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NON-UTILITY GENERATION OF ELECTRICITY IN BARBADOS: OPPORTUNITIES, NEEDS AND IMPEDIMENTS

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I. INTRODUCTION

A. BACKGROUND

In most developing nations expanded electricity supply to both urban and rural areas is a priority. Due to the expansion of their economies and the major influx of people into cities from rural areas, national governments and utilities must meet expanding urban demand. They must expand supply in urban areas to assure delivery of expected minimal levels of service and in rural areas assure that electricity is used to help create conditions which will keep or attract people and economic activity. Utilities are having difficulty in expanding their generation, transmission and distribution capability in light of national economic problems, competing priority areas for government investment, institutional and manpower limitations and their poor financial conditions. In addition, developing country utilities often rely almost entirely on imported oil as fuel. Except for hydro-based generation, other country-held and renewable energy resources have not been used or developed. It is evident that new and creative mechanisms are needed to encourage the utilization of renewable energy resources.

A candidate mechanism which has proven to be a very powerful stimulator of increased electricity generation and supply capacity in the U.S. is PURPA (the Public Utility Regulatory Policy Act of 1978). This legislative and regulatory package was directed at stimulating off-system or non-utility generation of electricity by private and public sector entities using renewable energy resources and technologies. PURPA is recognized as having been very successful in creating new economical and reliable supplies of electricity, especially through private sector investment. In California alone, alternative energy based electricity generating capacity almost quadrupled from 1981 to 1983. In this time period, cogeneration supplies rose from 200MW to almost 800MW and an additional 5,500MW

were being developed. Because of its success in the U.S., it has been identified as a possible model for developing country activities.

B. OBJECTIVE

This project involved a preliminary investigation of the past, present and future of renewable energy based non-utility generation and sale of electricity in several countries. The status and potential of private sector renewable energy based cogeneration (electricity generation by a private sector entity such as an industry) and the sale of excess capacity to a utility was also investigated. This study covered Barbados with some consideration also given to other eastern caribbean nations. Barbados was selected as a study site because of its similarities to other island countries and for the lessons which could be useful to other nearby Eastern Caribbean countries. In addition, Jamaica and the Dominican Republic were also visited and are treated separately. The principal objectives of the study as stated in the Scope of Work (Appendices) were to provide a study for AID and host countries that:

- Analyzes the existing electrical system and identifies policy, legal, regulatory, institutional and technical impediments to private sector generation of electricity for sale to the utility.
- Identifies renewable energy opportunities for the generation of electricity for sale to the national utility grid.
- Provides recommendations to foster private sector renewable energy based electrical generation in each country.

The nature and history of the U.S. Public Utility Regulatory Policies Act of 1978 (PURPA) was used as a principle source of information and comparison in this study. PURPA, an historic piece of U.S. energy legislation, requires that U.S. utilities buy power from private sector generators which primarily use renewable energy sources. It allowed private sector entities to generate and sell electricity under certain specific conditions without having to become

a public utility. The selling price was defined as the utilities avoided cost or which is essentially their marginal cost of generation. Implementation of the act was slow due to utility resistance and other problems which were ultimately resolved in court cases. However, the successful resolution of major issues and the major stimulative impact it has had on the development of non-utility renewable energy applications can be instructive. It has been particularly successful in California where the government actively used it to encourage renewable energy development in the utility and private sectors. It has also been shown to provide an economical and reliable additional source of electricity to help utilities meet demands without expansion of their oil based generating capacity. The goals of PURPA to stimulate the use of renewable energy resources by non-utility generators are also important in other countries and it was felt that an investigation of the potential for PURPA or other types of stimulative arrangements would be valuable in the countries covered by this study.

C. APPROACH AND TEAM

The study reported on in this volume is based on a one week visit to Barbados during which a two-person team met with a wide range of people to discuss renewable energy based Off-System Generation (OSG) of electricity and collect information. The team visited those institutions and individuals known to be involved in or considering regulation, generation and/or sale of electricity. Meetings were prearranged by local USAID Mission personnel and by team members. Additional meetings were scheduled with others as a result of information gained and contacts made while in-country. The project scope of work was explained and used as the basis of each meeting.

The E/DI Barbados team included Dr. James D. Westfield and Mr. Shibu Dhar. The one week visit, though short, was very efficient and was supported by the Mission's advance scheduling and the considerable background and relevant experience of the E/DI team members.

D. REPORT ORGANIZATION

The overall project includes consideration of Off-System Generation (OSG) of electricity and PURPA applicability in three countries. Because of this, three separate country reports have been prepared and the results of visits to each country are covered by the individual reports. However, because there are common elements and findings of interest to all readers the reports contain a number of identical sections. The format and organization of each report is also standardized.

The information presented in each report is organized to define the present situation and preview the future with respect to private sector renewable energy based generation of electricity. The use of PURPA and its status in the U.S. provides a benchmark to measure and illuminate opportunities, needs and impediments in each country. Report appendices contain detailed information which may be useful for selected readers as background and backup to portions of the text. The chapter presenting the summary, conclusions and recommendations is specific to the country. A separate volume presents a summary of the findings and recommendations of the study as well as background material on PURPA.

II. SUMMARY OF FINDING AND RECOMMENDATIONS

A. INTRODUCTION

In the Caribbean, as elsewhere, the financial condition of the electric utilities, struggling economics, and the general scarcity and cost of new capital makes service expansion and the transition away from imported oil long, difficult, and costly. More than ever before, the Caribbean countries are facing an era of limited financial resources. Capital investments by the Governments and their electric utilities, and the private sector must be efficient because there will be many demands on the available resources. Governments must also look to balancing the countries' interests in growth and development, preservation of environmental quality, and conservation of resources. Finally a program encompassing the elimination of barriers and the creation of incentives is needed to encourage the use of renewable energy resources and private sector participation in the energy field.

In eastern Caribbean countries one of the principal options which consistently meets the tests described above is the development and use of renewable and efficient alternative energy sources - solar, wind, biomass, small hydro, geothermal and cogeneration. Focussing public and private attention and capital towards these options should be one of the Government's main policy objectives for the electricity sector. The following policies and recommendations can help in this effort.

B. SUGGESTED ELECTRICITY POLICIES FOR BARBADOS/EASTERN CARIBBEAN

- To encourage private investment in energy efficiency and oil substitution through policy direction, and establishment of appropriate avoided-cost payments to small renewable resource based generators.

- To remove existing institutional barriers to using renewable and efficient energy options, including natural gas (Barbados) and cogeneration, in order to reduce reliance on oil.

- To continue to provide public and Government leadership in demonstrating renewable energy technology use.

- To consider using the approach taken to stimulating solar hot water in stimulating OSG and the use of other renewable energy technologies.

C. RECOMMENDATIONS

1. The Government should continue to remove technical uncertainties and regulatory/institutional barriers to the development of economical energy options.

The Government and utilities should initiate a series of utility policies, experiments and demonstrations to identify and resolve problems of integrating intermittent energy sources into utility electricity grids. They should also work with other agencies such as those which grant permits and those which could be substantial users (such as the water authority) to eliminate stumbling blocks and encourage examination of opportunities. A major barrier to private sector investment in renewable energy based electricity generation is the uncertainty of power purchase terms, siting requirements and long term commitment to private sector generation.

In the Caribbean islands several of the alternative energy sources, including wind and bagasse offer great promise but may produce electrical energy only on an intermittent basis. Integrating the energy from these dispersed sources into the utility grid presents both technical and managerial challenges. To expedite the introduction of alternative energy resources into the utility electrical system, each island's regulatory agency should authorize and direct the utility to define the system operating requirements of dispersed energy technologies. In addition, renewable energy based cogeneration power, wherever it is found feasible, should be examined by utilities to define how it can best be integrated and taken advantage of.

2. The Government should establish policy guidance for the use of renewable energy as a substitute for imported oil.

The Governments should consider introducing legislation or taking other policy guidance actions which will make it clear to utilities and the private sector that the development and use of renewable energy resources is a priority. Any public or private entity which can participate in the switching from imported oil to other indigenous energy resources should be encouraged to help. With respect to the electricity sector, the Governments should be clear in their commitment to help and encourage the transition to non-imported oil based generation.

3. The utility should develop and publish policies for dealing with off-system generators.

Subjects such as electricity purchase contract terms, avoided cost formulas, amounts of electricity they desire to purchase from others, availability of lines for wheeling, etc. should be defined.

The PUB should require BLP to adopt a set of regulations covering power buy back including conditions, price and requirements. BLP should also be required to develop a position and calculate and publish its rates for line leasing or "wheeling".

4. The Government should modify the Energy Cost Adjustment Clause (ECAC) mechanism to reward utilities who reduce imported fuel costs and to penalize utilities who fail to use available alternatives to reduce such costs.

Under the present ECAC mechanism, utilities, BLP in Barbados for example, are generally allowed to pass on to their customers the added costs of fuel price increases. These increases are typically imposed by fuel suppliers on the utilities. However, because oil fuel price increases may not be preventable, utilities should be encouraged to develop the capacity to use available, less expensive alternatives.

The purchase of electricity from private sector generators using renewable energy sources is one way to do this. Utilities are also not required to meet a minimum combustion or conversion efficiency and thus fuel adjustment pass throughs may be excessive. The PUB should consider requiring BLP to meet minimum combustion efficiencies or have their fuel adjustment charges reduced. This could act as an incentive for utilities to investigate alternative fuels.

5. Other agencies which offer help to OSG's should be publicized.

Programs such as regional development bank financing programs should be made known to potential OSG's. In Barbados, for example, the Caribbean Financial Services Corporation funded by USAID, Canada's AID organization, private banks, etc. has low interest money for qualifying regional energy projects. This could be a place for potential private sector generators to look for help especially if their project involved use of a renewable energy resource.

6. USAID should consider supporting the Governments in some of the above activities by offering technical assistance and entering into policy dialogues.

AID can be particularly helpful by making technical assistance available to the Government in areas such as legislation creation, assistance with standard OSG/utility contracting formats, calculating avoided costs, etc. They can also help by including, where possible, off-system generation emphasis in other projects and programs which they fund.

III. BARBADOS STATUS

A. BACKGROUND

Barbados, the most easterly of the Caribbean islands, lies immediately east of the Windward Islands, about 460 kilometers (270 miles) northwest of Venezuela. The island of Barbados measures 21 miles from north to south and about 14 miles from east to west. It has an area of about 166 square miles and a population of about 250,000. The Barbados Light and Power Co. Ltd. (BLP) is an investor-owned utility which operates under a franchise agreement (of Barbados Companis Act of 1955) and has the right to generate, distribute and sell electricity throughout the island. Approximately 52 percent of the total number of shares is held by the Government of Barbados and Barbadian private individuals. Prior to 1977, Canadian International Company was a major foreign share holder (46 percent of total shares) of BLP. However, after the liquidation of Canadian International Power in June 1977. Baldwin United Corporation of USA acquired those BLP shares.

B. UTILITY STATUS

The historical average peak electricity demand growth rate for Barbados for the last 8 year period (1976-1984) was 6.1 percent per year. The system peak for 1984 was 59.5 MW. The BLP forecasted annual growth rates for peak and energy demands are 5.6 percent and 5 0 percent respectively for the short-range period (up to 1987). The present system load factor is about 70 percent which is an indication of relative less variation of seasonal demands.

BLP's installed capacity in 1984 totalled 119.5 MW. The BLP generates its electrical power at two locations, Spring Garden and Garrison Hill. The location and size of the existing generating units

are included in Table III-1. In Table III-2, the electricity production and sales statistics summary for the 1976-1981 period are included.

At present, BLP does not have any plan to develop alternative energy technology resource such as solar, wind, biomass, cogeneration, etc., for electrical generation capacity during the next 10 years. However, they are participating in a wind turbine demonstration and are purchasing nominal amounts of electricity from two independent power producers. Detailed discussion of non-utility generation in Barbados is included later in this Chapter.

Oil and gas-fired plants will continue to make up 100 percent of BLP's capacity for the foreseeable future if the current trend of electricity production continues. However, the following major policy changes could alter the present resource mix for the BLP system:

- Removal of the natural gas distribution "bottle-necks" so that more natural gas can be burned for electricity production and thereby displacing imported fuel oil (diesel oil).
- Implementation of appropriate legislative acts which will promote private investments in the alternative energy resource development and sale of electricity to the BLP system at an equitable rate.
- Successful completion of the wind turbine electrification demonstration. This is problematical and BLP is presently skeptical about the chances of any appreciable contribution of wind turbines.

1. Fuel Use

A total of four different types of fuel are used by BLP to generate electricity. The Garrison diesel units burn predominantly No.2 distillate diesel oil, but depending on its availability from the adjacent refinery, a distillate known as "gas oil" is sometimes used which is heavier and cheaper than conventional diesel oil. Both diesel oil and gas oil are pumped from the refinery to the Garrison plant.

TABLE III-1

EXISTING GENERATING UNITS OF BLP SYSTEM

UNIT	YEAR INSTALLED	TYPE OF GENERATION	RATING IN KW
		GARRISON	
14	1960	Diesel	1,600
15	1963	Diesel	1,600
GM 1	1964	Diesel	1,600
GM22	1964	Diesel	1,600
GM 3	1965	Diesel	1,600
		GARRISON Sub-total	8,000
		SPRING GARDEN	
1	1967	Diesel	2,100
2	1967	Diesel	2,100
3	1967	Diesel	2,100
4	1967	Diesel	2,100
5	1967	Diesel	2,100
6	1969	Diesel	4,500
7	1969	Diesel	4,500
8	1971	Diesel	4,500
9	1971	Diesel	4,500
10	1982	Diesel	12,500
11	1982	Diesel	12,500
G.T.	1973	Gas Turbine	18,000
S 1	1976	Steam Plant	20,000
S 2	1976	Steam Plant	20,000
		SPRING GARDEN Sub-Total	111,500
		TOTAL GARRISON AND SPRING GARDEN	119,500

TABLE III-2

BARBADOS LIGHT AND POWER CO. LTD
GENERATION AND SALES STATISTICS - 1976 to 198

ITEMS	1976	1977	1978	1979	1980	1981
Peak Load - MW	40.4	43.2	47.8	51.0	53.3	56.4
Increase on prev. year - %	12.8	6.9	10.6	6.7	4.5	5.8
Gross Generation -MW. hr.						
Steam	79,882	212,289	210,843	229,554	251,046	261,630
Diesel	141,318	49,296	73,486	75,648	63,318	68,908
Gas Turbine	10,360	2,120	2,680	10,253	7,170	12,100
Total	231,560	263,705	287,009	315,455	331,534	348,638
Load Factor	65.3	69.7	68.5	70.6	70.0	70.6
Auxiliaries' Consumption MW. hr.	11,912	18,153	17,599	16,860	19,209	20,044
Auxiliaries' Consumption %-Gross Generation	5.1	6.9	6.1	5.7	5.8	5.7
Net Generation - MW. hr.	219,648	245,552	269,410	297,594	312,325	328,594
Sales - MW. hr.						
Large Power	78,679	86,640	92,605	103,922	108,001	118,696
Secondary Voltage Power	46,153	54,167	60,613	67,004	65,638	70,552
General Service	9,940	10,526	13,265	17,638	20,700	19,986
Domestic	60,462	66,860	72,602	79,260	82,994	86,724
Employee	822	833	860	909	894	939
Coin	68	59	49	42	40	17
Street Lighting	3,628	3,931	4,004	4,001	3,838	4,202
Total	199,752	223,016	243,998	272,776	282,105	301,116
Increase on prev. year - %	6.3	11.6	9.4	11.8	3.4	6.7
Losses - % of Net Gen.	9.1	9.2	9.4	9.2	9.7	8.4

Table III-2 (continued)

ITEMS	1976	1977	1978	1979	1980	1981
Numbers of Customers						
Large Power	111	113	113	116	134	142
Secondary Voltage Power	1,142	1,225	1,287	1,362	1,263	1,443
General Service	4,070	4,284	4,471	4,623	5,004	5,163
Employee and Coin	435	417	413	415	461	456
Total Metered	59,864	61,684	63,761	65,771	67,662	69,713
Average Consumption per Customer - kW. Hr./yr						
Large Power	708,820	766,726	819,513	895,879	805,978	835,887
Secondary Voltage Power	40,414	44,218	47,096	49,195	51,970	48,893
General Service	2,442	2,457	2,967	3,815	4,137	3,871
Domestic	1,117	1,202	1,263	1,338	1,365	1,387

The gas turbines and diesel units at Spring Garden are fueled by distillate diesel oil. This fuel is transported from the refinery to the station by road tankers. The boilers of the steam plant burn primarily Bunker "C" residual fuel oil but since October 1980 have also been retrofitted with auxiliary burners which use natural gas as fuel. At present a limited amount of indigenous natural gas is available for electricity generation due to distribution pipeline "bottle-necks". The annual natural gas usage is generally less than 10 percent of the Company's total fuel consumption.

The January 1982 BLP's fuel costs and consumption of the various fuels are summarized in Table III-3.

2. Transmission and Distribution System

Figure III-1 illustrates the major 24 KV transmission lines of the BLP system. There are seven 24 KV to 11 KV substations in the system which allow the primary distribution feeders (11 KV) to cover the entire island. The total length of 24 KV transmission lines is approximately 36 miles of which about 3 miles are underground cables in the City of Bridgetown. The 11 KV primary distribution network consists of about 770 miles of overhead line and 60 miles of underground cables in Bridgetown.

In 1981, a transmission and distribution upgrade program was initiated which includes conversion of about 250 miles of 11 KV distribution lines to 24 KV level and approximately 9 miles of 24 KV lines to 69 KV double circuit steel tower transmission lines between Spring Garden and two substations near Bridgetown. Also, overall power factor improvement is continuing. The short-range investment program for the BLP system is given in Table III-4.

TABLE III-3

FUEL COSTS AND CONSUMPTION OF BLP SYSTEM

	Fuel Types	1982 Costs Per Long Ton	1981 Consumption in Tons
1.	Bunker "C"	BD$ 384.0	85,209.185
2.	Natural Gas	BD¢ 24/cubic meter	1,048,516 cubic meter
3.	Gas Oil (Garrison only)	BD$ 533.83	505.913
4.	Diesel Oil		
	- delivered to Garrison	BD$ 728.00	21,194.721
	- delivered to Spring Garden	BD$ 760.00	

1 U.S.$ = 1.98 BD$

TABLE III-4

BLP SHORT-RANGE INVESTMENT PROGRAM

(all figures are in BD$)

Items	1980	1981	1982	1983	1984	1985	Total
1.Generation	3988	40942	36547	23587	17481	27182	149727
2.Transmission	285	1020	5211	6449	-	-	12965
3.Substation	2174	3384	6702	6128	419	439	19246
4.SCADA	-	376	1276	-	-	-	1652
5.Distribution Feeders	526	1907	1430	1790	1753	1398	8804
6.General Property	5703	8360	3601	5522	6175	7239	36600
TOTAL	12676	55989	54767	43476	25828	36258	228994

3. BLP Rate Structures

The rate structures shown on page III-10 are those which became effective on May 15, 1983. Usually, BLP requests a rate hike every two years to the Public Utilities Board appointed by the Government. The requests for rate revisions have been based on an acceptable rate of return on the rate base consisting of the sum of fixed assets, cash working capital and materials and supplies less accumulated deferred taxes.

A brief summary of present rate schedules for different customer classes is given below:

a. Domestic Service

For service to residential customers for lighting, cooking, heating, refrigeration and incidental domestic power in individually metered dwelling houses and apartments which are used only for private residential purposes:

i.	Fixed charge	BD$3.00/month
ii.	Energy charge (subject to fuel clause adjustment)	
	First 100 kWh	@ 17.6¢/kWh
	Next 900 kWh	@ 19.6¢/kWh
	Over 1000 kWh	@ 21.6¢/kWh

Minimum bill is BD$30 per month. A discount of 10 percent is provided for payment within ten days of issue of the bill, but does not apply to the fuel clause adjustment.

b. General Service

For lighting, combined lighting and power service to non-residential customers for which no other rate schedule is provided:

i.	Fixed charge	BD$5.00/month
ii.	Energy charge (subject to fuel clause adjustment)	
	All consumption	@ 22.6¢/kWh
	Minimum bill	BD$5.00/month

c. Secondary Voltage Power

Applicable to all customers (except street lighting) for single or three phase supply at standard secondary voltage conditions.

i. Demand charge

- BLP owned transformers BD$4.00/month
- customer owned transformers BD$3.00/month

ii. Energy charge

(subject to FCA) @ 20.6¢/kWh

Minimum bill. The minimum monthly bill shall be the appropriate demand charge plus the charge for the first 50 kWh/KVA of billing demand, which monthly bill shall not be less than the equivalent of a billing demand of 5 KVA plus 1000 kWh of energy at the appropriate rate.

d. Large Power

This rate is applicable to all customers (except domestic and street lighting) receiving supply at primary voltage.

i. Demand charge BD$3.0/KVA of billing demand

ii. Energy charge

(subject to FCA)

All kWh consumption 19.6¢/kWh

Minimum bill. The demand charge but for not less than 100 KVA of billing demand is the maximum measured demand of the current month of the maximum measured demand of the previous 11 months, whichever is greater.

C. NON-UTILITY GENERATION

At present in Barbados there is no specific legislative or regulatory mechanism which promotes non-utility generation and sale of electricity either to BLP or to any other potential user (Chapter IV contains an analysis of the existing legislation and identifies elements which could be useful). However, there are several self-generating industries on the island which generate electricity

for their own use. The two major private industries at present generating significant amounts of electricity are Barbados Sugar Industry, Ltd. and the Arawak Cement plant. The installed capacity of the cement plant is 12 MW and the maximum demand is approximately 8 MW. However, the cement plant is using oil/diesel as a fuel and interconnection and buy/sell decisions should be based on efficiencies and use patterns. At present there is a 40 kW wind turbine operated by the Free Energy Ltd., which is fully owned by the C. O. Williams Electrical Ltd. The electrical output of this wind turbine is used by the C. O. Williams Electrical Ltd. almost 90 percent of the operating time. The remaining 10 percent of the time, electrical energy is supplied to the BLP grid.

In the following subsection a brief discussion of the two non-utility electricity generators and their terms of agreement with the BLP is included.

Barbados Sugar Industry, Ltd. (BSIL)

The supply of electricity to the BLP started in an experimental fashion in 1980 at Four Square Sugar Factory. Various minor institutional complications limited the sale of electricity during the first year of trial. In 1984, the sales of electricity to the BLP have been as shown below:

	Sugar Factory	Total kWh Sales to BLP
1.	Andrews	114,000.00
2.	Four Square	226,560.00
3.	Portvale	795,000.00
	TOTAL	1,135,560.00

BSIL is working on additional improvements to the generating systems and expects to make a further increased sale of energy during the 1985 crop year. In good weather reaping seasons, BSIL expects to generate 500 kW electricity for sale almost continuously at Four

Square. At Andrews, they are hopeful of 700 kW on a continuous basis, and possibly 800 kW at Portvale.

The current electricity purchase price by the BLP is based on the fuel surcharge only and on the average in 1984 it was 12 BDc/kWh. BSIL feels that a considerable national benefit can be derived from their sales to BLP through savings of foreign exchange normally required to purchase fuel oil. Their total electricity output can be further increased by retrofitting existing boilers to higher steam pressures and incorporating natural gas burners for off-season electricity production. The main reasons for the present low production of electrical power in the three factories are:

- use of low steam pressure
- use of back pressure turbo generators
- high steam consumption for processing

It is clear that the electrical energy potential of bagasse is indeed considerable in Barbados and expanded use could help the country to reduce oil imports. To maximize the use of this renewable source of energy, it is necessary to consider the following two factors:

1. Implementation of legislation and development of government and BLP policies on expanding the composition of the avoided cost formula so BSIL can recover its investment in a reasonable time period.

2. Additional investments are required by the BSIL to improve the existing system by:

- increasing steam and power production from a given quantity of bagasse;
- decreasing the amount of steam needed for processing;
- enhancing the full value of bagasse through drying and densification.

At present BSIL does not have any plan for additional investment to improve the electrical output which can be sold to BLP. This is because the capital necessary for expansion is not available and the payback from expanded sales does not justify the investment.

2. Wind Projects

There is one wind project in operation in Barbados, which is a privately owned (C.O. Williams Electrical Ltd.) 40 KW wind turbine and is now interconnected with the BLP system. A letter of agreement has been signed by the C.O. Williams Electrical Ltd. with the BLP which allows them to feed surplus energy to the grid. At present only 10 percent of the turbine up-time energy output is supplied to the BLP system. A second project, (an IADB funded 200 KW project is to be implemented by 1986. The feasibility study for this project is in the final phase. After the successful completion of this project, the turbine will be sold or given to BLP or removed from the island. A tentative letter of agreement has been signed with the BLP for interconnection with the main grid. The details of future use of the turbine are not yet agreed to. CDB is also planning the installation and use of a small wind turbine on the island. The application site and user has not yet been decided upon.

The electric energy purchase rate from the existing C.O. Williams 40 KW wind turbine is similar to the BSIL agreement, i.e., based on the fuel surcharge only. At present it varies between BD 10¢/kWh and 12¢/kWh.

3. Other

There are also two private diesel based cogeneration operations at the Catelly Food Products and the Rum Distillary. The name plate rating of each unit is 250 KVA. No electricity is sold to BLP from these operations but is used internally.

D. REGULATORY BACKGROUND

1. Authority to Supply Electricity

The regulation of electric utility in Barbados is based on an "Act to facilitate and regulate the supply and use of electricity for lighting and other purposes and to confirm certain provisional orders made under the Electric Light and Power Act", December 8, 1899. This Act regulates every local authority, company or person who may, by any provisional order granted under this Act or by any special Act, be authorized to supply electricity within any area and to every undertaking so authorized on the island of Barbados. The electric utility, BLP, does not have the exclusive right to generate and sell electricity in Barbados. The Minister may from time to time, by provisional order, grant to any local authority, company or person the right, which may include an exclusive right, to supply electricity for any public or private purposes within any area and for such period as the Minister may think proper, but subject to the following provisions:

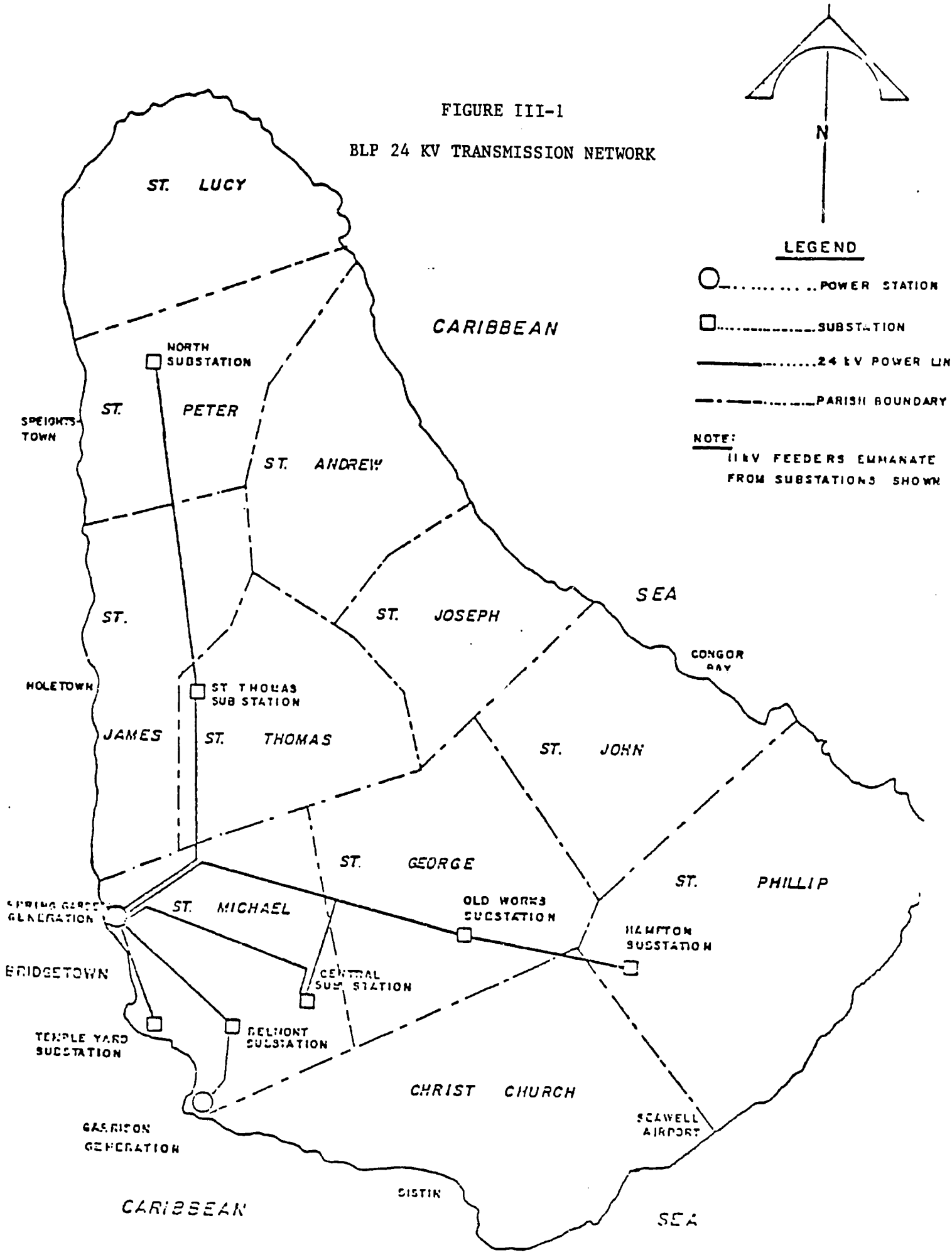
- A provisional order may be for any period, but the exclusive rights granted by an order shall not extend beyond the period of forty-two years from the commencement of the order granting such rights: provided that prior to the expiration of the period for which an order has been made a new order may be made granting rights, other than exclusive rights, to take effect from the date of the expiration of the order.

- No provisional order shall be of any force unless and until confirmed by an Act.

- Every local authority, company or person applying for a provisional order shall publish notice of their application by public advertisement in such manner and including such particulars as the Minister may from time to time direct or approve, and such order shall not be granted by the Minister until after the expiration of a period of three months from the date of the first publication of such advertisement nor until opportunity has been given to all parties interested to make representations or objections to the Minister with reference to the application.

FIGURE III-1

BLP 24 KV TRANSMISSION NETWORK



- A provisional order may, subject to this Act, be granted to a local authority authorizing them to supply electricity within any area, although the same or some part thereof may not be included within their own district.

- The provisional order may make such regulations as to the limits within which and the conditions under which a supply of electricity is to be provided and for enforcing the performance by the local authority, company or person, of their duties in relation to such supply and for the revocation of the order where the local authority, company or person fail to perform such duties and generally may contain such regulations and conditions as the Minister may deem expedient.

- Where in any area or part of an area in which any undertakers are authorized to supply electricity under any provisional order the undertakers are not themselves the local authority, the order may contain any provisions and restrictions for enabling the local authority, within whose jurisdiction such area or part of an area may be, to exercise any of the powers of the undertakers under this Act with respect to the breaking up of any street repairable by the road authority within such area or part of an area and the alteration of the position of any pipes or wires, being under such street and not being the pipes or wires of the undertakers, on behalf and at the expense of the undertakers, and for limiting the powers and liabilities of the undertakers in relation thereto, as the Minister may think expedient.

- No provisional order shall authorize the supply of electricity by any undertakers within the district of any local authority (not being themselves the undertakers) unless notice that such provisional order has been or is intended to be applied for has been given to the local authority by the applicants in such manner and for such time as the Minister may direct or approve.

- A provisional order may contain a power for the transfer thereof and the rights, powers and obligations thereunder with the approval of the Minister, and the sanction of Parliament: provided that no such transfer shall have any effect or validity unless it be made by deed or deeds and such deed or deeds are recorded at the Registration Office.

- Any Act confirming any provisional order granted in pursuance of this Act may, on the application of the undertakers thereby authorized to supply electricity,

be repealed, altered or amended by any subsequent provisional order granted by the Minister and confirmed by an Act.

2. Rate Setting Authority

The electric rates for the BLP are authorized by a five person Public Utilities Board appointed by the Minister. Except the Chairman of the Board, all other members are part-time employees. They are reimbursed on a per diem basis when the Public Utilities Board (PUB) is in session. PUB does not have any professional staff to evaluate independently the rate requests and/or justification of new facilities by BLP. When the rate changes are desired, BLP submits a rate change application to the Board with documentation supporting the request. In its consideration of the application the Board holds public hearings at which interested parties may intervene. In the past, requests for rate revisions have been based on an acceptable rate of return as the rate base consisting of the sum of fixed assets, cash, working capital and materials and supplies less accumulated deferred taxes.

3. Fuel Surcharge

A fuel surcharge allows the seller to make a periodic adjustment in rates, without regulatory review of approval, to correspond to a change in the cost of fuel used to produce the electric energy sold. BLP rate schedules include a fuel surcharge. The periodic adjustment in fuel surcharge is calculated to reflect the change in fuel cost between the base period and the current period.

A fuel surcharge was first introduced in BLP rates in 1965. This fuel surcharge was then only applied to the bills of commercial and industrial customers. After the rapid increase in fuel prices in 1973

the PUB decided to incorporate the fuel surcharge clause in the residential customers' rate base. The 1980 modification allowed the BLP to use the current month contract fuel prices thus preventing the accumulation of large under-recovery accruals.

E. SMALL POWER PRODUCERS POTENTIAL

Competition in the electricity supply sector in Barbados is possible and could be important for the development of the alternative energy technologies. As in so many other regulated monopolies, technological developments have overtaken and diminished some of the rationale for an electricity supply monopoly. The potential for an alternative energy path for Barbados is becoming clear. However, this would require a major transition from the existing energy use habits to very different ways of supplying and using energy, and would require matching of appropriate energy sources with end-use need.

Barbados has an abundance of options available to meet future electrical energy needs from alternative resources. In the following subsection some of these options are discussed briefly. In analyzing these energy resources, a conservative assumption is made about the capabilities of future technologies for resource utilization. The assumed alternative energy delivery systems require only applications of existing technology, therefore, these alternative resources can be developed immediately if appropriate regulatory environment such as tax credits and financial incentives are implemented by the government.

1. Electricity From Surplus Bagasse

All six sugar factories in Barbados were designed at a time when little attention was paid to the use of alternative sources of energy to produce electricity. Most sugar factories were designed to recover just enough energy from bagasse to meet their energy needs. In general the average sugar factory produces 12-15 kW/ton of cane

processed and uses about the same amount of energy. As an example, 25 tons of 50 percent moisture bagasse will produce just under 4,000 kWh using a back-pressure turbo generator operating at 200 psig and 500°F and exhausting at 10 psig. The same weight of bagasse will produce 9,700 kWh if the steam pressure and temperature are raised to 600 psig and 750°F, respectively, and a condensing turbo-generator is utilized instead of a back-pressure machine.

The lowest amount of excess bagasse was produced in 1979, 13,433 tons from 1,036,536.54 tons of cane. The greatest amount was produced in 1980 when 26,561 tons were taken from 1,208,622.91 tons of cane. It is estimated that approximately 21,000 tons of bagasse is available annually from all six sugar factories. This fuel could be utilized to produce 6,283,000 kWh of electricity which is approximately two percent of the island's present requirement. The maximum amount of oil-fixed capacity which can be displaced is about 5 MW for the short-range period.

2. Wind

Barbados has a good potential for wind energy. At present, a 40 kW turbine is operating commercially on the island. The BLP is also cooperating with the government in the development of a 200 kW wind turbine for electricity generation. A recent survey funded by a USAID grant to CDB shows that there are several excellent sites for wind turbines. A number of sites had average wind velocities of over 8 k/s. There are two types of wind systems that can be developed in Barbados: utility wind systems (such as CDB project) for supplying electricity directly to the utility power grid and distributed wind systems which may be connected to the grid but that are installed primarily for meeting on-site residential, agricultural, commercial or industrial electrical needs. Emphasis is on wind machines in the over 200 kW size range for utility systems, while for distributed systems, most opportunities are anticipated for machines of 100 kW or less. A major target for wind electrification is water supply. Some of the storage reservoirs are located near excellent wind sites and pumping

could be powered by wind turbines. At present the water utility has shown no interest in using wind turbines and has discouraged a private company interested in providing wind power for use by the utility.

Depending on what type of technical and economic assumptions one makes, the potential for wind produced electrification on Barbados can vary widely. At present, BLP feels that there is very little potential while specialists at CDB and the Caribbean Meteorological Institute assert that wind electrification could be a major contributor.

It is not possible to make a specific estimate of the size and number of wind machines which are practical or feasible. It is, however, possible to say that 5 percent of the current annual BLP supply could be supplied using proven technology and identified sites without major risk of diminished service. The economic feasibility of such a large installation is not known. (At 5% of the supply, this would require generation of over 10,000 MW hours of electricity per year).

If this 5 percent were to be supplied by wind turbines, at least 6 MW of wind machines would be required. This assumes that wind turbines would be supplying 35 percent of their rated capacity. This would require machines in the size range of 500 to 1 MW to be used at each site.

3. Cogeneration Potential

Cogeneration is the combined production of electricity and useful thermal energy. A typical example is producing electricity with a combustion turbine generator whose exhaust heat is used to heat an industrial process. Cogeneration often lowers a company's overall fuel requirements by about 30 percent as compared to the requirements for producing electricity and process heat separately. However, the implementation of cogeneration requires a capital outlay to purchase the necessary equipment.

In Barbados, cogeneration systems can be used in the food processing, rum and other industrial processes. The principal available options include conventional steam turbines, combustion turbines, diesel engines and waste heat recovery. The first three are generally referred to as topping cycles because thermal energy for process use is a by-product of electricity production. In waste heat recovery, a bottoming cycle, electricity is a by-product of process heat production. Cogeneration facilities could be installed in all sugar factories in Barbados and in a number of other industries. This is not being done at present because of the lack of investment capital for industrial purposes at a time when the island's economy is declining.

4. Biomass Waste Resources (BWR)

Biomass is the term used for organic waste matters. Most of these wastes (municipal solid wastes, sewage, agricultural wastes, etc.) are already being collected and disposed of without utilizing their energy potential. For electrical generation, biomass can be used to fire and steam boilers, or it can be converted to a gas or liquid to fire a boiler or gas turbine.

On an average, BWR contains about 79 percent combustible material, 10 percent glass, eight percent ferrous materials, one percent aluminum and two percent other organic material. The combustible material has a heating value around 5500 Btu/lb or about one-half the heating value of coal. A study of this source of energy for Barbados has been made and problems with collections, energy content and initial capital investment were found to make its combustion for electricity purposes unattractive.

5. Solar Energy

Barbados has a plentiful solar resource. Average insolation (solar radiation) on the island is somewhat higher than on most of the Caribbean islands with over 8 hours per day of sunlight producing

approximately 5.8 kWh/M^2 of available energy. There are three principal technologies which can be considered for converting solar radiation into electricity in Barbados: Solar thermal, solar salt pond and solar photovoltaic. There are important differences in the relative capability of these technologies to produce and store energy. Solar energy like wind energy, is an intermittent resource. Without the capacity to store energy, electricity production will be intermittent which alters the economic comparisons of solar electric to other more conventional technologies.

One project for air conditioning with solar thermal is already installed in a Ministry of Agriculture building. This technology is currently being evaluated to determine if it is economically and technically feasible. Other demonstrations are planned but presently there is no serious consideration of other uses. At present, PV is used on the island on a limited extent for powering communications systems especially on boats. The cost of the technology, approximately $10 per peak watt of installed capacity, is preventing further use.

IV. PURPA APPLICABILITY

A. INTRODUCTION

The history of PURPA in the U.S. included legislative, legal/regulatory and operation/administration phases. The process started with legislation being passed at a national level. This was followed by a period of information development, creation of the apparatus to implement and monitor the act, court and legal clarification of the law, and negotiations between regulators, utilities and off-system generators. Finally, arrangements were completed and actual generation and purchases have resulted. A short description of this process can be instructive to the consideration of the utility and applicability of a PURPA-type process outside the U.S. The following paragraphs summarize the nature and development process of PURPA in the U.S.

B. PURPA LEGISLATION

PURPA, enacted in 1978, was part of a major legislative energy package presented to the U.S. Congress by the Carter administration. It was targeted at stimulating conservation and the use of renewable energy resources to generate electricity. The legislation ordered all state Public Utility Commissions (PUC's) to "consider" by the end of 1981 the implemention of standards to promote "conservation, efficiency, and equity" in utility policies through voluntary changes in rate structure and other practices. Utilities were directed to publish detailed statistics on their cost of providing electricity, a requirement essential for determining their marginal costs for providing additional energy. The portions of the act which have been the most controversial and which have been the subject of most problems are Sections 201 and 210. These sections require public and private utilities to buy power from qualified small power producers using renewable energy resources and to sell them auxiliary power at

non-discriminatory rates. These sections also stimulated cogeneration by non-utility entities as a means of improving the overall utility efficiency. The Act further:

- Required PUC's to address existing constraints and establish requirements under which any qualifying independent power producer (of less than 80 megawatts) can tie into the utility grid.
- Streamlined the licensing process for cogeneration and renewable energy facilities of less than 30 megawatts.
- Required the Federal Energy Regulatory Commission (FERC) to publish rules governing establishment of "just and reasonable rates" for the buying and selling of power to utilities by qualifying facilities, specifying that, "no such rule...shall provide for a rate which exceeds that incremental cost to the electric utility of alternative electric energy."

C. PURPA IMPLEMENTATION

The time between 1978 enactment and mid-1980 was taken up in rules preparation and publishing by the Federal Energy Regulatory Commission (FERC). These rules, published in 1980, created two major problems for the utilities:

- Mandatory interconnection with all qualified independent power producers was stipulated, and
- A payment for purchased power based on "full avoided cost" was required.

These problems and many more led to court proceedings and finally in 1983 the U.S. Supreme Court upheld FERC's 1980 rules. During the time between 1980 and 1983, because of the uncertainty, PURPA applications were still affected.

Following the Supreme Court decision the number of applications increased substantially. California was one of the states which became a leader and innovator in the PURPA process. California's PUC

established a statewide methodology for determining avoided cost and thus eliminated the variance found in other states where utility avoided cost formula proposals are judged and approved separately. The PUC also closely monitors utility compliance and the qualification process. The avoided cost formula in California includes factors covering fuel, maintenance, line losses, administration, transmission and distribution investment, and capacity. This makes the avoided cost calculation more beneficial to off-system generators than if only fuel costs were included. California has also benefited because of the availability of capital, a good renewable energy resource base and excellent investment and other tax benefits.

The stimulation of conservation and renewable energy resources use in California brought about by PURPA and other attributes has been dramatic. As an example, between 1981 and 1983 the amount of on-line supply capacity rose from less than 200 MW to over 750 MW. I [illegible] the increase was similar. In the U.S. a total 45 million kWh o[illegible] created wind based electricity was produced in the one year be[illegible] 1982 and 1983. These increases, as mentioned above, were due to [illegible]y factors but in fact PURPA played a substantial role.

The above summary has identified the process, the key elements and the positive stimulation possible through legislative and regulatory programs such as PURPA. With this as a background it is possible to examine Barbados and identify opportunities, needs and impediments. In Barbados there are a number of in-place legal-institutional factors which influence and affect OSG. In addition to the factors brought out by the above discussion there are elements peculiar to non-U.S. and developing country situations. Some of these important factors which exist in Barbados are noted in Table IV-1.

TABLE IV-1

FACTORS AFFECTING PURPA APPLICABILITY IN BARBADOS AND OTHER EASTERN CARIBBEAN COUNTRIES

FACTOR	IMPACT
• Government ownership of utility	Allows more direct and rapid influence by Government
• Use of electricity supply by government to promote development and accompanying subsidy in prices	Developing country electricity supply is much more a part of government policy and utility expansion and operation are affected less by economics
• Government uses of electricity are often not paid for	Cash flow position of utility can be poor and expansion of generating capacity is often restricted
• OSG usually based on use of foreign technology	National savings in foreign currency outlay are spread over a long time and immediate impact may be a short-term increase in foreign spending
• OSG generally does not use fossil fuels	This will have a positive long-term impact on foreign exchange spending by diminishing oil purchases
• OSG sometimes involves foreign investors to pay for initial capital requirements	Balance of payments is negatively affected due to need to repatriate profits
• Limited utility technical capability, financial ability, and equipment condition	Any OSG private sector contribution to electricity generation may alleviate these problems
• The small number of opportunities for cogeneration or OSG	The overall impact and economic benefits of OSC may warrant only a case by case approach
• The government participation in technology demonstrations	BLP's participation in a wind electrification demo could delay changes in OSG policy until demo is complete

D. LEGAL-INSTITUTIONAL NEEDS

There is presently little precedent or established basis in Barbados for potential off-system generators to examine in order to evaluate the feasibility of a particular project. That precedent which does exist is summarized in Table IV-2. It is evident that established precedent does not provide a very clear or strong incentive for new projects. It appears that utility purchases are only attractive if the off-system generation project is already feasible and economical. BLP's existing position on OSG is neither economically attractive to others or assured to be permanent. Their case by case purchase of power at approximately 12¢ Barbados (US$.06) per kWh and the lack of assurances about a continuation of this policy limits a potential producer from seriously investigating project feasibility unless it is economically feasible without BLP purchases.

The existing institutional support for OSG is minimal at best. The current enabling legislation for electricity generation as defined in the Electric Light and Power Act and Amending Orders gives BLP the non-exclusive right to generate and sell power as a regulated public utility in Barbados until 1991. A new OSG must either sell electricity to itself and BLP and thus is required to negotiate with BLP, or have the GOB issue a provisional order designating it a public utility under the current legislation or have a special act passed. Becoming and operating as a public utility may not be warranted for a small producer and the imposition of the requirements on public utilities could prevent many otherwise feasible OSG projects from being undertaken. If an OSG produces electricity as a secondary business activity the current legislation does appear to allow limited sale to others by this OSG. Paragraph 3 of the Electric Light and Power Act states:

> " 3. No local authority, company or person shall supply electricity in any area except under an Act or under a provisional order granted under this Act:

TABLE IV-2

EXISTING OFF-SYSTEM GENERATOR-UTILITY
ELECTRICITY PURCHASE AGREEMENTS

Entity	Application	Arrangement
C.O. Williams Electrical	Self generation by wind turbine and sell back to BLP of excess electricity	Letter from BLP agreeing to purchase excess electricity at avoided fuel cost for an unspecified time
Barbados Sugar Industry Ltd.	Excess bagasse fired generation of electricity for sale to BLP	Negotiated agreement since 1980 for BLP to purchase all excess electricity at avoided fuel cost
Arawak Cement Co.	Excess and off peak oil/diesel fired electricity generation	Present cement plant reduced operations don't include any on-site generation but future operations may

Provided that this section shall not prevent any company or person from affording a supply of electrical energy to any other company or person where the business of the company or person affording the supply is not primarily that of the supply of electrical energy to consumers."

The existing Public Utilities Board (PUB) also has limited powers to affect and promote off-system generation. Two paragraphs in their legislation do provide for some involvement and could be interpreted to allow encouragement of OSG. Paragraphs 27 and 50 of the Public Utilities Act state:

" 27. The Board may make regulations prescribing the conditions to be contained in and to become part of all agreements entered into by public utilities in respect of any class of service."

" 50. Whenever the Board, after enquiry, finds that public convenience or necessity require the use by one public utility of the conduits, subways, poles, wires or other equipment belonging to another public utility, and that such use will not prevent the owner or other users thereof from performing their duties or result in any substantial detriment to the service and/or compensation therefore, the Board may make such order as it deems reasonable directing that the use or joint use of the conduits, subways, poles, wires or other equipment be permitted and prescribing the conditions to be observed and the compensation to be paid in respect of the use so permitted."

These two paragraphs could be used to require utilities to buy electricity from OSGs under given conditions and including considerations other than avoided fuel costs. Paragraph 50 could also be applied to overcome a major disincentive to wind powered electrification by OSGs. At present the wind regime in Barbados is excellent but only certain sites on the island are reasonable for use. For an OSG to take advantage of the wind regime he must either sell all power to BLP (an alternative which is not presently economically viable) or sell to itself and other users very near the site. If Paragraph 50 were interpreted and applied to stimulate OSG, the BLP could be required to lease the use of their lines to others. If this were possible at a just and fair cost, OSGs could, for example, use the best wind sites and supply electricity to major industrial users

not near the wind turbine by "wheeling" their power through BLP lines. There are obviously negative impacts to BLP if this were permitted. However, if the purpose is to provide for the most economical supply of electricity and stimulate renewable technology use consideration should be given to defining line lease or "wheeling" conditions and rates for BLP.

With the above as a basis it is apparent that some, but possibly not enough, legal-institutional basis exists in Barbados. The position of BLP is not uncommon or without justification but it is one which is a strong disincentive to OSG, cogeneration and the development of renewable energy resource use in electricity generation. The existing powers and staffing of the PUB have not been sufficient to encourage OSG.

E. UTILITY POSITION

In previous sections of this report portions of the BLP position on OSG, cogeneration and PURPA-type legislation have been introduced. Their stated general position is briefly summarized in the following paragraph.

BLP has been buying electricity from others since 1980 and can see the benefits from this on a selected basis. BLP has a surplus capacity to meet peak demand and thus is not presently in need of additional capacity. The reliability of OSGs or their technology is not established and an ongoing wind turbine demonstration in which BLP will participate will help define this. BLP will treat each request to sell them power individually but can foresee no substantial increase in the price they pay or in the terms of arrangements with OSGs. "Wheeling" has not been suggested by anyone and thus BLP has no policy on it. However, as a first opinion it does not appear to be either practical or in the best interest of BLP. Any other person or company can request status as a public utility. However, this would require hearings and consideration by BLP as to their position. BLP

sees no need or justification to include anything but avoided fuel cost in their payment for purchased electricity and believes that their current price structure and arrangements will provide them all the OSG supply they need.

A quote, included below, from the BLP 1983 Annual Report further reflects their opinion about OSG and about BLP needing to be self-sufficient. BLP feels that they need all the customers they can get. They do not want to have less customers but rather by their own improvements and expansion they will continue to supply demand and provide an equitable rate.

> "Expansion Programme
>
> A small island utility, such as The Barbados Light and Power Company, does not have the possibility to inter-connect with, and purchase power from other electric utilities when mechanical plant has to be shut down for maintenance, overhaul or because of equipment failure. Being thus isolated from any form of outside help, the Company should always have enough plant reserve based on past experience to maintain a high standard of reliability and minimize service disruptions.
>
> Expansion of the Company's generation, transmission and distribution facilities must necessarily depend on growth of the Barbados economy and customer demands. An important objective in design of the facilities is to improve the generating plant rate of fuel consumption and to keep transmission and distribution energy losses to a minimum in order to help keep the price of electricity at reasonably moderate levels."

With respect to PURPA, BLP sees no need for similar legislation in Barbados. The country is small, BLP service is extensive and they believe that their rates are equitable. If an outside generator wants to become a public utility the mechanisms are in place. BLP does buy power from others but at 12¢ Barbados per kWh it is only economical for a few producers. As an example, a private company has been generating its own power for internal needs for the last year using a 40 kW wind turbine. BLP believes that this is an experiment and they

are only committed to the purchase arrangement with this OSG as long as it makes economic sense to BLP. They do not believe this or other arrangements establish a precedent.

The OSG (C.O. Williams Electrical Ltd.) does not have a very beneficial sale-purchase arrangement with BLP. It is essentially an instantaneous purchase or sale connection. Whenever the Company's demand exceeds the wind turbine's production, they buy electricity from BLP at approximately BD $0.32 per kWh. When wind turbine supply exceeds demand, for example at night, they sell electricity to BLP at approximately BD $0.12. Each month the avoided cost is re-calculated by BLP and C.O. Williams is paid for BLP's purchases at the calculated avoided cost. C.O. Williams pays BLP separately for the amount they used from the BLP system. This is essentially the same arrangement which BLP has with the sugar producers. BLP does not see any justification for giving any OSG capacity or other credits or for calculating avoided fuel cost using their most expensive fuel as a basis.

F. GOVERNMENT POSITION

The Government of Barbados has taken no official position on OSG and because of their involvement with BLP as a partial owner they are not likely to. The Government believes that there are already legal bases for handling requests for OSG status. The Electric Light and Power Act outlines the process and conditions under which an OSG can petition for permission to be a utility. The PUB can deal with regulation and rate setting. Because of the existing BLP agreements with OSGs there is further evidence that a variety of routes are open to OSG.

The question of equipment import duty help, tax incentives and foreign ownership profit repatriation are open to discussion on a case by case basis and the government feels that these are not presently a deterrent to OSG. In the case of OSG by C.O. Williams Electrical, the

government waived import duty on the wind turbine, however, in this case it was done because the project was considered to be an R&D effort and not a commercial venture.

As an owner of the BLP the government is subject to criticism and pressure by those seeking to be elected. This political pressure is often in the form of criticism of the BLP rate structure, excessive profitability, outage history or general service level. The government has not taken an active role in the operation or management of BLP and appears to be attempting to separate itself from any day to day or policy involvement.

The Government has a model to examine if they wish to expand their support for OSG. Over the last several years a major program to encourage solar hot water heating has been implemented. This program has included tax incentives, import duty exoneration, financing assistance, major publicity, focused government participation and technical assistance. The result has been a significant increase in the use of the technology and thus a diminished electricity use. Similar government attention to OSG involving policy direction, legislation, technical assistance and financial incentives would also stimulate OSG.

G. PRIVATE SECTOR POSITION

The private sector in Barbados interested in OSG is not easily identified or contacted. The main entities are the companies already involved in OSG. Their opinions and positions are not yet well formulated but those which are, are noted below.

The principal elements of the private sector position are as follows:

- A general lack of knowledge or understanding about what is possible or useful in terms of negotiating with BLP and others.

- A concern about the future of BLP purchases and the terms of those purchases.

- A desire to have things such as tax benefits, siting rules, regulatory policies and import duties made explicit.

- A feeling that the present government policies and BLP electricity purchase terms do not make OSG economical except under very limited circumstances.

- An uneasiness about having to go through the legal process of being granted the right to sell electricity and having their books open to scrutiny (becoming a public utility). This will be very costly and time consuming and the outcome is hard to predict. Thus private sector entities would like something like PURPA to clear up the unknowns, facilitate approval and allow them to easily estimate the economic returns from an OSG project.

- A concern about the availability of capital to finance upfront equipment purchases necessary to institute cogeneration or OSG.

H. AVOIDED AND MARGINAL COST ANALYSIS

Under PURPA the utility must purchase electric power generated by a qualified OSG at the utility's avoided cost. Avoided costs are defined as the incremental cost a utility would have to pay to generate or purchase power if no qualified facilities were in their system. This cost is approximated by the marginal cost of generation for each utility. Under this definition avoided costs are influenced by service levels, time of day, equipment in use, cost of fuel mix and reliability of delivery of power by the OSG. There is no standard method for calculating avoided cost but the most frequently used formulas are based on the following:

1) The Energy Avoided Cost Method: Based on the actual incremental energy cost or energy avoided cost for "as available" energy.

2) Average Fuel Method: Based on monthly average fuel costs or energy portion of purchase power costs (this is essentially the present method used by BPL).

3) Incremental Fuel Method: Based on the incremental fuel avoided at the time of purchase from the qualifying facility.

The question of capacity credits is also important and there are several arrangements in use:

- A standard energy rate and a capacity payment;
- A standard energy rate and no capacity allowance;
- An energy rate that includes capacity factor; and
- A standard energy rate with options for negotiating capacity payment.

Capacity payments, if included, are generally based on the length and terms of the contract, reliability, etc. Utilities in the U.S. generally believe that capacity credits are appropriate for OSGs which can demonstrate reliability and availability and which are willing to enter into long-term contracts with the utility. The determination of reliability and availability, however, is less clear. Most U.S. utilities operate according to the principles of economic dispatch in that the most expensive or marginal plant is turned on last and turned off first when the need arises. In other cases avoided capacity costs are based on long-run capacity expansion plans of the utilities where "long-run" refers to the next source of supply of power of the utility. Therefore, if a utility is to begin constructing a new oil-fired unit next year, even though that construction will take eight years, the cost of that facility would determine long-run avoided costs, despite wholesale contract purchase meanwhile. The calculation of avoided cost is also usually focused on the units or plants that carry the top of the power load.

The concept of avoided-cost based rates is new to utilities and does present difficulties that are yet to be satisfactorily resolved. There is no "standard" method in the industry for calculating avoided costs because each utility has divergent characteristics in load, generation mix, capacity, capital structure, etc. The most frequently

cited methods for calculating avoided energy and capacity costs are shown above.

In Barbados, as was mentioned previously, the existing avoided cost calculation is based on the price of Bunker C fuel and BLP's average efficiency for units using this fuel. A marginal cost study has been prepared for BLP as a part of a World Bank loan financed expansion program but copies were not available. The management of BLP has not yet officially accepted the report and were reluctant to discuss marginal cost. It was indicated that they were considering using marginal cost criteria in structuring rates in the future.

I. RENEWABLE RESOURCE CONTRIBUTION

The renewable energy resource base in Barbados which is presently being used for electricity generation includes wind, bagasse and solar. These are the renewable energy resources most adaptable to use as fuels for electricity generation by off-system generators. At the present time all three resources are being used to generate electricity in Barbados but only bagasse and wind are being used to any extent. Of the three possible sources only wind and bagasse represent a major near term potential for any additional off-system generation.

The quality and quantity of the wind regime in Barbados has been well defined. A recently completed wind and solar resource quantification study by the Caribbean Meteorological Institute has identified several locations where average wind velocities exceed 8 M/S (18 miles/hour). This excellent resource base, the existence of one turbine providing OSG which has operated for over a year, and the ongoing IDB-GOB wind electrification demonstration indicate that wind has a strong potential as an energy source for OSG. The present use of wind to generate electricity involves a 40 kW Dutch wind turbine operating at a site where the wind regime is not optimum. This operation (C.O. Williams Electrical Ltd.), according to the owners, is

not financially rewarding. If all of their costs are included except the cost of money and income is accounted for by crediting all internal electricity use at BD $0.30 and all sales to BLP at BD $0.12 the annual payback rate is approximately 11.5 percent. Their installed cost for the 40 kW machine was BD $3.00 per Watt.

The principal potential off-system users of this resource would be the water utility which used approximately 100 million kWh's of electricity in 1982 for pumping and other uses. Some of the water storage reservoirs are in excellent locations for wind turbines. Other possible off-system users of the wind resource would include industries and major hotel-tourism complexes. For both of these latter types of users to take advantage of wind electrification most would have to have an off-premises location for a wind turbine. This location problem requires either a new or dedicated set of distribution lines for each user or the ability to contract with BLP for the right to use (wheel through) their distribution lines.

The largest potential user of the wind resource for generation of electricity is BLP. They are presently defining their role in the GOB-IADB financed wind electrification demonstration. At the time of this study BLP was planning to be a paid subcontractor responsible for system operation or solely a purchaser of electricity generated by the wind turbine. They will use the results of the study (8 - 10 months of turbine operating data is now expected to be produced by 1987) to help them decide on what role wind turbines should play in their future development. They do not now believe that wind turbines can be economically effective in a utility because they could only be used for fuel saving and could not substitute for needed peak capacity. Thus, fuel savings would not be enough to pay back the purchase, installation and operating costs of the turbine. BLP is, however, awaiting the results of the demonstration to help answer some of the questions about the feasibility of grid connected wind turbines in Barbados.

The sugar industry in Barbados uses bagasse to meet their heat and electricity needs as discussed earlier. BSIL has the potential to expand their off-system generation in light of the excess bagasse they have. However in order to bring on more generating capacity a large capital investment is required.

V. OTHER EASTERN CARIBBEAN ISLANDS

A. UTILITY SUMMARY

Electric utilities on Eastern Caribbean Islands have suffered financially as the cost of new power plant construction and imported fuel cost increased in recent years. The total installed capacity of seven Eastern Caribbean Islands (Antigua, Grenada, Dominica, St. Kitts/Nevis, Montserrat, St. Lucia, St. Vincent) is about 69.33 MW as of 1982. Almost 93 percent of this capacity is based on diesel fuel oil and the remaining 7 percent is hydro-electric. In Table V-1 a summary of all electric utilities' generation capacity, fuel type and future development programs are included. In Table V-2, a summary of all islands' electricity generation and sales statistics for 1977 to 1981 period is included. Also included is a summary of rate structures in all seven islands.

Even though these islands do not face an immediate crisis in electricity supply, basic problems remain. Caribbean's electricity supply system is heavily dependent on expensive imported fuel. Consequently, the electricity sector continues to be vulnerable to supply and price variations in these fuels. Cost-effective alternative energy resource development programs are not being initiated rapidly or completely enough, and the current regulatory system seems inadequate to promote private investments in this area.

B. FUEL SUPPLIES AND ELECTRICITY RATES

Caribbean's heavy dependence on imported fuel oil is the primary reason electricity rates have risen in recent years. Increased fuel costs to utilities are being collected through higher rates to consumers. On each island, utility bill increases reflect primarily the increase in power plant fuel costs. In 1983 BLP, the largest eastern Caribbean utility, paid approximately $5 million Barbados

TABLE V-1

GENERATION SUMMARY TABLE

Island Name	Installed Capacity	Fuel Type	Comments
1. Antigua	Crabb Peninsula: = 8.28MW Cassada Gardens: 6.84 MW Total: 15.12MW	Diesel Oil	A third plant was scheduled for operation in mid 1982 Status: Unknown
2. Grenada	Queens Park Station: 8.355 MW	Diesel	Three 1250 KW diesel units were planned for mid-1983
3. Dominica	Trafalgar Padu: 2.84MW Fond Cole' and Melville Hale: 3.781 Total: 6.62MW	Hydro Diesel	Future hydro development on Roseau River has been identified. Status: CDB funded for the study.
4. St. Kitts/ Nevis	St. Kitts Station 9.14MW Nevis Station = 1.40MW Total: 10.54 MW	Diesel	No major plans for future development
5. Montserrat	Plymouth Plant 5.25MW	Diesel	No major plans for future development
6. St. Lucia	Union Power Sta. = 12.1MW Vieux Fort Power Sta. = 3.00MW Total: 15.1MW	Diesel	A site has been identified at Cul-de-Sac, south of Castries. First unit for this new station is planned for late 1985, installed capacity maybe 5MW
7. St. Vincent	South Rivers 0.870MW Rimond: 1.10MW Subtotal: 1.97MW	Hydro	A new 2800 KW medium speed generative unit at Cane Hall Power Station
	Kingstown: 2.125MW Cane Hall: 3.65MW Beguia: 0.6 MW Subtotal: 6.375MW Total: 8.345MW	Diesel	A new hydro is planned for operation by the end of 1985

TABLE V-2

SUMMARY OF ELECTRIC RATE STRUCTURES

ISLAND NAMES	DOMESTIC	COMMERCIAL	INDUSTRIAL	OTHER
1. Antigua	Tariff A: Applicable to private homes using less then 100 kWh/month -40¢/kWH minimum charge E.C. $8.00/mo.	monthly demand charge of E.C. $6.0/KVA Energy Charge of: 1-100 kWh 38¢/kWh 101-250kWh 35¢/kWh 251 &above 30¢/kWh	- Demand Charge of of E.C. $6.00 per KVA Energy charge: 1-100/KVA 38¢/kWh next 250/KVA 32¢/kWh above 250 38¢/kWh	- General Purpose Tariff: Applicable to gen'l lighting of all premises as well as temporary supplies
	Tariff B: 1-100 kWh 40¢ 101-400kWh 35¢ above 400kWh 30¢ minimum charge E.C. $25.0/mo	Min. charge is the highest demand charge realized in preceding 11 mos.		45¢ kWh & minimum charge is E.C. $10.00/mo.
2. Grenada	1st 50 21¢/kWh 2nd 50 24¢/kWh Remainder 26¢/kWh monthly minimum charge $4.00	1st 75 23¢/kWh Next 4925 24¢/kWh Remainder 25¢/kWh	- Demand Charge $20/mo. per kW -17¢ per kWh for for all consumption minimum monthly charge $10.00	Street Lighting 23¢/kWh The government enjoys a 10% discount on its basic billing
3. Dominica	Under the existing tariffs all consumption of electricity is charged at the same rate of E.C. $0.25 per kWh per month. There is no minimum monthly charge. This rate applies to all customer classes.			

TABLE V-2 (continued)

SUMMARY OF ELECTRIC RATE STRUCTURES

ISLAND NAMES	DOMESTIC	COMMERCIAL	INDUSTRIAL	OTHER
4. St. Kitts/ Nevis	Fixed Rate 33¢/kWh with minimum monthly charge of $4.0/mo of Floor Space 1-75 16¢/kWh 76-150 13¢/kWh above 150 10¢/kWh plus -1st 200 sq ft or part thereof - $4.00/mo. -next 500 sq ft - $5.0/mo -next 500 sq ft - $4.0/mo -for every additional 500 sq ft - $2.5/mo.		Small Loads up to 15 KVA Energy Charge: 1-3000 13¢/kWh above 3000 10¢/kWh Demand Charge -1 KVA and under $7.5/month -above/KVA-$10.0/KVA large loads in excess excess of 15 KVA Energy Charge: 1-5000 12¢/kWh above 5000 10¢/kWh Demand Charge: 1st 15 KVA - $10.0/mo. next 35 KVA - $8.0/mo next 50 KVA - $5.5/mo All KVA over 100 - $4.0/mo	Government Rate Energy Charge only of 33¢/kWh. A minimum charge of $4.00 tax domestic customers on the fixed unit rate is used.
5. Montserrat	-28¢/kWh per mo. -$3/50/mo for homes less than 1200 sq ft. -$15.00/mo for homes greater than 1200 sq. ft.	1st 4000 33¢/kWh Remaining 30¢/kWh Minimum Charges: -$5.0/mo less than 1200 sq. ft. -$20.00/mo for areas above 1200 sq. ft.	All Consumption: 25¢/kWh No minimum charge is applied	Street Lighting: All consumption at 31¢/kWh

TABLE V-2 (continued)

SUMMARY OF ELECTRIC RATE STRUCTURES

ISLAND NAMES	DOMESTIC	COMMERCIAL	INDUSTRIAL	OTHER
6. St. Lucia	All consumption at $0.175/kWh Minimum Charge is $5.00/mo.	0-75 38.5¢/kWh above 75 18.5¢/kWh Minimum Charge: $20.00/mo.	Basic Charge: $3.00/KW/mo. demand, and 16.5¢/kWh/mo.	
7. St. Vincent	27.5¢/kWh All Consumption monthly minimum charge - $5.00	All Consumption: - 28.5¢/kWh A monthly service charge based on the floor area in sq. ft. of the premises served. The floor area plus lighting area plus 50 sq. ft. x 38¢ is charged as minimum monthly charge.	All Consumption: - 25¢/kWh Fixed Charge: $5.00/KW/mo.	All Consumption: - 20¢/kWh
8. Beguia	Minimum Charge: 5.20/mo 32.5¢/kWh energy charge.	Minimum Charge: $20.00/mo 33/5¢/kWh energy charge.		All Consumption: 35¢/kWh/mo. Government enjoys 10% discount in both St. Vincent & Beguia

TABLE V-2a

ISLAND: ANTIGUA

GENERATION AND SALES STATISTICS - 1977 TO 1981

	1977	1978	1979	1980	1981
Peak Demand - KW	7900	7750	8150	9030	10040
Gross Generation KW.HR.	44,642,162	45,995,960	44,867,495	52,667,580	56,206,220
Load Factor - %	64.5	67.7	62.9	68.7	63.9
Fuel Cons. - Imp. Gall	3,000,400	3,161,762	2,904,748	3,460,392	3,475,107
KW.HR./I.Gall. Fuel	14.3	14.5	15.4	15.2	16.2
Fuel Cost - E.C. $	4,089,930	5,240,711	4,981,127	8,258,683	12,109,995
Station Use - KW.HR.	1,569,820	1,474,420	1,123,690	1,155,773	1,246,760
Station Use - % Gross Gen.	3.5	3.2	2.5	2.2	2.2
Net Generation - KW.HR.	43,072,342	44,521,540	43,743,805	51,471,807	54,959,460
No. of Customers					
Domestic	13,549	14,050	14,600	15,118	15,683
Commercial	1,229	1,420	1,470	1,545	1,570
Industrial	55	64	75	82	92
Total	14,833	15,534	16,145	16,745	17,345
Sales - KW.HR.					
Domestic	14,084,831	14,960,557	14,968,475	16,582,823	19,110,114
Commercial	15,039,064	15,473,893	13,180,990	16,080,314	17,986,490
Industrial	5,001,900	5,033,564	6,450,180	5,025,098	5,620,622
Total	34,125,795	35,468,014	34,599,645	37,688,235	42,717,226
Losses - % Net Gen.	20.8	20.3	20.9	26.8	22.3
Av. Cons. per Customer KW.HR./Year					
Domestic	1,040	1,065	1,025	1,097	1,219
Commercial	12,237	10,897	8,967	10,408	11,456
Industrial	90,944	78,649	86,002	61,282	61,094

TABLE V-2b

ISLAND: GRENADA

ELECTRICITY SERVICES LTD. - GENERATION AND SALES STATISTICS - 1976 TO 1981

	1976	1977	1978	1979	1980	1981
Peak Load - Kilowatt	3870	4130	4470	4515	4570	4470
Increase on Prev. Year - %	12.2	6.7	8.2	1.0	1.2	2.2
Gross Generation - MW.HR.	18,947	21,561	24,007	24,511	25,479	24,708
Load Factor	55.9	59.6	61.3	62.0	63.6	63.1
Fuel Consumption - Imperial Gallons	1,244,180	1,469,230	1,648,722	1,711,360	1,727,518	1,665,796
Fuel Cost E.C. $	--	--	2,284,903	3,563,370	5,463,182	5,718,596
KW.HR./I. Gall.	15.2	14.7	14.6	14.3	14.7	14.8
Sales - MW.HR.						
Domestic	6,648	7,297	8,256	8,841	8,958	--
Commercial	7,787	9,373	10,142	10,258	10,378	--
Industrial	541	880	842	810	1,390	--
Street Lighting	179	190	195	190	190	--
Total	15,155	17,740	19,435	20,099	20,916	19,972
Increase on Prev. Year - %	1.8	17.1	9.6	3.4	4.1	4.5
Losses - % of Gross Gen.	20.0	17.7	19.0	18.0	17.9	19.2
No. of Customers						
Domestic	7426	7967	8518	8772	9080	--
Commercial	892	948	938	945	984	--
Industrial	20	18	18	19	22	--
Street Lighting	9	9	9	9	9	--
Total	8347	8942	9483	9745	10,095	10,275
Avg. consumption per customer KW.HR./Year						
Domestic	895	916	969	1008	987	--
Commercial	8703	9887	10,812	10,855	10,547	--
Industrial	27,050	48,889	46,778	42,632	63,182	--

TABLE V-2c

ISLAND: DOMINICA

GENERATION AND SALES STATISTICS - 1976 TO 1981

	1976	1977	1978	1979	1980	1981
Peak Demand KW.	3050	3250	3660	3690	1620	2660
Increase on prev. year - %	8.9	6.6	12.6	0.8	-56.1	64.2
Gross Generation - MW.HR.						
Hydro	14,125	14,429	15,388	8,930	4,012	10,614
Diesel	1,280	1,847	1,970	3,201	2,689	2,000
Total	15,405	16,276	17,358	12,131	6,701	12,614
Increase on prev. year - %	9.5	5.7	6.6	-30.1	-44.8	88.2
Load Factor - %	54.1	57.2	54.2	37.5	47.2	54.1
Fuel Consumed - Imp. Gall.	88,519	127,877	138,319	228,913	213,714	154,308
Co. Usage - MW.HR.	279	220	253	221	240	229
Net Generation - MW.HR.	15,126	16,056	17,105	11,910	6,461	12,385
Sales - MW.HR.						
Domestic	6,189	6,651	7,375	5,246	2,231	5,034
Commercial	4,633	4,661	4,630	3,254	1,792	3,984
Industrial	846	875	1,151	661	131	270
Other	1,006	957	950	700	359	725
Total	12,674	13,144	14,106	9,861	4,513	10,013
Increase on prev. year - %	15.7	3.7	7.3	-30.1	-54.2	121.9
Losses - % of Net Gen.	16.2	18.0	17.5	17.2	30.2	19.1
Number of Customers						
Domestic	8706	9179	9647	1172*	3458	5523
Commercial	518	506	516	82	276	361
Industrial	38	38	37	0	12	18
Other	628	652	674	119	392	530
Total	9890	10,375	10,874	1373	4138	6432

* Post hurricane figures Dec. 1979.

TABLE V-2d

ISLAND: ST. KITTS/NEVIS

GENERATION STATISTICS - 1977 TO 1981

A. St. Kitts	1977	1978	1979	1980	1981
Peak Demand - KW	3590	4050	4050	4400	4680
Increase on prev. year %	2.3	12.8	0	8.6	6.4
Gross Generation - MW.HR.	18,549	19,769	21,568	24,026	26,632
Increase on prev. year %	-1.22	6.58	9.1	11.5	10.8
Load Factor - %	59.0	55.7	60.8	69.5	65.0
Fuel Cons. - Imp. Gall.	--	1,234,583	1,346,703	1,495,501	1,604,929
KW. HR./Gallon Fuel	--	16.0	16.0	16.1	16.6
Fuel Cost - E.C. $	1,660,830	1,885,590	2,833,200	4,952,190	5,697,200
Station Use - MW.HR.	502	585	611	659	692
Station Use - % Gross. Gen.	2.7	3.0	2.8	2.7	2.6
Net Generation - MW.HR.	18,047	19,184	20,957	23,387	25,940

B. Nevis					
Peak Demand - KW	540	625	640	640	900
Increase on prev. year %	8.0	15.7	2.4	0	40.6
Gross Generation - MW.HR.	3288	3200	3241	3566	3939
Increase on prev. year %	4.46	-2.4	1.28	10.0	10.5
Load Factor %	69.5	58.4	57.8	66.9	50.0
Fuel Cons. - Imp. Gall.	217,589	207,044	213,472	216,821	--
KW.HR./Gallon Fuel	15.1	15.5	15.2	16.4	--
Fuel Cost - E.C. $	319,855	328,110	470,190	850,850	--
Station Use - MW.HR.	153	161	178	200	--
Net Generation - MW.HR.	3135	3039	3063	3366	--

TABLE V-2e

ISLAND: MONTSERRAT

GENERATION AND SALES STATISTICS - 1977 TO 1981

	1977	1978	1979	1980	1981
Peak Demand - Kilowatts	1780	1810	2050	2070	2120
Increase on prev. year %	6.3	1.7	13.3	1.0	2.4
Gross Generation - MW.HR.	9400	10,000	10,200	11,700	11,900
Increase on prev. year %	4.4	6.4	2.0	14.7	1.7
Load Factor - %	60.3	63.1	56.8	64.5	64.1
Sales - MW.HR.	7900	8600	8800	9900	9900
*Losses and Unaccounted For - %	16.0	14.0	13.7	15.4	16.8

* Includes station and other company usage, which averages about 4.5%.

TABLE V-2f

ISLAND: ST. LUCIA

GENERATION AND SALES STATISTICS: 1977 TO 1981

		1977	1978	1979	1980	1981
Gross Gen. MW.HR.	N	38,079	43,138	46,277	45,276	
	S	11,801	-	14,471	13,088	
	Total	49,880	-	60,748	58,364	
Fuel Cons. I.G.	N	2,291,517	2,584,115	2,873,904	2,797,667	
	S	943,804	913,615	971,118	890,955	
	Total	3,235,321	3,497,730	3,845,022	3,688,622	3,897,610
KW.HR. per I.G.	N	16.6	16.7	16.1	16.2	
	S	12.5	-	14.9	14.7	
	Overall	15.4	-	15.8	15.8	
Fuel Cost Total E.C.$		4,294,020	4,890,253	8,093,629	11,206,798	15,251,537
Station Use MW.HR	N	1,944	2,125	2,191	2,178	
	S	541	565	589	562	
Station Use % Gross Generation	N	5.1	4.9	4.7	4.8	
	S	4.6	-	4.1	4.3	
	Overall	5.0	-	4.6	4.8	
Net. Gen. MW.HR.	N	36,135	41,013	44,086	43,098	
	S	11,260	-	13,882	12,526	
	Total	47,395	-	57,968	55,624	

TABLE V-2f (continued)

ISLAND: ST LUCIA

		1977	1978	1979	1980	1981
Sales MW.HR.	N	29,527	33,259	36,984	34,422	
	S	9,362	10,746	12,603	11,587	
	Total	38,889	44,005	49,587	46,009	
Losses % Net Gen.	N	18.3	18.9	16.1	20.1	
	S	16.9	-	9.2	7.5	
	Overall	17.9	-	14.5	17.3	
No. of Customers - N+S -						
	Domestic	11,540	12,412	13,256	13,390	13,885
	Commercial	1,426	1,475	1,519	1,573	1,588
	Industrial	69	69	71	68	72
	Total	13,035	13,956	14,846	15,031	15,545

TABLE V-2g

ISLAND: ST LUCIA

	1976	1977	1978	1979	1980	1981
NORTHERN SYSTEM						
Peak Demand MW	6.00	6.65	7.15	7.90	8.00	8.55
Gross Gen. MW.HR.	34,363	38,079	43,138	46,277	45,276	46,700
Load Factor %	65.4	65.4	68.9	66.9	64.6	62.4
SOUTHERN SYSTEM						
Peak Demand MW	2.10	2.16	2.40	2.70	2.70	2.40
Gross Gen. MW.HR.	10,490	11,801	-	14,471	13,088	12,700
Load Factor %	57.0	62.4	-	-	61.2	60.4

TABLE V-2h

ISLAND: ST. VINCENT

GENERATION AND SALES STATISTICS - 1977 to 1981

	1977	1978	1979	1980	1981
Peak Demand KW	4,110	4,750	4,890	4,630	4,660
Increase on prev. year - %	6.8	15.6	2.9	5.3	0.6
Gross Generation - MW.HR.					
Hydro	8,382	9,925	9,681	10,021	10,509
Diesel	10,236	12,218	14,923	15,734	15,746
Total	18,618	22,143	24,604	25,755	26,255
Incease on prev. year - %	10.3	18.9	11.1	4.7	1.9
Load Factor - %	51.7	53.2	57.4	63.5	64.3
Fuel Consumption - imp.gall.	-	797,474	-	970,812	1,028,908
KW.HR./imp. gall.	-	15.3	-	16.2	15.3
Sales - MW.HR					
Domestic	7,644	8,048	-	8,926	9,172
Commercial	5,952	6,735	-	7,110	7,600
Industrial	1,263	2,576	-	3,226	3,236
Street Lighting	320	310	-	390	391
Total	15,179	17,669	-	19,652	20,399
Increase on prev. year - %	10.7	16.4	-	-	3.8
*Losses - % of Gross Gen.	18.5	19.2	-	23.7	22.3
No. of customers					
Domestic	8,744	9,138	-	9,697	10,603
Commercial	1,091	1,136	-	1,168	1,223
Industrial	55	57	-	42	39
Street Lighting	34	33	-	30	31
Total	9,924	10,364	-	10,937	11,896
Avg. consumption per customer					
KW.HR./year					
Domestic	874	881	-	920	865
Commercial	5,456	5,929	-	6,087	6,214
Industrial	22,964	45,193	-	76,810	82,974

* Includes power station auxiliaries and company usage estimated to average 3 percent of gross generation.

TABLE V-2i

ISLAND: BEGUIA

GENERATION AND SALES STATISTICS - 1977 to 1981

	1977	1978	1979	1980	1981
Peak Demand - KW.	268	282	282	294	Instruments damaged by fire
Increase on prev. year - %	1.9	5.2	0	4.3	
Gross Generation - MW.HR.	989	1,131	1,120	1,217	
Increase on prev. year - %	24.7	14.4	1.0	8.7	
Sales - MW.HR.					
Domestic	407	443	-	523	580
Commercial	284	311	-	341	381
Street Lighting	12	13	-	13	13
Total	703	767	-	877	974
Losses - % of Gross Gen.	28.9	32.2	-	27.9	-
Number of Customers					
Domestic	667	678	-	680	-
Commercial	72	78	-	99	-
Street Lighting	1	1	-	1	-
Total	740	757	-	780	-
Avg. consumption per customer - KW.HR./year					
Domestic	610	653	-	769	
Commercial	3,944	3,987	-	3,444	

dollars for oil and natural gas to run its power plants. At 1970 oil and gas prices, this same fuel would have cost about one-eighth the cost. From 1979 to 1983 utility fuel costs increased 75%, while gross generation increased only 19%. As the price of generating fuel increased, so did the cost of electricity for fuel. Since the rising cost of oil is routinely passed through to utility customers, the use of alternatives to free the Caribbean from oil-based electricity generation is a means of stabilizing electricity rates.

The relatively small-scale and short construction periods typifying these alternatives permit a utility to add them to its generation system in smaller, more affordable increments. This enables utilities to keep pace with gradual increases in demand and facilitates the transition to alternative based energy production and supply systems not dependent on foreign petroleum.

Alternative energy can also reduce the impacts to energy consumers in the Caribbean of sudden interruptions in their energy supply. With an accelerated development program, alternatives could provide nearly 60 to 70 percent of the Caribbean's electricity by 1995. A strategy of energy supply diversity, emphasizing alternatives and conservation can eliminate virtually all oil generation by Caribbean's electric utilities. Caribbean Islands annually spend millions of dollars on imported oil for electricity generation. Alternatives such as solar, wind, small hydroelectric, bagasse, biomass and geothermal, using locally available resources, offer the Caribbean the opportunity to invest in its own energy production.

Of course no energy technology is perfect, and the benefits listed above are tempered by risk, cost and environmental concerns. Wind and solar energy resources can be intermittently available, raising system reliability and standby reserve margin concerns. Large numbers of dispersed small energy-generating sources pose new management problems for utilities. Some alternatives like solar and wind, may not be cost competitive with conventional resources until the technology is further developed and mass produced. Alternatives

may also have relatively high pre-investment and capital costs, albeit with low or no fuel costs, which place them at a disadvantage in times of high interest rates.

C. ALTERNATIVE ENERGY RESOURCES

Eastern Caribbean Islands possess numerous alternative energy sources that can be developed to displace imported oil - these alternative energy sources are abundant (for example, geothermal in St. Lucia, bagasse on several islands, solar and wind in Montserrat, etc.) and renewable or available from domestic resources. Preliminary review of renewable resources indicates that it is possible to develop and use many of these sources because of their unique advantages for the Caribbean.

For example, in sugar refineries, cogeneration technologies make more efficient use of conventional fuels and allow bagasse to produce both electricity and industrial heat or steam in one operation. On some of the eastern Caribbean Islands geothermal heat can be used to power both small-scale electric generators and to provide industrial processing heat. In many of their applications renewable resources such as wind, solar and small hydroelectric, and biomass can be used in small-scale systems which are easily dispersed throughout the islands. This will result in fewer environmental impacts than conventional power plants. Biomass/bagasse energy offers an additional benefit because the technology often uses waste materials that have historically presented a disposal problem.

Alternative energy sources offer Caribbean businesses and consumers several significant benefits. A primary attraction is the ability to provide energy and power at relatively stable prices. Alternatives such as wind, small hydro-electric and solar energy require fixed capital costs but little fuel and O&M expenditures.

D. UTILITY'S ROLE IN DEVELOPING ALTERNATIVES

Table V-3 summarizes several alternative energy resource development programs on the seven eastern Caribbean Islands. These include small hydroelectric, wind power and limited quantities of bagasse. These islands possess several other indigenous alternative resources which may offer potential for market acceptance and cost-effectiveness and can benefit from government regulatory involvement. The Regulatory Act should be directed to the electric utilities to .."develop and coordinate a program for indigenous energy resource development such as solar, wind, biomass, bagasse, geothermal and small hydroelectric."

TABLE V-3

SUMMARY OF ALTERNATIVE ENERGY RESOURCE

Island Name	Alternative Energy Resource
1. Antigua	In Antigua with today's technology, the only commercial alternative energy resources are solar and wind. The government and Antigua Electric Light Co. have installed and are testing a 100 kW wind turbine. At present there are no plans to develop any solar electric energy. Although there is a small sugar factory in Antigua there is not enough surplus bagasse to generate significant quantities of electricity.
2. Grenada	A pre-feasibility study for small-hydro power resources was completed in 1981. This study has identified a potential site for mini-hydro power plants, sizes varying from 2000 kW to 200 kW. No other investigations related to alternative energy resources are actively underway at this time.
3. Dominica	Dominica's undeveloped hydro-electric resources represent the logical choice for further alternative energy resource development. A preliminary study indicated that there is good potential for geothermal

	energy in certain areas of South Central Dominica. Also, the coconut industry is of great importance to Dominica's economy and coconut shells could possibly offer an alternative source of energy.
4. St. Kitts/Nevis	Recent studies have indicated that there are potential sites for wind power generation. Electricity can be generated by burning surplus bagasse at the sugar factory. At present, factories incinerate bagasse on order to dispose of the surplus. Also, hot springs in Nevis suggest the possibility of some geothermal potential on the island.
5. Montserrat	Wind and geothermal energy are the only two alternative energy resources which could be exploited to reduce the dependence on imported oil. There are no large streams on the island which would allow hydro-electric power development. Solar water heating will not contribute significantly to reduce the electric energy or oil consumption.
6. St. Lucia	The hydroelectric potential of the island is small in relation to its total electric power demand. Surface manifestations of geothermal activity at Surfriere hold the promise of generation of electricity from geothermal sources in that area. Other than solar hot water heaters, no other alternative energy sources are presently considered for commercial development.
7. St. Vincent	There are several potential undeveloped hydroelectric sites on the island. Volcanic activity in the northern section of the island indicates the potential for geothermal power in the future. In Beghia it may be possible to develop wind-power but no formal feasibility study is being undertaken.

Table V-3 clearly indicates that there are several potential alternative energy resources on the eastern Caribbean Islands but at present only a small fraction of these resources is being exploited. This summary table also indicates that there is very little private investments in the alternative energy resource development program on the Caribbean Islands.

E. INSTITUTIONAL NEEDS

The government's proper role in shaping society and responding to social problems is much in debate. Some people argue that all energy problems can be resolved if left to the operation of "free-market" forces. Others believe a strong regulatory role for government is necessary to overcome market imperfections and to balance resource allocation with security, environmental and social equity concerns.

Caribbean Islands' energy policy so far has relied mainly on government actions as a means of channeling investments into conventional energy technologies. This approach did not recognize that "free-market" forces can also be useful in promoting economically rational choices. Also, the few regulatory institutions on the Caribbean Islands have not developed policies which work with and through market forces. There is no legislation which encourages private investors to develop an alternative energy project and sell the electricity to the distributing utility at an avoided cost of generation. In fact on some of the islands it is illegal to generate electricity, even for private use, unless the approved utility grants this right.

The Caribbean's current energy policy has focused primarily on meeting the immediate needs based on imported diesel oil generation. This policy did not promote a diverse range of energy options, including various alternative energy technologies. Government policy should be focused on accelerating development of a variety of local resource based energy options because they can provide the greatest long-term social and economic benefits. Alternatives and renewable resources are found to offer stable fuel prices and greater diversity and flexibility than their conventional counterparts.

F. REGULATORY BARRIERS

There are three major regulatory barriers on the Caribbean Islands which prevent private development of alternative energy resources. The first is that the utilities are not obliged to buy power from qualified cogenerators or small power producers and in those instances where they do, they may not be offering a fair price. The second is that the utilities may discriminate against cogenerators or small power producers in providing utility services, such as by refusing to provide back-up services - to do so at reasonable rates - or refusing to operate in parallel with small power producers. The third perceived barrier to small power producers is that a sale to a third party via utility transmission network (power wheeling) is not allowed.

These are some of the basic institutional barriers which will have to be resolved to promote alternative technologies and private investment in the electricity sector.

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