. SOLAR COOKERS	I.P.M.	Faculte des Sciences, Université de Dakar	1978			Parabolic			Abandoned due to low output.
	Ecole Polytechnique de Thies (EPT)	E.P.T.							Prototype; I.P.M. plans to experiment with heat storage
9. OTHER: VARIETY OF EXPERIMENTAL ACTIVITIES	Enseignement Moyen Pratique	Langouak	1974						Windmills constructed with local materials (bamboo, calabashes); solar cooker; rainwater catchment; solar distiller; hand pump. Training facility has since been abandoned.

II - TRIP REPORT

Initial Contacts with Checchi and DGRST

The purpose of my trip was to assist in the early stages of the design of a Renewable Energy Project for Senegal.

I arrived in Dakar on November 3, a few days in advance of the team. I immediately made contact with Ernest Murphy, a consultant to Checchi, Inc. Murphy was in Senegal in conjunction with an AID-financed study on Energy in the Food System and was scheduled to return to the U.S. on November 5. The purpose of our meeting, which had been prearranged in Washington, was to continue coordinating the Checchi study and the project design effort, both of which are energy-related and will involve many of the same Senegalese organizations. Murphy provided me with a list of names and addresses of organizations and individuals he had contacted while in Dakar (See Appendix 2) as well as recommendations on which of these would be most useful for us to contact. This information proved to be very useful to the team.

On November 6 Jim Procopjs (Program Officer, USAID/Dakar) and I met with Mr. Mar of the Delégation Générale à la Recherche Scientifique and Technique (DGRST). The team would be working closely with the DGRST, as this is the GOS agency responsible for coordinating all research and development (R&D) in Senegal. Mr. Mar had been designated the primary DGRST contact (and counterpart) for the design team. Mar opened the meeting by expressing some confusion over the arrival of yet another group of US energy experts (we had been preceded by Kurt Hecht of the National Academy of Sciences and Murphy of Checchi). We responded by explaining that the objective of the current team was to design a project for providing financial and technical support to the appropriate Senegalese organizations in the field of renewable energy. We also noted that we were closely coordinating our work with both the NAS and Checchi. We then set up a time for a second meeting with DGRST after the team's arrival November 7. We asked that Mr. Sene (Director, Division for Innovation and Technological Progress, DGRST) and Mr. Djibril Fall (Director, Institut de Physique et Meteorologique), be invited to participate in this meeting. Mr. Jacques Diouf, the Delegue of DGRST, was out of town until November 11. It was agreed that we would meet with him at the first available opportunity after his return to Dakar.

On November 8, Steedman, Walker, Kassé and I met with Mar, Sene and Fall. (Kooi and Spooner were not scheduled to arrive in Dakar until the following week.) Steedman described the general outlines of the proposed project for Senegal. He also shared with the group his recent experience with designing a similar project in Mali. Mr. Fall summarized the work currently being undertaken by IPM and extended an invitation to the team for a tour of the research lab and compound. The discussion then turned to procedures for designing the project, and the role of DGRST in this effort. Sene indicated that DGRST would make the initial contacts and set up appointments with the appropriate Senegalese institutions. (This decision later proved to slightly delay the team effort, as Sene had other commitments during the week of November 8-16 and was unable to devote time to the needs of our team.) A meeting was, however, promptly scheduled with Mr. Kergreiz of IUT on November 10.

Institut de Physique Météorologique

Dr. Djibril Fall, Director of IPM, gave the team an extensive tour of the research facility and compound. IMP began operations in 1955 and is the principal institution conducting research on solar energy in Senegal. (Other organizations working in this area include the Institut Universitaire de Technologie and the Laboratoire des Semi-Conducteurs de la Faculte des Sciences.) For the past 20 years it has measured solar radiation in close cooperation with the World Meteorological Organization and the USSR (Leningrad). Over the years, prototypes of solar collectors, distillers, fish dryers and hot water heaters have been built and tested. These R&D efforts are discussed below in greater detail.

The IPM has been experimenting with low-temperature flat plate collectors, to be used primarily for pumping water, since 1957. In 1968 a 1 KW "Segal" pumping system was installed on the grounds of IPM and is still in operation today. With a collector surface of 88 m^2, it pumps water at the rate of 5-6 m^3/hour (operating 5-6 hours daily) from a depth of 25 meters. The cost was 17 million CFA. This system was subsequently fabricated and installed by SOFRETES in Senegal and several neighboring countries, including Upper Volta, Mali and Niger.

Seven years later, in 1975, a second prototype was installed at IPM. (This system was not in operation at the time of the team's visit.) The cost of this 1 KW system was half that of the Segal pump, or about 8-9 million CFA. The collector surface was also reduced, for a total surface of 70 m^2. This prototype has since been installed in 4 rural areas in Senegal: Médina Dakhar, Méouane, Niakhene and Diagle. They were manufactured by SOFRETES* and installed by SINAES.** IPM is continuing its research efforts on the flat plate collector with the following objectives: (1) to better adapt the pumps to the local environment and climate; (2) to reduce the cost and (3) to make possible local fabrication and installation by Senegalese industry. Experiments are being conducted substituting plastic for glass for the collectors (to date this has shown little promise) and using a uniform heat transfer liquid.

The IPM is experimenting with a prototype of a fish dryer, based upon the thesis work of a University student in 1966-67. Consisting of 8 m^2 of collectors, it can dry up to 250 kilos of fresh fish in 48 hours. IPM is working closely with the Institut de Technologie Alimentaire (ITA) to test the nutritional qualities and taste acceptability of the dried fish. The traditional method of drying, by laying the fish out in the sun and open air, does not kill the microbes

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*SOFRETES (Société Française d'Etudes Thermiques et D'Energie Solaire) is a French company (based in Montargis, France) involved in research, development and manufacture of solar energy equipment.

**SINAES is a Senegalese firm jointly owned by public and private interests in Senegal and France. It was created to fabricate and install solar systems in Senegal.

in the fish. These microbes proceed to consume the flesh of the fish, leaving behind only skin and bones. It also exposes the food to dust, insects and other foreign objects. The temperatures which can be obtained with the solar dryer are high enough to kill these organisms. And the dryer also isolates the food from foreign objects. If perfected, this technology could have a considerable impact on increasing local food supply (by decreasing post-harvest losses) as well as a positive impact on health (by increasing the amount of available protein and decreasing exposure of the food to bacteria.). A major drawback to widespread adoption of the dryer is its high cost relative to traditional methods, the latter requiring no capital investment. IPM is exploring ways to decrease the cost of the dryer by substituting lighter materials (such as locally produced fibrocement) for wood.

IPM is also conducting R&D on hot water heaters, and is working with a model imported from the Solar Energy Lab (ONERSOL) in Niamey, Niger. The Niger prototype is heavy and expensive and IPM is experimenting with alternative construction materials (such as polyester) which are lighter and cheaper. IPM has recently reached an agreement with SINAES where the latter will mass produce solar hot water heaters.

IPM has done some work with solar distillation and solar cooking. A prototype of a distiller was constructed in 1975/76 but was abandoned due to its low output. A parabolic solar cooker is in the process of being constructed. IPM is now contacting foreign laboratories (particularly in India and the U.S.) in search of heat storage technologies which could be used in conjunction with the cookers.

The purpose of this first visit was to familiarize the team with the work being undertaken by IPM. As Fall noted, we were primarily exposed to IPM's achievements. It was late in the day when the tour came to an end, and Fall promised to share some of the Institute's problems with the team at the next meeting. The team did not return to IPM during my stay in Senegal. However, Kooi (the team's energy technologist) had previously worked with Dr. Fall in 1975/76 and planned to spend considerable time with IPM's staff during the design effort.

We later learned from Jacques Diouf that IPM has recently been designated the primary solar research organization in Senegal, and will be responsible for directing and coordinating all efforts in this sector. It is intended that this action will decrease competition among the various solar energy R&D organizations: IPM, IUT and the Semi-Conductor Lab. To better meet these new responsibilities, IPM will become a separate, autonomous body within the University of Dakar.* The Institute will also be restructured and a tentative organization plan was provided to the team.

ENDA

The team met with Philip Langley who works with ENDA (Environmental Training Program). This is a non-profit, non-governmental international organi-

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*To date, it has been attached to the Faculty of Science.

zation based in Dakar with activities throughout the third world. It is supported by the African Institute for Economic Development and Planning (IDEP, Dakar), the United Nations Environmental Programme (UNEP, Nairobi), the Swedish International Development Authority (SIDA, Stockholm) and the Swiss Technical Cooperation (CTS, Bern).

Langley has compiled information of some solar energy experiments currently underway in Africa, and is in the process of completing a large map of Africa which illustrates the locations of solar energy activities. (See Appendix 3 for Langley's partial listing of renewable energy activities in Senegal.) He recommended that we contact Father Picard at Caritas, who could brief us on the two biodigesters installed at Nianing and Ndjioukh Fissel. He noted that both the IUT and the Ecole Polytechnique at Thies have been conducting R&D on windmills. He also made reference to a private company, Construction Metallique de Thies, which has the capability to build windmills. Langley believes that the possibility exists in Senegal for craft production of simple windmills, and has heard of a welder in Rufisque who has built his own.

Langley had a number of additional suggestions regarding organizations and individuals the team might contact. These are listed below.

- Mr. Bashizi, UNICEF. Bashizi is an expert on administrative reform in Senegal and its implications for local participation in development. He also has an evaluation, written by Mrs. Ngom, on the introduction of diesel grain grinders in Senegal.

- Mr. Massata Gueye, Mr. Seyda and Mr. Keita, Centre d'Extension Rurale (CER). The CER is responsible for providing advisory technical services to rural communities.

- Mr. Faba Diouf, Bureau de l'Aide de Petits Projets, Ministry of the Interior. This office provides assistance in drafting proposals for small projects and identifying potential sources of funding.

- Dr. Lauturz, School of Medicine, University of Dakar. The School of Medicine may be interested in water heating technologies for use in dispensaries.

Institut Universitaire de Technologie

The team was accompanied by Mr. Sene of DGRST to the meeting with IUT.

Mr. Kergreiz, Dean of the IUT, opened the meeting by expressing great irritation for what was apparently a third briefing in a three year time frame for Americans allegedly concerned with energy. He noted that he had been visited by someone in 1975; and again more recently by James Bever of the Overseas Development Council in 1977. He had subsequently received a report from Bever but had

not been otherwise informed of the outcome of Bever's trip. We explained that we were in Dakar to build upon Bever's work. We explained the AID process for project design and approval. Kergreiz expressed impatience with the slowness of AID operations and noted that the U.S. would have to act quickly if it hoped to make an innovative, distinctive contribution to energy development in Senegal. (The implication was that if the U.S. didn't act quickly, other donors would fund the exciting projects and the U.S. would be left on the periphery.) We tried to explain that this was not a U.S. concern, and that the purpose of the proposed U.S. project was to support and build upon on-going activities in Senegalese research organizations, as well as undertaking village-level surveys and installing devices in selected rural sites.

Kergreiz then briefly explained the work being undertaken by IUT. Research is being conducted on various systems for pumping water, including low temperature solar collectors, photovoltaics, and Savonius windmills. Another area of priority is refrigeration (energized with solar cells or windmills) for preserving vaccines, dairy products and vegetables. Kergreiz showed us a dozen technical reports written by IUT personnel on various energy systems, and agreed to share them with C. Kooi. He also indicated that IUT's most pressing problem is the lack of funds to pay salaries of Senegalese technicians. Any assistance AID could provide to meet this need would be welcomed. These technicians would be trained at IUT to work in rural areas.

Pompes Guinard

The team met with Maurice Chermette, the Pompes Guinard representative for West Africa. This French company has installed photovoltaic water pumping systems in several sub-Saharan countries, including 5 in Mali, 1 each in Upper Volta and Niger, and 3 in Senegal. In Senegal, systems have been installed at the Centre National de Recherche Agronomique (CNRA) in Bambey, and in the two villages of Babek and Toki. Installed in February 1978 and financed by FAC, the Bambey pump used RTC (French) solar cells and has a peak power of 900 watts. The water is used primarily for drip irrigation. At the same time a similar system, using Solarex solar cells, was installed at Babek. Financed by Pompes Guinard and private French sources, this 900 watt system pumps 80 m^3/day at a depth of 24 meters. A third system was recently installed at Toki, and went into operation in November 1978. The total cost of the Bambey and Babek systems each came to approximately 7.5 million CFA, or approximately $34,900 (exchange rate of $1 - 215 CFA). Of this, approximately 2.2 million CFA, or $10,200 is for the reservoir and fencing.

The team visited the town of Babek and talked to the village men about the solar pump. We had learned earlier that until recently, the village had no potable source of water. The women of the village were collecting water from a well over 6 kilometers away. Caritas subsequently provided funding for drilling a borehole, which extended 140 meters before fresh water was reached. A handpump was then installed and used until the solar pump was in place.

The Babek system includes a large metal storage tank with a capacity of 20 m^3. The villagers have since constructed 3 smaller reservoirs, each with a capacity of 3 m^3, which are fed by the larger tank. The first reservoir is used by the villagers of Babek; the second by all other neighboring villages; and the third is used to irrigate a 1 hectare vegetable garden. Here, cabbage, carrots,

radishes, beets, melons and tomatoes have been planted by the children of Babek.

We learned that the men of Babek have formed a cooperative, which boasts a membership of 240 people. Membership dues amount to 1,000 CFA per man, and to date the village has collected 170,000 CFA. It was not clear from our discussion with the villagers what this money was being used for, although it appeared that it had financed the construction of the smaller reservoirs. There was also some discussion about plans to form a women's cooperative. We were told, however, that the details for this plan had not yet been worked out by the village men, and we were unable to obtain any further information on this.

Before we left Babek, the men asked us if we could assist in providing construction materials to the village for building several more reservoirs. These would be used to expand the gardening operations. We explained that our team was unable to meet this request, but agreed to relay their message to the Caritas office in Dakar.

We learned from Mr. Chermette that plans are underway to install 30 more pumps in Senegal, to be financed by FED (75%) and the Catholic Relief Service of the U.S. (25%). The Ministry of Hydraulics (GOS) is also seeking French funding for an additional 20 systems. And SODESP, the GOS livestock agency, has requested a proposal from Pompes Guinard for the installation of a 25 KW pump in the region of Ferlo to pump 400 m^3/day at 80 meters.

A major advantage of the Pompes Guinard system is that it requires almost no maintenance. A major disadvantage of the system is that it is, for the most part, a turnkey operation, with little or no participation by Senegalese organizations or villagers. To date the system has operated without a hitch, but if at some future time a technical problem should arise, a technician would have to be sent for.

Mr. Chernette informed us that Solarex (a U.S. company) and Pompes Guinard have just created a new firm, France Photon, based in France, which will begin production of Solarex panels in December 1978.

Pompes Guinard is obviously interested in the Senegal Renewable Energy Project, and sees it as a potential source of business. This interest has been fueled by a U.S. project in Mali which provides financing for the purchase and installation of 4 Guinard pumps. The logical next step is to question the role of Guinard pumps in the Senegal project.

Without prejudging whether or not the U.S. should incorporate photovoltaic pumps in this project, I would like to raise a number of issues which should be given consideration during the design process. First, to what extent does the installation of a Guinard pump meet the objectives of the Senegal Renewable Energy Project to strengthen Senegalese R&D capabilities, to develop potentially replicable solar devices which meet felt needs, and to test these devices in village sites? As noted above, little or no Senegalese participation is involved in the fabrication and installation of these systems (with the exception of the reservoirs and fencing). The high cost of these systems precludes widescale use in the near and medium term. And other donors, primarily the French, may finance the installation of up to 50 additional pumps over the 3 already in operation. One might well

question if the U.S. could better spend its resources and optimize its contribution by supporting some of IPM's work on solar fish dryers and distillers, for example, or in training Senegalese energy experts at IUT. Another possibility is to provide support for the installation of hand pumps, which don't have the allure of solar systems, but nevertheless have the potential for addressing the problem of pumping water in the short-term. These hand pumps are cheaper, thereby being more accessible to a larger number of villages; and they can be produced locally and maintained.

A second issue which needs to be considered is the possibility of justifying a waiver for the purchase of French equipment. Although this was granted in the case of the Mali project, it may become more difficult to obtain approval in the future, given the growing interest of American industry in solar technology and potential overseas markets for this technology. U.S. taxpayers' support for French industry may prove to be a sticky issue on the Hill, even while recognizing that no U.S. firm now manufactures a reliable solar pump. On the other hand, Pompes Guinard's recent agreement with Solarex may minimize this problem.

SINAES

We did not have an opportunity to formally meet with Mr. Marc Frager, director of SINAES, while I was in Senegal. At the time he was busy with visitors from Thermo-Electron and SOFRETES, who were in town to plan for the installation of a solar irrigation pump at Bakel. The team had an appointment to meet with Frager the week following my departure. I did, however, have an opportunity to talk briefly with Frager about SINAES' plans for the future.

SINAES, a local company based in Dakar, was created for the purpose of installing, and eventually manufacturing, solar technology in Senegal. During the first years of operation, it imported 4 SOFRETES solar collector systems which were subsequently installed in the villages of Médina Dakhar, Méouane, Niakhene and Diagle. More recently it has expanded its operations to include windmills and solar hot water heaters. A windmill was installed at Diagle and is operating in conjunction with a solar collector. Another, larger windmill will be installed at L'Ouli in early 1978. SINAES also installed a hot water heater on the rool of La Residence Hotel in St. Louis during the summer of 1978. It provides hot water for the hotel's 36 rooms and kitchen at an average temperature of 45-50° C. According to Frager, this system cost about 5-6 million CFA and will pay for itself in 4 years.

SINAES has recently reached an agreement with IPM to mass produce IPM's design of a solar hot water heater. Frager is now in the process of negotiating with the GOS for preferential treatment (i.e. no duty on imported parts) and a guaranteed market (i.e. government regulation that a percentage of all new construction use solar hot water systems).

The company is jointly owned by Senegalese and French interests, both public and private. Although the GOS currently has the largest single share in SINAES at 23%, the sum total of French interests comes to approximately 65%. (Table 2, although incomplete, gives a general picture of the company's ownership pattern.) The predominant participation by the French in this local company is another reflection of the extent of French support and influence on the development of solar energy in Senegal.

TABLE 2. SINAES: Pattern of Ownership

PARTNER	PERCENTAGE OF OWNERSHIP
Government of Senegal	23%
Private Senegalese interests	5%
S.C.M.T. (Senegalese Company)	1-2%
West African Development Bank	5%
SOFRETES	15%
French Petroleum Company	7%
Renault	13%
Caisse Central	7.5%
SOFEE	7.5%
Briau	?
Aerowatt	1%
Total	86%

Meeting with Jacques Diouf, Delegue of DGRST

The team had its first meeting with Jacques Diouf, the head of DGRST, on November 17. He explained to the team that DGRST was in the midst of developing a research strategy for renewable energy in Senegal. To this end a working group has been formed and includes representatives of IPM, IUT, SINAES and SENELEC, among others. A questionnaire had been prepared, and missions are being sent to each region to learn about local needs. This will be followed by meetings with each region's governor. The national areas of priority, according to Diouf, are for energy sources for: pumping water; cooking; and preservation (through refrigeration) of food and vaccines. He noted that IPM will become the primary organization responsible for undertaking and coordinating research in renewable energy. IPM will become an autonomous body within the University of Dakar, and will be internally restructured to enable it to better meet these new responsibilities. Diouf also explained the institutional setup of DGRST, and noted that the Direction for Innovation and Technological Progress (headed by Mr. Sene) will be responsible for implementing research results.

Steedman then outlined the proposed AID project, informed Diouf of the current status of the design effort, and presented a number of issues for DGRST consideration. The first of these related to the choice of sites for village surveys and tests: the criteria to be considered in choosing sites and how the team should best organize its limited time for visits to the various regions. Diouf listed several factors he thought important, including: ethnicity; ecological zones; production; village size; and the level of technological sophistication. To determine which areas to visit, he recommended that the team meet with representatives of the Amenagement de Territories (Ministry of Planning) and the Direction de Cooperatives (Ministry of Rural Development). DGRST agreed to make the necessary arrangements for the team to meet with representatives of these organizations.

Another issue discussed was the best organization in Senegal for undertaking the village level survey. Diouf's opinion was that ISRA (Institut Sénégalais de Recherches Agricoles) would be a prime candidate for such an undertaking. This organization reports to DGRST, and has specialists dispersed throughout Senegal in such fields as meteorology, economics and agricultural production. Another candidate would be the development societies such as SAED and SODEVA, which are part of the Ministry of Rural Development. Both ISRA and the development societies undertake operations throughout the country, which Diouf felt was a major advantage over a Dakar-based, centralized organization. His preference was for ISRA, as this falls under the control of DGRST and would keep to a minimum the number of organizations involved in project implementation.

The third item on the agenda was to request approval for a team meeting with the appropriate Senegalese organizations to present the project to them for comments and suggestions. A tentative date of December 4 was agreed upon. This would give the team time to incorporate into the project paper any changes and/or recommendations resulting from the meeting.

Toward the end of the meeting it was agreed that the team would return to DGRST the following week with a travel plan. DGRST promised to provide whatever assistance it could, including cables to each region informing the responsible officials of the team's pending visit.

During our meeting, Diouf made references to the other U.S. efforts in the energy field. He noted that the National Academy of Sciences had agreed to provide an energy specialist to assist DGRST in developing the national strategy for energy. He asked that I check on the status of this request after I returned to Washington. (A message was subsequently sent to Dakar on December 1.) He also mentioned the Checchi study, but was skeptical about the usefulness of this exercise.

Fissel-Langomak

Having heard that a number of solar and wind technologies had been installed in the village of Langomak, the team traveled to M'Bour to learn more about this experimental work and to seek permission to visit the site. At M'Bour we were briefed on the objectives and achievements of the Langomak program, which is known as "Enseignement Moyen Pratique" and is administered by Promotion Humaine. We were informed that the center was a training facility for children and young adults, to teach them how to construct a variety of technologies using local materials. As explained to us, the objectives of the center were threefold:

(1) To expose and familiarize rural people to alternative sources of energy based upon the sun and wind.

(2) To demonstrate that technology does not necessarily have to be imported, but can be fabricated on-site with locally available materials.

(3) To attract and stimulate the interest of research institutes (such as IPM and IUT) to provide assistance to rural areas in improving the efficiency of these technologies.

These experimental activities were primarily geared toward meeting needs for water and food preservation. To this end, several windmills had been constructed. One of these had been fabricated with calabashes and had been hooked up to a Savonius motor. Another, designed by a Mr. Sahores, had been made with bamboo and had been constructed in several other countries (Guinea Bissau and Upper Volta). A solar dryer had been constructed and had apparently worked relatively well. It had proven to be cleaner and faster than traditional drying methods. One drawback was its small size and volume. The center also had a solar cooker which had been designed by Mr. Moumouni of the Niger Solar Energy Lab (ONERSOL). It consisted of 2 calabashes, reflectors, and black painted stones. We were informed that there had been a problem with the reflector which prevented the cooker from generating sufficient heat for cooking. It was, however, apparently used for heating wax for the manufacture of candles.

The team then traveled to Fissel where we were joined by the sous-prefet, who accompanied us to Langomak. When we arrived, we found that the center, consisting of approximately a dozen mud and thatched structures, had been abandoned. We inspected the well-site, where we found remnants of a windmill, a solar distiller, and a rainwater catchment basin. Not far away we found another well with a Caritas hand pump, which was still being used by a neighboring village. We returned to the center where we found a dusty solar cooker, a diesel grain grinder, and the remnants of another windmill which had apparently broken during a strong windstorm.

Several explanations for the abandonment of the center were:

- lack of support for the center from the outside;
- lack of fresh water (the well was saline).

It would be interesting and useful to try and piece together the history of the center as a lesson for future activities. The possibility and desirability of reinstating the center should be explored. Perhaps some financial support for this could be provided under the proposed AID project.

Ndjioukh Fissel and Nianing

After leaving Langomak we headed toward the village of Ndjioukh Fissel where Caritas has installed a methane digester. En route we stopped at L'Ouli to take a look at an anenometer, which has been measuring wind speeds since September 1978. SINAES plans to install an Aerowatt windmill at this site sometime in early 1979. The proposed system, to be financed by the FED, will pump 15-20 m^3/hour. This village also has two Caritas hand pumps which were being operated by children. Two small concrete reservoirs had been constructed nearby. A couple dozen cattle were standing around the well, waiting to be watered.

At Ndjioukh Fissel we examined the methane biodigester, designed by a Swiss technician and based upon the Indian model. It was situated on the periphery of the village chief's compound. Primary source material was animal dung, collected by the chief several times a week. Four latrines had been built near the digester, and were connected directly to the digester by a pipe. The methane gas is piped into the chief's compound and fuels a small burner and a lamp. We were given a demonstration of how these worked. We were informed that enough gas is being produced to fuel approximately 6 additional cookers and lamps. However, these appliances are not available in Senegal and must be special ordered from India. Apparently some lamps had been imported but the bulbs had broken during shipment. The sludge produced by the digester is being used as a liquid fertilizer and is applied to the surrounding farm fields.

Our next stop was Nianing, where Caritas has installed a second digester at the Centre de Formation Agricole. This digester was not in use due to a number of technical problems. Also, the cooker was too small and the pressure of the flame too weak for preparing large quantities of food for the students. At the time of our visit, couscous (the local dish) was being prepared with a butane burner.

The experience at Ndjioukh Fissel suggests that methane gas is a potential source of energy in rural areas. However, futher R&D is required before this technology becomes technically and economically feasible.

III - CONCLUSIONS AND RECOMMENDATIONS

Conclusions

To date, the majority of support for the development of solar energy in Senegal has come from France. In 1968, IPM worked closely with the Etablissements Pierre Menoin at Montargis in France in designing and building a prototype of the Segal pump. The Director of IUT, Mr. Kergreiz, is a Frenchman. A French firm, SOFRETES, has manufactured 4 1 KW solar collectors which are now operating in rural areas. It is also working on a joint project with the U.S. and the GOS to install a 60 KW system in Bakel. A second French firm, Pompes Guinard, has already installed 3 1 KW photovoltaic pumping systems in Senegal. Proposals have (or are being) submitted for the installation of an additional 50 systems over the next few years. SINAES, the local Senegalese company responsible for manufacturing and installing solar technology in Senegal, is largely owned by French interests. And the company's director, Mr. Frager, is a French citizen. Plans are underway to install an Aerowatt (French) windmill in the village of L'Ouli in early 1979.

Other donors, including the U.S. and the Germans, are now beginning to show an interest in supporting the development of solar energy in Senegal. In view of the strong historical development of the French, the question to be addressed is how the U.S. can best contribute to this effort without duplicating the efforts of the French. My own feeling is that the U.S. should not necessarily provide additional support to SOFRETES and Pompes Guinard: financing for their systems is already forthcoming from the FAC and the FED. It would appear that the U.S. could optimize its input by supporting some of the important R&D activities currently underway in Senegal which are not receiving the same measure of support as the French-produced solar collectors and photovoltaic systems. An example is the fish dryer being developed at IPM, which, once perfected, has the potential for making a tremendous impact on the supply of nutritious food in Senegal. Another device which could provide an immediate, widespread solution to the problem of pumping water is the Caritas hand pump.

Another area deserving attention, and excluded from the Project Identification Paper for the Renewable Energy project, is reforestation. In the short and medium term, firewood will continue to be the primary source of fuel for cooking in rural areas. Deforestation to satisfy these needs has reached crisis proportions in Senegal. A program of village woodlots in selected sites (perhaps the same sites where village surveys will be conducted and solar devices installed) would begin to address these immediate needs for fuelwood. Such a program, which could begin immediately, would encourage active participation by the villagers in project implementation at the earliest stages. It would also be a demonstration to the villagers that this project will have a tangible, beneficial outcome.

Recommendations

1. AID/W and USAID/Dakar should inform all key GOS contacts of the outcome of the design effort, and provide them with written documentation on the project (either the PP itself or an abridged edition of this document). Mr. Kergreiz of IUT has already been promised this information as soon as it is available.

2. The PP team should give consideration to Kergreiz' request for financial assistance to be used to train and pay for the salaries of Senegalese technicians. This would contribute to strengthening a cadre of energy specialists, a major step toward strengthening local institutional capacity to address national energy needs.

3. A major GOS priority in the energy sector is to develop improved methods for pumping water. In rural areas, women manually perform this task and spend many hours by the well drawing water. Some experimental work is now underway which couples water pumps with solar collectors, solar cells and windmills. These systems are, however, very expensive and are financed by the donor community (particularly the French). Another alternative for the short-term is the use of hand pumps. Several have already been installed in villages by Caritas, and appear to be working well. The design team should consider the role of hand pumps as an intermediate step. These pumps are much cheaper than solar systems (a 1 KW solar system costs from $25,000 - $40,000). These hand pumps reduce the amount of human energy now required to draw water, and offer an economic and technical alternative to solar systems until such time when the cost of these systems decreases and becomes more within the reach of the typical Senegalese village.

4. The team should consider the possibility of including in the project a program for village woodlots. This program could begin immediately after the project agreement has been signed, and would begin to address the need for firewood, the primary source of fuel for cooking in rural areas.

5. It would be useful to learn more about the history of the center at Langomak--its achievements and the reasons for its demise. The team might consider providing support for revitalizing the center, which symbolized local efforts to manufacture technologies meeting village needs and using village skills and resources.

Biodata on Members of Senegal Renewable Energy Project Design Team

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Department of State

OUTGOING TELEGRAM

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TAGS:

SUBJECT:DESIGN OF SENEGAL RENEWABLE ENERGY PROJECT

REF: (A) DAKAR 7107, (B) ABIDJAN 9187, (C) STATE 259051
(D) DAKAR 7569

1. AS PER REFTEL (C), COMPOSITION OF DESIGN TEAM IS AS FOLLOWS: CHARLES STEEDMAN, DESIGN OFFICER; CLARENCE KOOI, ENERGY TECHNOLOGIST, SHEILA WALKER, ANTHROPOLOGIST; MOUSTAPHA KASSE, ECONOMIST; AND CLARK SPOONER, ENGINEER. STEEDMAN AND WALKER SCHEDULED TO ARRIVE DAKAR O/A NOVEMBER 7. KOOI TO ARRIVE ONE WEEK LATER, O/A NOVEMBER 14. CONFIRMATION OF TEAM'S ARRIVAL AND REQUEST FOR HOTEL RESERVATIONS WILL FOLLOW SEPTEL, AFTER SIGNATURE OF IQC WORK ORDER, UNLESS MISSION BELIEVES HOTEL SITUATION IN DAKAR BEHOOVES MAKING RESERVATIONS NOW. BRIEF BIO-DATA FOLLOWS.

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2. ULINSKI PLANNING TO ARRIVE DAKAR O/A NOVEMBER 2.

3. FOR ABIDJAN: VERY PLEASED SPOONER AVAILABLE TO WORK WITH TEAM. NEWSOM

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Mr. Hans Quanjer (Solar Energy Publication)

SENEGAL

Dakar	*Institut de Physique Météorologique (IMP) de la Faculté des Sciences, Université de Dakar : Cuisinière solaire parabolique ; séchoir à poissons ; chauffe-eau solaires ;* *pompes solaires prototypes 1957-66) SOMOR) SECRA) ITTA* *pompes solaires 1966 NADJE 1200l/H* *1968 SEGAL 6m3/H* *1975 ONUDI* *(Publicité SOFRETES ; le Technicien Africain, Jan-Mars-1976 ; Bulletin du SMUH N°80, Ethiopiques Juillet 1976)*
Dakar	*Institut de Technologie, Université de Dakar. Pompe Solaire : capteur incorporé au toit du bâtiment (en construction Nov.1976).*
Dakar	*Laboratoire des semi conducteurs, Université de Dakar.* *Station expérimentale de pompe solaire à base de photopiles.* *(Ethiopiques, Juillet 1976).*
Dakar	*Institut de Technologie Alimentaire (ITA). Séchoir Solaire pour fruits (prévu).*
Dakar	*Ecole Polytechnique de Thiès (EPT)* *Cuisinières et capteurs solaires* *(Informations de Monsieur KOECHLIN).*

Zones Rurales

Médina-Dakhar (Rég.de Thiès)	*Mars 1976*	*4 pompes solaires (SOFRETES 8 à 10m3/H sur 20m.*
Méouane (Rég.de Thiès)	*Prévu Juillet 1976*	
Niakhene (Rég.de Thiès)		
Diagle (Rég.du Fleuve)		

(Publicité SOFRETES ; Le Technicien Africain Jan-Mars 1976 ; Bulletin du SMUH N°80 ; Ethiopiques Juillet 1976).

Ferlo (idem ci-dessus?)	*Projet de Pompe Solaire modèle "Alexandroff" (Stand SOFRETES, Foire de Dakar 1974).*
Fleuve Sénégal	*Prévu en 1976: Central Solaire de 60Kw pour l'irrigation de 100 ha à partir de capteurs solaires de 3000 cm2 ; une turbine pour l'électricité et une pompe. (Le Technicien Africain, Jan-Mars 1976 ; Ethiopiques, Juillet 1976).*
Niagourey Région de Louga	*Centre Rural Expérimental d'Energie : projet géré par la SENELEC avec financement du PNUE. Energie Solaire, énergie éolienne et gaz-biologique recouverte en électricité pour village d'environ 1.000 habitants : exhaure de l'eau, cuisson des aliments; éclairage, irrigation, désalement, réfrigération, climatisation. (Le Technicien Africain Jan-Mars 1976 ; Informations orales).*
Fissel-Langomak (Département de M'Bour, Région de Thiès)	*Centre National de l'Enseignement Moyen Pratique : Cuisinière solaire à calebasse. (Visites personnelles à Langomak ; pour description technique voir Bulletin du SMUH, N°80).*
Dahra (Région de Louga)	*Projet de moteur solaire de 10Kw pour forage (Ethiopiques, Juillet 1976).*

Khartoum	*Institute of Solar Energy and Related Environment Research, University of Khartoum : 2 pompes SOFRETES/ FAC ; Séchoir à poissons (Information Michel BAUMER ; Liste du GRET).*

Source: Philip Langley, Quelques Données sur les Experiences d'Utilisation de l'Energie Solaire (ENDA, Reproduction ENDA/EV/8243, DAKOC-64), pp. 9-11.