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PAPER ON NEW AND RENEWABLE

SOURCES OF ENERGY

IN JAMAICA, WEST INDIES

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UNITED NATIONS PAPER

SECTION A.

1. BACKGROUND

Jamaica is one of the developing countries that are most adversely affected by the rising price of oil. This is particularly so due to:

i) Imported petroleum represents 99% of the island's commercial energy consumption;

ii) Jamaica is a major producer of bauxite and alumina producing two-thirds of the country's export earnings and utilizing approximately 50% of imported petroleum;

iii) Jamaica's energy utilization is among the highest in the developing world. This is in part due to the fact that much of it's industrial base is energy intensive, and oil dependent. It's per capita energy consumption is 8.0 Bbl. per annum of fuel oil equivalent.

iv) Jamaica currently has little or no conventional resources. For these reasons if economic growth is directly related to available energy, the case for the development of alternative energy sources is very strong.

2. POLICY

Because of the country's vulnerability to imported oil, Jamaica has developed an Energy Policy of which the primary objectives are:

i) To reduce dependency on imported energy and diversify the present energy supply mix of the Jamaica energy system;

ii) To accelerate exploration for energy resources and the development of new and renewable energy supplies.

These policies are represented in the country's energy plan indicating priority objectives:

a) Short-Term (1-3 years) - are largely those dealing with Conservation measures and programmes. Enhanced energy conservation by conducting comprehensive energy end use surveys and a national publicity campaign aimed at persuading domestic, commercial and industrial and public sector consumers to take simple conservation measures to reduce energy utilization, through increased efficiency which in some cases will involve retro-fitting. Other elements of this conservation will include fiscal measures. There will also be R & D towards the introduction and establishment of all the feasible renewable energy resources (e.g. solar, wind, biogas) as soon as possible during the 1980's.

b) Mid Term (3-5 years) - are largely concerned with energy supply and demand diversification. Diversification of the present energy supply mix based on detailed technical studies including:

   (a) coal and peat as alternative fuel for electricity generation;

   (b) utilization of garbage as fuel;

   (c) utilization of municipal sewage for methane gas generation;

   (d) further implementation of all economically feasible renewable energy sources to meet local energy needs. This phase particularly refers to medium and small hydro projects;

   (e) rationalization and implementation of an efficient and appropriate transport policy. For example the use of barges and increased use of the railway for transporting heavy and bulky goods. Efficient low energy urban and rural transportation for people is also being studied for implementation

c) Long-Term (over 5 years) - are largely concerned with institutional development, major energy projects, new and emerging renewable energy technology development, and energy planning and coordination. These are based on the following:

i) Energy development measures

(a) A major oil and gas exploration onshore and off-shore on the Pedro Banks.

(b) Completion of all the hydro-electric feasibility investigation and implementation of the mini and the mid and western hydro projects as well as the phased implementation of the Multipurpose Blue Mountain Hydro Project.

ii) Energy Planning and Coordination

(a) Continued development of the Energy Division with responsibility for policy planning analysis, coordination, and monitoring of the implementation and the efficient functioning of all energy projects programme in Jamaica

(b) Offering enhanced encouragement and leadership in all sectors of the Energy Development programme. These will include support for training, research development and investment for the various national energy programmes.

3. ORGANIZATION

To emphasize the importance Jamaica attaches to the area of energy, the former Ministry of Mining and Natural Resources was re-structured and re-named the Ministry of Mining and Energy in 1979.
The Division of Energy within the Ministry:

- Co-ordinates and influences all energy related projects,
- encourages and promotes research, development, demonstration and

implementation of new and renewable energy projects and technologies,

- designs national energy models of the islands energy resources,
- estimates, monitors, and influences current, and future energy needs and formulates (conventional and non-conventional) energy policies and programmes.

4. INSTITUTIONAL INFRASTRUCTURE

The Energy Division of the Ministry of Mining and Energy has an established Staff Structure (see Table I). It provides the major thrust in the research, development and implementation of new and renewable energy sources, and in the evolution and execution of strategies for their use.

Advisory arms of the Ministry are the "Alternative Energy and the National Advisory Council on Energy Conservation" committees.

The Division is supported in research and development by -

(a) The Petroleum Corporation of Jamaica, who is the principal implementing agency of the Ministry.

(b) The College of Arts, Science and Technology (Solar.)

(c) Scientific Research Council and the University of the West Indies (Biomass).

(d) The Bureau of Standards.

Other interrelations of the Ministry include the Jamaica Public Service Co., Ministry of Agriculture, the Ministry of Finance in the planning and procurement of funds and project implementation, Forest and Natural Resources Conservation Department. (See Table II for Co-operative Working Relationships).

5. MINISTRY STAFF STRUCTURE

Refer to Appendicies, Table I.

6. POSSIBLE ROLE OF NEW AND RENEWABLE RESOURCES

In view of present world trends in the cost, projected demand for petroleum in Jamaica (say 5%/yr.), and the increasing difficulty for the country to provide foreign exchange to meet increasing costs, the role of new and renewable resources attracts a new dimention of importance.

An assessment of renewable energy in 1979 indicated that by the end of the decade, sound and steady diversification of the energy resources could result in 38.1% of total energy needs being supplied by non-oil resources.

The areas of diversification and contribution are as follows:

Solar	3.5%	(approximately)
Biomass	6.8%	"
Coal fired/electrical generation	13.4%	"
Conservation	14.4%	"
	38.1%	

Developments in Hydropower in the second decade could amount to an additional 20%. Consequently, by the end of the 20th century new and renewable resources could provide approximately 50% of the total energy demand.

7. ASSESSMENT OF NEW AND RENEWABLE ENERGY RESOURCES

Since 1978-80 Jamaica has initiated -

i) Preliminary Assessments have been done in the following areas of renewable energy:

   (a) Solar Energy - Commercial and Industrial.

   (b) Solar Energy - Agricultural.

   (c) Biogas Applications.

   (d) Energy Conversion from Waste.

(e) Preliminary investigation in Ocean Thermal Energy Conversion.

ii) Prefeasibility Study - Blue Mountain Multipurpose project (hydro/domestic and irrigation water).

iii) Feasibility Study - Mid-Western Hydro projects.

8. PROJECTS - EVALUATION

PROJECTS	STATUS	FINDINGS
Solar Water Heating	Feasibility Study	a) Most cost-effective when replacing electric or LPG water heating. b) Marginally cost-effective when replacing diesel water heating. c) Not cost-effective when replacing Bunker C. oil.
Solar Cooling	Feasibility Study	- Not cost-effective.
Solar Crop Drying	Feasibility Study	- Systems components and research data needed to establish economically feasible system.
Biogas Applications	Feasibility Study	- National Biogas programme is economically and technically feasible. Five-year programme recommended.
Energy Conversion from Waste	"	- Economically Feasible - but waste collection programme is improved.
Hydro-electric (Great and Rio Bueno River)	"	- Technically feasible.

PROJECTS	STATUS		FINDINGS
Coal	Pre-feasibility Study	-	Coal-fired plant is cost-effective. Feasibility Study recommended.
Blue Mountain Multi-purpose Hydro/Water	Pre-feasibility Study	-	Economically feasible-need Technical Feasibility.
Ocean Thermal Energy Conversion (OTEC) Wind.	Pre-feasibility Study	-	Environmentally feasible. Require economic and technical study.
Geothermal	Economic Survey	-	Assessment study being initiated.
All Island Mini-Hydro Study	"	-	To be initiated.
Solar Thermal) Photovoltaic)	"	-	Pending Development of Technology.
Nuclear Energy	"	-	Not feasible.

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SECTION B

ECONOMIC ASSESSMENT

OF

NEW & RENEWABLE ENERGY SOURCES

JAMAICA

In the long term Jamaica has a variety of options to develop a comprehensive programme and energy-mix to subsequently reduce the dependency on imported oil.

The major problem is not the lack of renewable energy sources but the economic requirements, management, research and development of some technologies to be technically and economically acceptable.

The variety of energy mix which can be considered are -

i) Solar Energy a) commercial and industrial
b) agricultural.

ii) Biogas Applications

iii) Energy Conversion from Wastes

iv) Biomass

v) Hydro-electricity

vi) Solar Thermal

vii) Ocean Thermal Energy Conversion

viii) Wind Energy

ix) Photovoltaic

x) Geothermal.

ASSESSMENT

1) a) SOLAR ENERGY - Commercial & Industrial

Jamaica's high level of solar radiation (450 langleys/day) and relatively moderate ambient temperatures provide an ideal climate for the implementation of proven solar technologies. The immediate potential lies in the area of water heating for residential, commercial (hotels) institutional (hospitals) and industrial users.

Solar cooling though having a high utilization is not yet proven cost effective even with high performance collectors.

b) Agricultural

Jamaica offers ideal conditions for the utilization of practical, proven, low cost solar systems for the drying of agricultural crops. The programme can help to eliminate spoilage, preserve agricultural products for non-harvesting periods and hence reduce consumption of fossil fuels.

Immediate requirements to establish an economic programme for solar energy would involve -

a) Establishment of solar radiation stations;

b) development of air-tight solar collectors;

c) research and development of agricultural crop drying characteristics;

d) establishing design standards;

e) training programmes for engineers and technicians;

f) improvement in the manufacturing sector of the industry;

g) tax incentives.

2) BIOGAS - APPLICATIONS

Jamaica has many conditions which lend themselves to the successful application of biogas as an alternative energy source. Most of the economy is agricultural and survey indicators viz. climate, temperature, animal numbers and agricultural wastes show that biogas application is economically feasible and adaptable in Jamaica.

3) ENERGY CONVERSION FROM WASTES

Two previous studies here indicated a refuse volume of 100 tons/day in the Kingston Metropolitan area, and the recovery of energy from waste is technically and perhaps economically feasible using the preferred technology of Water Wall incineration.

The immediate problem is the successful recovery of the urban wastes.

Immediate requirements:

a) Feasibility survey for the development of smaller units outside of or within the Metrolopitan area.

b) Improvement and investments to achieve an efficient Garbage Collection Service.

4) BIOMASS FIRED ELECTRICAL GENERATION

Due to the inherent fact that Jamaica is an agricultural base country, there is an abundance of organic wastes in agro-industries i.e. the banana, coconut, coffee, sugarcane, forestry and general agriculture as primary sources of biomass.

Available technologies for conversion into energy are:

direct combustion or partial pyrolysis to charcoal tar and gas or complete pyrolysis or gasification.

The most likely feasible method is direct combustion to electricity.

The immediate need: An island Biomass survey of incidence quality and quantity and generation characteristic to establish the real potential and mechanism for utilization.

5) HYDRO

Hydro power availability in Jamaica is not very large, but the reliability and low operational costs of this resource is accepted. The main disadvantage is its high capital costs. Hydro power can become more cost-effective if the civil works component can be reduced. Present installed capacity of hydro power in Jamaica is 20.1 mw with an annual generation of 131,229 mwh or 10.1% of the Jamaica Public Service generation in 1975.

Jamaica has additional potential of four categories -

i) The Blue Mountain Multipurpose Project = 220 GwH/yr.

ii) Mid-Western projects = 51. GwH/yr.

iii) Small Hydro projects = 17 GwH/yr

iv) Mini Hydro projects proposed for assessment.

The potential if developed within the next 10-15 years could provide an additional installed capacity of 65 mw or approximately 30% of the Jamaica Public Service Co. generation (1980).

The immediate requirements: Funding for technical economic feasibility and implementation.

6) SOLAR THERMAL

No assessments are presently available for the conversion of solar energy into electricity due to the State of the Art Development.

The immediate needs: Funding for feasibility and demonstration plants.

7) OCEAN THERMAL ENERGY CONVERSION

A brief overview of the OTEC potential of Jamaica by SWEDISH OTEC, identified three (3) favourable sites on the North Coast between Montego Bay and Annotto Bay. Commercial OTEC plants are planned by the USA and Japan. Since the access to the national grid system is relatively easy, Jamaica should have a strong case in the site selection. No decision is yet taken.

Immediate requirements:

i) Collection and evaluation of geological, geophysical, bathymetric, oceanographical and meteorological data.

ii) Lobbying for Jamaica as a site for a demonstration plant.

8) WIND ENERGY

The minimum requirements for the utilization of wind in generating electricity is 12-14 mph. Studies have indicated the average wind speed in Jamaica as 7 mph.

The energy potential therefore for electricity is minimal, however, a programme is planned for an Island Wind Survey to indicate the most favourable sites.

9) PHOTOVOLTAIC

There is a potential for the use of photovoltaics due to Jamaica's radiation factor; the utilization will depend on the economic development of the technology.

10) GEOTHERMAL

The potential in Jamaica is now being preliminarily surveyed.

TECHNOLOGIES OF INTEREST

i) Solar Thermal (energy conversion).

ii) Ocean Thermal Energy Conversion.

MAIN CONSTRAINTS

The primary constraints in the development of projects are -

i) Financing for -

a) Research and Development.

b) Feasibility Studies.

c) Implementation.

ii) Education and Training - of Managers, Engineers and Technicians.

iii) International Banks acceptance of marginally economic projects since the Social Economic Appraisals are not considered in prioritization.

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SECTION C

OCEAN THERMAL ENERGY CONVERSION

AND SOLAR THERMAL

These two of the new and renewable energy sources now thought to be on the verge of commercial viability, Jamaica considers them to be the two most likely to make contributions to its specific energy needs. As a number of prototype installations are now being considered, Jamaica would like its advantages as a potential site for demonstration units to become internationally recognised. Among the more important factors which weight heavily in Jamaica's favour in this regard are the following:

1. Geography

There is great potential for OTEC in Jamaica. A temperature gradient of more than 20^0C can be found at several locations along the Jamaican coasts.

Along the northern coast, the continental shelf is narrow and the continental slope is steep. For most of the length of that coast, the distance from shore to the 100 meter isobath varies from about 0.5 kilometers to 2 kilometers. In places, the width of the continental shelf is less than 1 kilometer and the continental slope is nearly vertical.

2. Solar Thermal

In the past, the radiation measurements in Jamaica were carried out for total incident radiation. This means that no information is available for the direct and diffuse components, and these have to be estimated by calculation.

A radiation survey is currently in progress but the scope of the project must be analysed before the siting and dimensioning of any project.

3. An integrated Electrical Grid

The publicly owned Jamaica Public Service Company is the sole electric utility in the island. The company's system is totally integrated and power fed into any point of the grid could conceivably be distributed throughout the island. It is estimated that fifty percent of households island-wide and about ninety percent of urban households now enjoy the advantages

of electricity. Thus the benefits to be derived from an OTEC plant would be distributed throughout a wide cross-section of the community.

Connecting the OTEC plant to the national grid would present no significant problems. The most suitable location for such a plant would be off the northern coast, for OTEC, and East of the island for STEC which would also provide favourable conditions for inter-connection with existing or planned transmission of distribution systems.

With an installed generating capacity of about 400 megawatts and a peak demand of approximately 240 megawatts the utility's system size is especially appropriate for the size of demonstration units now planned at about 10 megawatts. Units of such a size on that system would be large enough to be significant in the overall generation picture and would provide realistic operational experience but at the same time would not be so large as to create system upsets should the reliability of the prototypes be lower than that of conventional generating units.

4. Operational Costs

Because more than ninety percent of Jamaica's electricity is produced from oil, the kilowatt hour costs are relatively high. If the utility were to purchase the power from OTEC at the cost of the power it replaces a significant contribution would be made towards the operating costs of the demonstration unit. This is especially so as the OTEC power would most probably replace the more costly power from the older, less efficient thermal units.

5. Communications

Jamaica's communication facilities with foreign countries are excellent. By the standards of most developing countries, the infrastructure for domestic communication is also very good.

6. Skill Resources

A reasonable level of industrialisation results in the availability

of a variety of technical skills, should as would be required in the installation, operation and maintenance of the plants.

7. Conclusion

Despite the advantages listed above, a data gathering program is needed to determine with certainty the most favourable locations for both demonstration plants and to predict what performance can be expected. Jamaica has already begun such a program, but there is need for specialised assistance from abroad.

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TABLE I

ENERGY DIVISION

MINISTRY OF MINING AND ENERGY

ORGANIZATION CHART

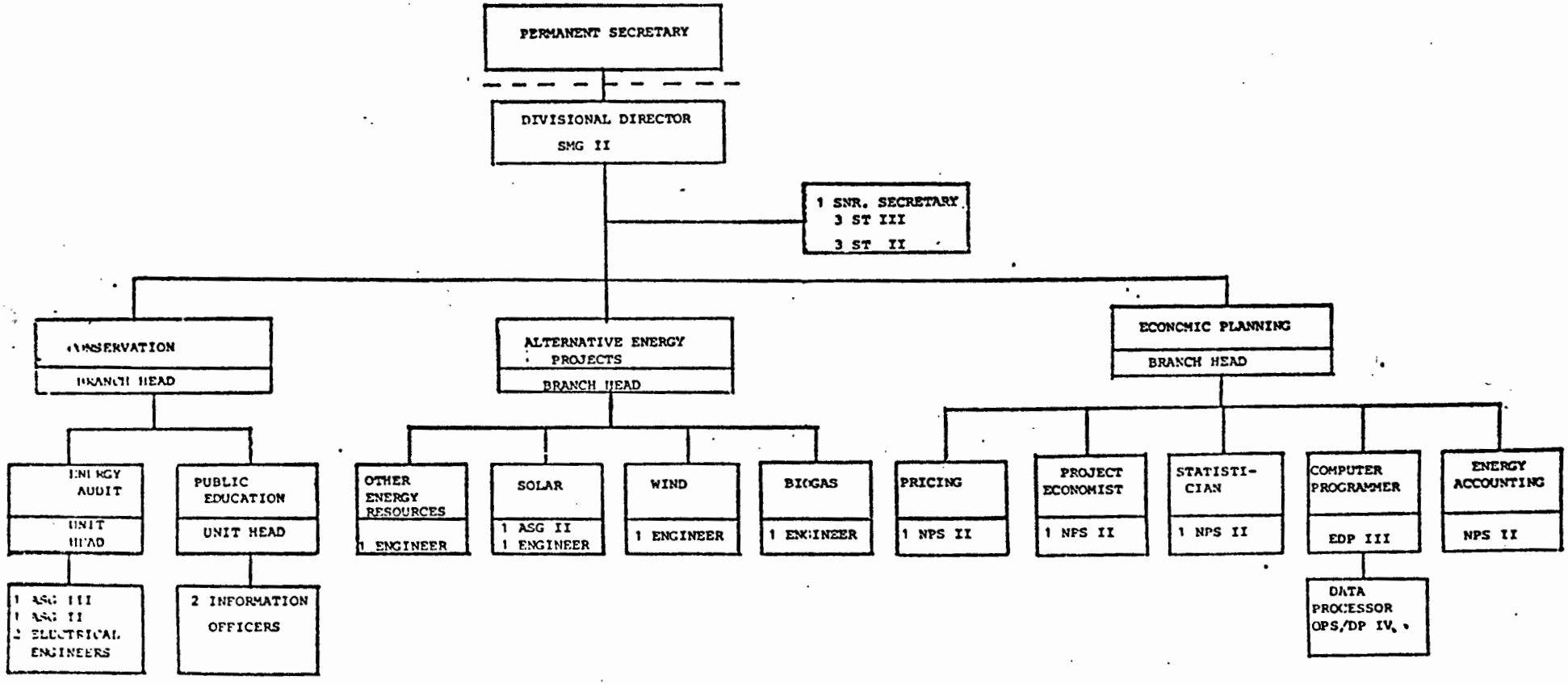

CHART SHOWING COOPERATIVE WORKING RELATIONSHIPS WITH
ENERGY DEPARTMENT - MINISTRY OF MINING & ENERGY