

RENEWABLE ENERGY ACTIVITIES IN SENEGAL

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ABSTRACT

Available data suggest that Senegal has considerable potential new and renewable energy resources, including solar, wind, biomass, hydro and peat and lignite. This sector has only recently become established. Existing programmes are discussed. Government and organisational involvement, financing and manpower training are outlined.

INTRODUCTION

Senegal faces two major energy problems: the rising cost of petroleum (CFA francs 81 billion in 1983) which consumes more than 50% of the export earnings and accelerating deforestation (120,000 ha forest destroyed each year).

A programme known as "RENES" (Energy Redeployment in Senegal) has been established which at present constitutes the only reference and guide for action in the energy field until a national strategy has been formulated. Through the RENES programme, Senegal aims to halve its import of petroleum products by 1990 and replace them by local energy resources.

This paper describes the activities and organisations established to promote the development of new and renewable energy resources in Senegal.

AVAILABLE NEW AND RENEWABLE ENERGY

Solar energy

Solar energy has been used for more than 20 years in Dakar where the levels of radiation are recorded routinely. Average values for the area are:

- global radiation : $5.8 \text{ kWh/m}^2/\text{d}$
- horizontal diffuse radiation : $2.07 \text{ kWh/m}^2/\text{d}$

Solar intensities are less well known for the rest of the country. In cooperation with the national meteorological services 9 measuring stations have recently been set up in the interior (Podor, Louga, Linguere, Bambey, Tambacounda, Kedougou, Ziguinchor) in order to evaluate the potential solar energy. However accurate up-to-date solar data are not yet available in these regions.

Wind energy

A dozen national meteorology stations set up at airports measure wind speed and direction. Analysis of data over a period of five years shows that the wind potential which can be exploited in Senegal is limited to a 30-40km wide coastal strip going from Saint-Louis to Sine-Saloum, as well as along the river Senegal from its mouth to Rosso. The average maximum speeds are from 5 to 6 m/s. Further data have been obtained by a network of measuring stations established in recent years throughout the country.

Biomass

Potential sources of biomass in Senegal include: forests and natural vegetation; waste and agricultural by-products; and seaweeds collected on the coast. To these products can be added plants designed to produce domestic fuel. This source is still insufficiently developed in particular for the cultivation of fast growing species such as eucalyptus and graminaceous plants.

A recent study, funded by the Danish government and conducted by GOWICONSULT-ORGATES, on the efficient use of agricultural by-products as domestic fuel has shown the existence of an important biomass potential south of the Kaolack-Tambacounda line whereas biomass resources are rarer north of this line. Projections over 10 years of the available agricultural waste and by-products give estimates of 762,000 tons biomass for 1984-85 and 1,345,000 tons for 1993-94.

Hydroelectricity

In addition to the large hydroelectric power stations (eg Manantali, Kekreti, Sambagalou) important possibilities for mini and micro power stations exist on the Senegal and Gambia rivers. A study financed by CEE and carried out by ORGATEC has made an inventory on the rivers of a certain number of sites that may be equipped with micro water power stations.

Other sources

Although the newly found peat and lignite resources are not renewable they are a an indigenous source of energy. The Nyayes peat bed estimated at 50 million m³, is now undergoing an important development programme. Lignite and mangrove peat deposits are currently being evaluated and exploration is now under way.

Energy conservation measures must be taken into account in defining any coherent energy policy. In a study by a Canadian company Gaucher Pringle, it was estimated that Senegal could save 63,000 TEP in the industrial and transport sectors.

PROGRAMMES

In addition to the solar and wind potential evaluation programme, other programmes have already been implemented or are in the process of being set up by various bodies and institutions.

Heat and thermodynamics programmes

Water heating

The water heater currently marketed in Senegal will be assembled by the Industrial Company for Solar Energy Applications (SINAES) industrial unit now being built in Thies. It is well designed but expensive. SINAES is working to develop a cheaper water-heater made with local materials.

Solar drying

Two types of dryers have been developed for the processing of fish: one at the food technology institute (ITA) and another at CERER. They are respectively:

- a cheap individual small scale construction in the form of a drying tent,
- a semi industrial type with plane collectors designed for cooperative use. A 100 m² model that can dry 750 kg of fish in two days has been in operations at Guet Ndar (Saint-Louis) since November 1983.

Model dryers have also been designed for agricultural products and fodder.

Solar distillation

A modular distiller with a surface of 2.3 m² has been developed. An 80 m² distiller, designed for the CNRA at Bambey, is to be constructed once the tests have led to reliable conclusions.

Pumping

In 1976, four thermodynamic solar pumps manufactured by SOFRETES were installed to provide the concerned villagers with drinking water. Nine years later, none of these pumps are in good working order. More reliable equipment has been designed and will replace these.

Generation of electricity by means of thermo-dynamics line

Design faults have also been a problem in thermo-dynamic projects. The Diakhao power generation station never worked satisfactorily. The project to build a 100 kw generating station in the Fleuve Region has been modified. The thermo-dynamics source initially chosen was abandoned in favour of a photovoltaic option.

Photovoltaic line

Basic research on photocells

The Faculty of Science of the University of Dakar has been carrying out basic research on semiconductors.

Pumping

Several experimental and pilot plants have proved more successful than thermo-dynamic pumps. A programme to develop a pumping system to supply medium range power (25-50 kw) is currently being planned and negotiations for external funding are underway.

Rural electrification

Only one application exists in this area at the moment: the experimental centre for energy in rural areas at Niaga Wolof, where a 5 kw photovoltaic generator coupled to a 4.6 kv aero generator provides the village with electrical energy.

Other applications

Within the programme known as "use of new and renewable energy" a pilot experiment is successfully supplying photocell electrical energy to a health centre at Mont-Rolland.

The Post Office and Telecommunications of Senegal has "solarised" the North axis Hertzian beams situated between Bakel and Matam and plans to do the same with the Hertzian relays between Kaolack and Ziguinchor.

Biomass

Production of vegetable briquettes

A study on the use of agricultural byproducts as domestic fuel was completed in July 1984. This study, carried out by COWICONSULT-ORGATEC, proposed a ten year master plan to use rationally agricultural byproducts. The programme will explore the production of briquettes from agricultural products and their use as domestic fuels.

Fermentation

Various types of methane fermentors are under study, eg at the Senegalese Institute for Agricultural Research (ISRA), the University Institute of Technology (ENSUT) and CERER. These studies are oriented towards the production of methane and promotion of the widespread use of equipment adapted to locally available raw materials and to the social and cultural habits of the rural population.

A feasibility study on the building of a bagasse or sugar molasses alcohol production unit is to be conducted by a Brazilian company.

Gasification and Pyrolysis

A feasibility study of a pyrolysis plant was begun by SONACOS, but abandoned due to the unavailability of the raw materials, groundnut shells. In compliance with the fifth programme of development for Senegal, FED has agreed to finance the construction of a biomass power station. A feasibility study is underway.

The problem of the availability of raw materials, could be solved by the increased production of ground nuts resulting from the completion of dams currently under construction.

Energy conservation activities

Improved Stoves

CERER has developed two types of improved stoves. For rural communities, a wood-burning stove called Ban Ak Suuf has been perfected. This stove, made from clay and sand, consumed 30-40% less wood than traditional open-fire cooking. Moreover, the model currently being encouraged throughout the country has been adapted to local socio-cultural traditions. More than 12,000 stoves have already been constructed. Funding has just been granted to continue the programme, whose objective is to construct 300,000-500,000 stoves.

For urban areas, a charcoal burning stove called Sakanal has been perfected. This metal stove consumes 40-50% less charcoal than traditional malgache stoves.

Peat Development

Combustion tests on briquettes made of a mixture of peat and charcoal have given satisfactory results. Also, feasibility studies conducted by the Senegalese Peat Company on the use of peat as a domestic fuel substitute for charcoal have revealed very interesting conclusions. A plan for the construction of a production centre for peat briquettes has been formulated and presented to financial backers who have already expressed interest in the project. However, the peat plant programme is moving slowly. A counter-evaluation, already underway, has been asked for by the World Bank.

Wind Energy

Research into the development of wind energy has been divided between the Ecole Polytechnique of Thies (EPT) and ENSUT. In the first phase EPT conducted research on rapid rotation windmills (aerogenerators), while ENSUT concentrated on problems with slow rotation windmills and coupling of photovoltaic cells to aerogenerators for pumping.

Upkeep and maintenance of new and renewable energy equipment

The majority of equipment installed in Senegal to date has been for purposes of research and experimentation and therefore, provisions for maintenance have been overlooked during the initial planning stages. Unfortunately, this has often led to difficulties.

To rectify this oversight, 25 million CFA francs was released by the National Energy Fund to SINAES to provide for the upkeep and maintenance of new and renewable energy installations.

Negotiations with France are currently in progress to find a means of repairing new and renewable energy equipment already installed in Senegal.

COORDINATION, STRUCTURE AND RESOURCES

Coordination and structure

Government ministries, institutes and research centres, private industry, and extension organisations, are all involved in the development of policies, research, and exploitation of renewable and alternative energy resources.

Government ministries

The ministries concerned include:

- Ministry for Scientific and Technical Research (MRST)
- Ministry of Industrial Development and Handicraft - responsible for the energy policy of Senegal.

- Ministry of Environmental Protection - which promotes the use of new and renewable energy resources and, in particular, the development of biomass energy.
- Ministry of Rural Development - which supervises the training of personnel selected to operate new and renewable energy equipment in rural areas, as well as promoting the use and development of biomass energy.
- Ministry of Social Development - which supervises the training of users and promotes consumer awareness.

Institutes and research centres

CERER (formerly IPM) was created in 1960 as an Institut de Faculte. Since 1980, it has had the status of Institut d'Universite. Its activities have centered primarily on the evaluation of solar and wind potential, thermal and thermodynamic transformations of solar radiation, follow-up investigations of solar and wind installations, methane fermentation, and finally energy conservation in the areas of improved stoves and building insulation.

ENSUT, besides its intermediate and advanced training programmes, conducts research in a variety of areas: 1) photovoltaic conversion; 2) wind energy machines adaptable to and constructible in Senegal; 3) wind generators; 4) fermentation for methane production; and 5) the biotechnologies of fermentation.

The Senegalese Institute of Agricultural Research (ISRA) is primarily interested in biogas, conducting experiments with various prototypes of methane digesters at its centre in Bambey. The CRODT also examines the fuel potential of algae.

The Institute of Food Technology is responsible for the development of new transformation and preservation methods suited to Senegalese food production. Its efforts have centered on the perfection of solar tents designed for drying fish.

The Faculte de Sciences of the University of Dakar has contributed to two areas of research. Its laboratory for semi-conductors performed fundamental studies on thin-layered photovoltaic material.

Private industry

SINAES was created in August 1976 by the Government of Senegal - which furnished 50% of the capital - and by various partners from the Senegalese and French private sector. It has been responsible for the construction, installation, marketing, and maintenance of solar and wind equipment, and thus has assembled and installed nearly all of the new and renewable energy equipment in Senegal.

Extension of organisations for non-renewable energy resources

SENELEC, as a producer of electricity, is interested in the use of new and renewable energies and participates together with MRST in the implementation of various projects, notably those with an electricity generation component, provided that SENELEC controls the management of these projects.

Personnel

Although important efforts have been made to train local personnel, their numbers remain insufficient to promote a rapid mastery of the development of the sub-sector. They may even be decreasing in number.

To correct this tendency, measures have been examined to promote employment and avoid the desertion of trained personnel. The 1985-89 four year plan will give a prominent place to the fields of new and renewable energies, as did the previous four-year plan (1981-85).

Financing

In order to support the development of new and renewable energies in Senegal, foreign money lenders have agreed to a relatively significant financial contribution. Thus, over the last ten years, more than five thousand million CFA francs have been invested in the sub-sector. Exterior financing, which represents more than 75% of this amount, has been received by Senegal, principally in the form of grants.

Regulations and institutions

In order to encourage the development of the sub-sector, which is still in its initial stages, the government has taken various measures.

Law 81-22 of 25 June 1981 allows purchasers of solar and wind equipment to deduct from their taxes the total amount of money spent to this end.

Circular from the Prime Minister, 10.226 PM/SGG/ECT of 24 December 1972 recommended that all government buildings and certain types of houses built by SICAP and by OHLM should be equipped when needed with solar water heaters.

To support its policy of the voluntary development of new and renewable energy resources, the Government of Senegal created SINAES in 1976. In 1980 SINAES was granted certain tax advantages in order to fulfill its new and renewable energy objectives.

The interest that Senegal accords to the development of new and renewable energies is illustrated on a regional scale by the participation of Senegal, along with eight other countries of the CEAO and the CILSS, in the implementation of the Regional Centre for Solar Energy, headquartered at Bamako.

PERSPECTIVES AND CONCLUSION

The years to come will undoubtedly see the further development of new and renewable energy resources. Its impact on rural life will become increasingly important.

Senegal is a developing country with an agriculturally-based economy, confronted moreover by severe energy and food problems. The exploitation of new and renewable energy resources must become a leading priority in its economic and social development if these problems are to be resolved.

There must be a continuing evaluation of potential new and renewable energy resources and design of practical and economically feasible systems for their application throughout Senegal.

The following priority objectives for the renewable energy programme have been identified:

- Decreased consumption of wood and charcoal
- Pumping of water in rural regions
- Conservation of foodstuff and medicine
- Rural electrification
- Heated water
- Production of petroleum substitutes.

Considering the innovative character and the advanced technical potential of the sub-sector, an effective training policy must be followed to provide skilled personnel to continue developing the sub-sector.

Concerning the transfer of technology and financial support for national programmes, bi and multi-lateral cooperation must be reinforced and diversified as much as possible. These programmes will be formulated exclusively in regard to previously defined objectives.

The problems to overcome are immense. However, past experience has established tested and effective procedures, and Senegal, with the help of friendly countries is better equipped to take up the challenge.