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SEYCHELLES NATIONAL PAPER TO UN CONFERENCE ON NEW AND RENEWABLE SOURCES OF ENERGY, NAIROBI KENYA 10TH - 21ST AUGUST 1981

P. F. SHILTON - RESEARCH AND DEVELOPMENT OFFICER, SEYCHELLES

1.0 Background and Objective

1.1 The Seychelles has just inaugurated an Integrated Energy Project which aspires within a period of 20 years to reduce the dependence of the Republic as far as possible on conventional fossil fuel as its main source of energy. If totally successful, the project will enable the entire Seychelles archipelago to become independent of fossil fuel.

1.2 The project is divided into 3 phases of 3, 10 and 7 years respectively and is designed initially to provide a power supply of the order of 50 - 100 kw for each of the outer islands which are earmarked for development. Concurrent with the development of these small energy packages will be the carrying out of feasibility studies for the production of larger scale power related to the reduction of dependence of the major islands of Mahe, Praslin and La Digue on oil importation. Inherent in the first phase will also be a study of energy conservation and re-use of waste heat, etc. In order to carry out the project, Phase I will require the creation of workshop and laboratory facilities which will be needed to sustain the research and development effort and the start of training of Seychelles counterpart staff in the relevant technologies.

1.3 Phase II will be the establishment of the developed energy packages on the chosen outer islands, the fabrication and/or marketing of energy conservation devices and the mobilization of financial support for the large device(s) should the feasibility studies indicate their economic viability.

1.4 Phase III will be the completion of installation of the small energy packages on such other islands as may require them and the erection and commissioning of the large scale generation method chosen.

2.0 Project Justification

2.1 The provision of an energy package on the outer islands will enable the integration of the island population into the development process of Seychelles as outlined in the Seychelles Development Plan.

2.2 It will also provide for a considerable improvement in the environmental condition of the islanders.

2.3 It could form a basis for technical co-operation with those island states among developing countries such as The Phillipines, Southern Pacific Islands, Mauritius, the Caribbean, etc.

2.4 The present island conditions require improvement in a number of the basic essentials such as health, living standards and communication which improvement could be made possible by the provision of the proposed energy package.

2.5 The Seychelles is an archipelago with a land area of approximately 450 square kilometres and an exclusive economic zone of around 1.05 million square kilometres. The major islands of Mahe, Praslin and La Digue contain some 85% of the total population of around 60,000. It is remotely situated in the middle of the Indian Ocean with severe constraints of communication and supply. It is currently completely dependent upon the importation of oil for energy supplies and, as such, bearing in mind the present global oil situation, is in an extremely vulnerable position. The ability of the Government to achieve its national goals is totally dependent upon the accessibility of energy and, while there is no oil shortage at the moment, oil comes at a price and there is a considerable degree of urgency for the provision of alternative energy sources.

2.6 In view of the lack of both raw materials and an industrial base, there are few sources of revenue available to the Government which are not at risk, for example tourism. The savings of importation costs, both by the achievement of an energy policy unrelated to oil, the implementation of a research and development capability and the promotion of a scientific and technological ability will play a great part in reducing the vulnerability of Seychelles in the economic sector.

2.7 The major problems in implementing the project relate to a lack of infrastructures, appropriate technology and a data base and it would appear that these areas should be the first target. There are also problems related to the restriction of options due to the location of the Seychelles and the limitations of both manpower and natural resources. It would further appear that the technologies which are required to be used for the project are still to a large degree in an experimental phase and already some difficulty in obtaining "state of the art" reports from comparable schemes has been experienced.

2.8 Attempts to alleviate this situation have been made by close liason with both the African and Asia/Pacific regions under the aegis of the Commonwealth Science Council's various energy projects, while high level bi-lateral contact has been established with various countries to obtain assistance on both the manpower and technological fronts. Furthermore the Government has implemented an expanding system of education within which is proposed the establishment of a Polytechnic which will provide higher education locally.

2.9 The original conception for the project has come about both as a result of a likely continuing crisis relating to oil supply and, perhaps equally importantly, the need to develop the whole archipelago as an integrated system with greater production capacity.

2.10 An essential feature of the project which will enable both the pilot scale project and ultimately the total energy problems to be solved will be the establishment of a suitable laboratory and test bed facility equipped with relevant instrumentation, workshops and assembly bay, without which adequate monitoring of the success of the project stage by stage cannot be made.

2.11 It is to be hoped that during the next 5 - 10 years the "state of the art" of the more hopeful of the potential large energy producers such as wave power, tidal power, etc., will have clarified and because of the Seychelles location will provide an even greater potential for large scale energy production.

2.12 It is the present intention of the Government to establish in the near future 2 x 100 kw gasification plants on the islands of Coetivy and Farquhar respectively and enquiries in respect of suitable hardware have already been instituted by the Seychelles Electricity Corporation whose responsibility it will be, with manufacturer's assistance, to instal and commission the units and to supply the requisite distribution network. These units will most likely be of the mixed fuel type with spiking by fuel oil thereby giving an element of flexibility to cover maintenance, shut down and biomass shortage possibilities.

3.0 Solar Energy

3.1 Introduction

The diffuse nature of solar energy is a definite advantage in the developing world where the energy demand is low and oil or other fossil fuels are expensive. In many areas there is not as much need for high density energy sources as there is in developed countries. Thus, solar plants of the appropriate kind could soon be competitive in warm developing countries such as the Seychelles.

It would certainly be inconceivable to chart medium to long range objectives here without considering solar energy. Below will be discussed the various types which are of immediate interest to the Seychelles.

3.2 Water Heating for domestic and industrial applications

For small units, freedom from maintenance is essential and efficiency is relatively of secondary importance. Later on solar air conditioning, refrigeration and freezing could be considered. However, for the time being, the technology in general is not sufficiently developed for consideration in the first phase with certain possible exceptions. The equipments which would be tested are simple flat plate collectors, and possibly, compound parabolic collectors or CPC's.

3.3 Process Heat for a variety of industrial applications

A great number of industries e.g. laundries, dairies, food canning and processing plants, breweries, etc., require not only hot water, but also low pressure steam which could conveniently be produced by arrays of CPC's located, for instance, on the roofs of the buildings or over parking lots. Alternatively, CPC's could produce hot air for copra and other crop drying applications in the field.

3.4 Power Generation

A bank of CPC's could be used to produce steam directly to drive generators via conventional prime movers or small steam turbines. This option could be of great relevance to the island energy package and perhaps later for the overall energy scheme.

3.5 Photovoltaic Electrical Power Generation

Photovoltaics are not yet cheap enough for commercial power generation. However, they may be economical for specialized applications such as radio beacons, communication equipment, etc., in remote areas and as such bear a direct relevance to the island energy package.

Therefore Phase I should take a look at the performance of a small cell bank to consider the environmental effects and to establish the validity of the system as a whole.

3.6 Proposed Laboratory Programme

The objectives of Phase I in the solar field are as follows:

1. Gather insolation data in locations which appear favourable for solar energy use.
2. Test compoments for flat plate and CPC collectors for domestic and industrial hot water.
3. Develop an integrated package of which certain components could be locally fabricated and others bought in for a typical house or a small industrial enterprise.
4. Test components for CPC collectors for industrial use (low pressure steam or hot air).
5. Determine manufacturing and operating costs for the above collectors.
6. Purchase and test under local conditions a small solar voltaic array.
7. Determine under which conditions and locale the above systems will be competitive with diesel generated power.

4.0 Biomass Gasification

4.1 Introduction

A biomass gasifier converts wood, residues and other biomass forms to a gas which can be burned in existing gas and oil burners for heat and power or in engines for power and transport. Gasification allows a retrofit of existing oil and gas combustion equipment and immediate use of renewable biomass supplies. Whenever liquid fuels become scarce or too expensive, the gas generated will allow operation of existing spark or diesel engines for power generation, transportation and heavy machinery use.

Moreover, in the not too distant future, low grade coals alone or mixed with biomass, could be processed in biomass gasifiers, thus obviating the need to use oil in power generation. Gasification of wood or low grade coal is an old technology which needs updating for application to new needs. Today, pre-commercial units of novel types are being demonstrated and units essentially derived from Second World War technology (Duvant, Imbert, etc.) can be purchased.

4.2 Proposed Programme

To start with, existing pilot facilities of the moving bed gasifier type, probably downdraft, will be identified in order to test our local feedstock e.g. coconut husk and successful tests might lead to the purchase of a small capacity unit for test runs on Mahe and subsequently implantation on a selected outer island.

It is possible that the newer fluidized bed type gasifier be selected, for instance the Omni-Fuel gasifier which claims to be able to gasify almost any kind of biomass or low grade coal.

Additional tests will involve feedings gas from an air-blown gasifier into a diesel engine and determining how much diesel fuel can be saved, probably 90%. More advanced gasifiers of the fluidized bed type, are being developed which would produce medium BTU gas and would require no injection of diesel fuel.

4.3 Tests will be carried out in collaboration with both the Agricultural Department and the Island Development Corporation to establish the feasibility of growing hybrids such as leucaenia or casuarina as an intercrop with coconut, thereby increasing the potential biomass yield of the outer islands.

5.0 Windpower

5.1 Introduction

Given favourable regimes the use of wind for power generation and for water pumps can be a most promising factor of resilience for a country. The power extracted could be as much as 77 kw/square kilometre. Spacing between units should be at least 30 times their diameter due to retarding effects on the earth's boundary layer. The most important parameter is the average annual velocity of the wind.

5.2 Programme

The main objective is to establish a data base on wind availability across the archipelago. If time and money permit the following will be done :

- Produce detailed climatological data and energy available contours for favourable locations.

- Find the wind velocity distribution pattern in time.

- Determine the probable duration of any high wind speeds for safety purpose (Furling velocity of the windmills).

- Determine the extent of calm periods using wherever possible existing meteorological data in order to reduce the number of detailed local studies.

- Carry out design studies to define the size and type of machine best suited to local needs and how to interface the output with existing electrical networks.

- Test a small unit circa 10 kw on a suitable island location.

6.0 The major islands of Mahe, Praslin and La Digue

As will be realized from the above there exist in Seychelles two basic and perhaps relatively unrelated energy problems that of the outer islands and that of the main islands where the majority of the population are concentrated and where the major power requirement exists.

It would appear that given the present "state of the art" in regard to power production as outlined in 3.0 to 5.0 above, allied to limiting factors of solar radiation, wind and available biomass in Seychelles, the production of a major power source within these frameworks is unlikely to be achieved.

6.1 The existing power requirement for Mahe alone is presently some 10MW which is projected to increase by 1985 to 13.6MW and by the year 2000 to 25.6MW. Even assuming the introduction of restrictive tariffs combined with consumer education and the introduction of an off-peak bonus it is unlikely that a reduction of this projected demand by more than about 13% could be achieved, which would result in demands on the same time scale of 10.0, 12.5 and 21.6 MW respectively. It is obvious therefore that an alternative solution requires to be found and it would seem that the sea which is everywhere in close proximity would present the most likely option.

6.2 In this context three alternative possibilities present themselves:

(a) Wave Energy

(b) Tidal Energy

(c) Ocean Thermal Energy (OTEC)

In regard to (a) and (b) there are certain constraints mainly in respect of the ecological and tourist elements of our economy. Seychelles is a tourist paradise and the construction of vast areas of concrete to impound water particularly on the coast, would detract to an unacceptable extent from the natural beauty of the island(s).

It is also true that both the wave patterns and the tidal range of only about 1.5 metres would be unlikely to allow exploitation of such schemes economically.

This leaves the third option, that of Ocean Thermal Energy to be explored and based on our present rather limited knowledge of the requirements we feel that there might be a definite potential for macro-power generation in the Seychelles, using this method.

It is understood that a mini OTEC is currently operating as a pilot scheme in Hawaii and although it is of low power generation capability it would appear to be fulfilling the design requirements with a minimum of problems. It is well known that the up-scaling of such technologies can create a host of unforseen problems but we have been informed that the capability for construction of, and the availability of hardware for, a unit of 10 MW output capacity presently exists and that those concerned with the OTEC systems are interested in finding a suitable site for its implantation.

Given that 10 MW of power could substantially fulfil our present demand of generated power, for the whole of Mahe, the installation of such a system, which would no doubt be regarded as a pilot plant for most other countries, would be capable of providing the necessary design data for larger systems. It could, at the same time, achieve the object of Phase III of our Integrated Energy Project, in making Seychelles the first country in the world to be independent of fossil fuel for electrical generation. What better project could be envisaged for International co-operation.

7.0 Several constraints have already been indicated in regard to particular systems, for some of which, solutions can be envisaged, whereas others appear to be insoluble, either presently, or in the foreseeable future. Perhaps one of the most serious is our lack of a technological base and the infrastructures that such a base implies.

7.1 Our total population of 60,000 is about equivalent to that of a village in Europe and in which such village could one reasonably expect to find the level of expertise required to run the technological background of a whole country.

It is felt that this constraint can be removed provided that overseas bursaries can be provided for the training of Seychellois in the relevant technologies and that sufficient funds are made available to build and equip the laboratory and test facilities needed. As an interim measure employment of expatriate staff would appear essential, preferably through aid schemes.

7.2 Seychelles is basically devoted to two industries, Tourism and Copra and contains virtually none of the basic raw materials needed to sustain an industrial base in the generally accepted form. Furthermore the very limited local market stifles attempts to develop industry save perhaps in the agricultural and construction fields. Even there all the available arable land is limited to some 10,500 hectares while practically all the materials of construction such as steel and cement require to be imported.

7.3 Our position in the centre of the Indian Ocean over 1500 kilometres from the nearest continental land-mass, that is Africa, means that Communications are inevitably difficult and expensive and the capability to reduce fuel importation by some R20,000,000 per annum, would substantially assist the importation of basic essentials and raw materials, in order to generate an industrial base.

7.4 Because of this relative isolation it is essential that liason with countries having a technological capability in Alternative Energy be developed and maintained and to this end a National Research and Development Council has been set up which will work closely with the Research and Development Section of the Ministry of Planning and Development and also with other Ministries and Authorities such as the Electricity Authority, etc.

8.0 Conclusions

8.1 There is little doubt that two very different energy packages based on non-fossil fuel are required for Seychelles.

The first of the order of 50 - 100 kW per package is to satisfy the outer island energy requirements while the latter, of the order of 10MW in the first instance, is required for Mahe. The latter might also be considered as a supply for Praslin and La Digue together with other local islands within a reasonable transmission radius of Mahe.

8.2 In order to achieve this, the generation of a technological base and the provision of suitably qualified staff, is essential. Implicit in this section is the training of local staff to take the place of temporary expatriate expertise.

8.3 Financial and technological assistance will be needed in substantial amounts to ensure the completion of the project over the whole of the project period of some 20 years.

8.4 Successful completion of the project, would give the world a pilot plant scale model needed for the generation of larger and better alternative energy production, directly related to actual working conditions. It would equally importantly upgrade the living standards and secure the independence of the Seychelles Nation in energy.

Appendix I

Seychelles Oil Imports (1979)

Total value of imports R 115 Million (US $ 18.5M)

Volumes (in millions of Tons)

Internal Use

	LPG	138
	Aviation	360
	Petrol	5,545
(1)	Kerosene	2,204
(2)	Gasoil	18,782
	Others	595
	Total =	27,624 (37% of total imports)

Re-export

(3)	Jet A1	24,604
(4)	Gasoil/Diesel	20,603

(1) Used mainly for lighting and cooking

(2) Primarily for electricity generation

(3) Aircraft

(4) Marine

Appendix II

Electricity Consumption Analysis (%)

Lighting	14.81
Water Heating	14.07
Refrigeration	12.59
Cooking	7.87
Ironing	2.34
Air Conditioning	17.43
Process Plant/Motors	19.02
Telecommunications	1.38
Pumping/Drying	4.91
Miscellaneous	5.58
	100

Electrical Energy Pattern (1979)

A typical distribution pattern for electrical consumption for a 24 hour cycle shows a minimum of 3.7 MW and a maximum of 8.9 MW with peaks of 7.8 MW between the hours of 0900 - 1300 and 8.9 MW between the hours of 1800 - 2100.

Projected Demand (1970 - 2000) MWh

1970	6
1975	25
1980	45
1985	65
1990	85
1995	101
2000	125

Appendix III

Meteorological Data - Seychelles Airport Sea Level

Month	Insolation (Mean of 3 years)	Sunshine Hours (Mean of 8 years)
January	4.77	4.8
February	5.31	6.5
March	5.76	6.7
April	5.52	7.5
May	5.87	9.1
June	5.57	7.9
July	5.63	7.3
August	6.92	7.8
September	6.55	7.8
October	5.54	7.5
November	5.62	7.1
December	4.45	5.3
Yearly Average	5.59 KWh/m^2	7.1 hours

Note:

The above figures are undoubtedly influenced, but it is not known to what extent, by the generation of local cloud cover from the mountains directly behind the Airport.

Wind Speeds (1980) Seychelles Airport (10m)

A wind speed mean of 4.03 m/sec. with maximum record gusts of around 21 m/sec have been recorded from November to March NW and April to October SE in direction.

Appendix IV

Population

Estimated Projections (1978 - 2003)

Total Population

1978	62,150
1983	68,740
1988	76,380
1993	84,350
1998	92,700
2003	101,440

Working Population

Year	1976	1977	1978	1979
Private Sector	9,650	10,300	9,125	9,300
Public Sector	5,275	5,725	6,225	6,975
Total	14,925	16,025	15,350	16,275

Tourism

Year	1976	1977	1978	1979
Arrivals	49,500	54,500	65,000	78,900
% Transit	6%	9.4%	11.6%	12.8%
Beds Available	1,870	2,040	2,360	2,520