Report No. 5466-JM

Jamaica: Issues and Options in the Energy Sector

April 1985

Report of the Joint UNDP/World Bank Energy Sector Assessment Program

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JAMAICA

ISSUES AND OPTIONS IN THE ENERGY SECTOR

APRIL 1985

This is one of a series of reports of the Joint UNDP/World Bank Energy Sector Assessment Program. Finance for this work has been provided, in part, by the UNDP Energy Account, and the Canadian International Development Agency through the UNDP; and the work has been carried out by the World Bank. This report has a restricted distribution. Its contents may not be disclosed without authorization from the Government, the UNDP or the World Bank.

ABSTRACT

Jamaica is a small island country in the Caribbean. Economic performance was poor after 1973 as a result of external shocks and the impact of domestic policies. The bauxite/alumina industry and tourism are the major economic activities and alumina exports have substantially underwritten most of the development in the country. However, over the past few years both the output and exports of this sector have declined sharply. The economy has recovered somewhat in the last three years. GDP grew by 3.2% in 1981 and 1.8% in 1983. The economy stagnated in 1982, primarily because of the impact of the industrial recession on the bauxite/alumina industry. The growing burden of oil imports (US$386 million in 1983) cuts heavily into the country's exports (US$673 million in 1983). This report focuses on the many steps which are needed to improve the situation in the energy sector and discusses the technical, organizational and institutional policy and investment options which should be followed during the next 10-15 years.

ACRONYMS

BOS	-	Bureau of Standards
CAST	-	College of Arts, Science and Technology
CIDA	-	Canadian International Development Agency
EEC	-	European Economic Community
FIDCO	-	Forest Industrial Development Company
GOJ	-	Government of Jamaica
IBRD	-	International Bank for Reconstruction and Development
IDB	-	Inter-American Development Bank
IMF	-	International Monetary Fund
JBI	-	Jamaica Bauxite Institute
JOS	-	Jamaica Omnibus Service Company
JPS	-	Jamaica Public Service Company
KMR	-	Kingston Metropolitan Region
MONENCO	-	Montreal Engineering
MPUT	-	Ministry of Public Utilities and Transport
MMET	-	Ministry of Mining, Energy and Tourism
NACE	-	National Advisory Council on Energy
NACEC	-	National Advisory Council on Energy Conservation
NBC	-	National Development Bank of Jamaica Limited
NRCD	-	National Resources Conservation Department
OLADE	-	Latin American Organization for Energy Development
OTEC	-	Ocean Thermal Energy Conversion
PCJ	-	Petroleum Corporation of Jamaica
PIOJ	-	Planning Institute of Jamaica
PIU	-	Project Implementation Unit
PSIP	-	Public Sector Investment Program
PSMP	-	Power Sector Master Plan
REPL	-	Rural Electrification Programme Limited
SRC	-	Scientific Research Council
UNDP	-	United Nations Development Programme
USAID	-	United States Agency for International Development

This report is based on the findings of an energy assessment mission which visited Jamaica in March-April 1984. The mission comprised Messrs: Zia Mian (Mission Chief); Gary Gaskin (Deputy Mission Chief, Conservation); Luis Gutierrez (Power Economist - IDB); Homayoon Ansari (Petroleum Exploration); Roy Chin (Refinery Consultant); Abu Talib (Renewables Consultant); Jaime Millan (Power Specialist - IDB); Bob Abramson (Institutional Specialist); Anssi Kalamari (Peat Consultant); Jan Lindemark (Hydropower Consultant); and Ms. Polly Jones (Macro Economist). The mission benefitted from discussions with the USAID energy project in Jamaica and was assisted by Mr. Hamid Khan (Energy Economist - UN Energy Project in Jamaica) with the technical analysis of the petroleum subsector. The draft report was discussed with the Government of Jamaica in March 1985.

CURRENCY EQUIVALENTS

Through April 1977	US$1.000 = J$0.909	J$1.000 = US$1.100
	- Dual exchange rate system -	
April 1977 - May 1978		
May 1978	US$1.000 = J$1.550	J$1.000 = US$0.645
December 1978	US$1.000 = J$1.695	J$1.000 = US$0.590
May 1979 - January 1983	US$1.000 = J$1.781	J$1.000 = US$0.561
	- Dual exchange rate -	
Jan 1983 - Nov 1983		
(Official Rate)	US$1.000 = J$1.781	J$1.000 = US$0.561
(Parallel Rate)	US$1.000 = J$2.71-2.96	J$1.000 = US$0.338-0.369
	- Floating band -	
November 1983 - Present		
(Dec. 1983 avg.)	US$1.000 = J$3.40	J$1.000 = US$0.294
May 1984	US$1.000 = J$3.70	J$1.000 = US$0.270

MEASUREMENTS

BTU (Btu)	British thermal unit	=	0.252 kilocalories
Bbl	barrel	=	159 liters (42 US gallons)
BD	barrels per day		
boe	barrel of oil equivalent	=	6 million Btu.
m3	cubic meter		
GWh	gigawatt hour		
MWh	megawatt hour		
hz	hertz		
kWh	kilowatt hour		
kV	kilovolt		
MVA	megavolt ampere		
pa	per annum		
tonne	metric ton		
Tpa (tpa)	tonnes per annum		
TOE (toe)	tonne of oil equivalent	=	39.68 million BTU (10 million kilocalories)
MBD	thousand barrels a day		
MTOE (Mtoe)	thousand TOE (toe) = 1,000 tonne of oil equivalent		
US Gallon		=	0.833 imperial gallon or 3.785 liters

ENERGY CONVERSION FACTORS

Fuel 1/	TOE per physical unit 2/
Liquid Fuels (tonne)	
LPG	1.08
Avgas	1.04
Gasoline	1.05
Kerosene/Turbo Fuel	1.03
Diesel Oil (ADO)	1.02
Biomass Fuels (tonnes)	
Bagasse	0.45
Firewood	0.33 - 0.35
Coconut Husk	0.41
Coconut Shell	0.51
Coconut Palm Wood	0.27
Coal (tonnes)	0.62

Conversion of one barrel of oil (Bbl)	Barrel of oil equivalent (BOE)
LPG	0.699
Aviation Gas	0.798
Turbo Gas	0.920
Kerosene	0.920
Gasoline	0.873
Diesel Oil	0.968
Fuel Oil	1.00

1/ 1 TOE (toe) = 10 million kcal
= 39.68 million Btu

2/ Avgas (Aviation Gasoline) = 1413.6 liter/tonne
LPG (Liquified Petroleum Gas) = 1729.1 "
Gasoline (Motor Spirit) = 1356.8 "
Kerosene/Turbo Fuel = 1229.1 "
Diesel (ADO) = 1186.5 "

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SUMMARY OF ISSUES AND RECOMMENDATIONS

1. Jamaica is a Caribbean island with a population of 2.2 million and a GNP per capita of US$1,300 (1983). The economy is mainly dependent upon the bauxite/alumina and tourism industries. Rapid economic growth was experienced during the 1960s, mainly due to the development of these two industries. However, from 1974 to 1980, real GDP declined and by 1980 it was 18% below the 1973 peak. Over the same period, the balance of payments was under continuous pressure, mainly due to stagnating bauxite/alumina exports, falling tourism receipts, private capital outflows, and an oil import bill increasing from US$72.7 million (18.5% of exports) in 1973 to US$406.8 million (53% of exports) in 1982; the current account deficit rose from US$180.3 million in 1973 to US$380.3 million in 1982, resulting in mounting debt service and pressure on the rate of exchange. 1/

2. Imported oil continues to be the main energy source in the energy balance (89% of supply in 1983) while at the same time adding substantially to the country's mounting external debt. Substitution of oil by indigenous energy resources 2/ has been minimal and even if proven reserves of peat, hydropower and bagasse were developed to their optimum capacity, only a minor contribution to future energy supplies can be expected.

3. With oil demand estimated to grow at 4.5% p.a. (1983/90), a concerted effort is required to exploit coal substitution opportunities and increase demand efficiencies. The consumption of imported oil is heavily concentrated in the alumina, transport and power subsectors which in 1983 respectively consumed 39%, 16% and 12% of total oil imports. Within the major oil-consuming subsectors of alumina and power, as well as in sugar, substantial potential for oil substitution exists. In 1981, per capita energy consumption was 0.98 toe; however, after discounting the energy-intensive bauxite/alumina enclave, per capita consumption falls to about 0.31 toe. While energy consumption on a per capita basis is reasonable, improvement in energy efficiency relative to GDP has been

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1/ From November 1983 to March 1985, the J$ has devalued from US$0.561 to US$0.189. External debt rose from US$349 million in 1973 to US$2,800 million at the end of 1983. In June 1984, the IMF approved a SDR 136.6 million credit facility, conditional upon a major reduction in the central government's deficit; restrictions on the growth of credit; and a unified flexible exchange rate in order to achieve an overall balance of payments surplus.

2/ In 1983, indigenous resources made up 11% of total energy supplies. The breakdown of the 1.58 million barrels of oil equivalent (Mboe) supplied was 67% bagasse, 30% fuelwood and 3% hydropower.

poor and indications are that since 1974 energy efficiency has actually declined in many important production and service sectors.

4. Within the energy sector the Government faces a multitude of issues. Some require urgent resolution while others, although important, must be treated as less urgent.

Immediate Priority Recommendations

5. These recommendations are framed against a background of foreign exchange shortages and an extremely high debt-service ratio. 3/

Priority Short-term Recommendations

(a) The Jamaica Public Service Company (JPS) rehabilitation program is a critical element in repairing the nation's energy infrastructure. All investments ($J52 million) required to keep this program on schedule should be undertaken (2.7). 4/

(b) JPS should implement a disciplined preventative maintenance program and the Government should ensure that adequate foreign exchange is made available for purchasing spare parts (2.9).

(c) Within the existing foreign exchange constraints, the Government should provide the refinery with a foreign exchange budget so that refinery operations can be planned according to the foreign exchange allocated (3.20).

(d) The Government should restructure the Ministry of Mining, Energy and Tourism (MMET) so as to focus its efforts on energy policy, planning and sector coordination (6.3).

(e) When appropriate, the responsibility for developing electrical generation options should be transferred from the Petroleum Corporation of Jamaica (PCJ) to JPS (6.13).

Priority Long-term Recommendations

6. The primary objective of the long-term action plan proposed in this report is to develop an efficient and cost effective energy supply. A secondary objective is to reduce dependence on imported oil. Accordingly, the mission recommends that: (a) the scope of the existing energy

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3/ Jamaica's debt service ratio is expected to be around 40%.

4/ References in parenthesis are text paragraphs where recommendations are discussed in detail.

conservation program be expanded so that all ministries are involved; (b) high level inter-ministerial committees be established to review and monitor energy projects; (c) all power developments be evaluated within the framework of the Power Sector Master Plan (PSMP); (d) greater levels of energy efficiency be achieved in the alumina, sugar and tourist industries; (e) high priority be given to increasing the energy efficiency of the transport sector; and (f) a centralized monitoring and reporting system be introduced consistent with the need to improve efficiency. The Government should ensure that all projects have a sound economic justification, so that scarce foreign exchange and manpower resources are not diffused and wasted on low-return energy projects. Detailed recommendations on a subsector basis are discussed in the following sections.

Power Subsector

7. The main issues in the power subsector are: implementation of a least cost power development program (which includes selective rehabilitation), the restructuring of power tariffs, reduction of system losses and resolution of labor problems.

Pricing

8. The present five categories of tariffs used for billing purposes discriminate amongst consumers on the basis of kWh usage and do not reflect the cost differences that the various consumer groups impose upon the system. A new tariff structure is required which reflects the cost variations of supply, groups similar types of consumers, and promotes a rational consumption pattern by conveying the correct pricing signals. JPS has recently commissioned a study which should help in redesigning the present tariff structure. The mission recommends that the present tariff structure should be changed within one year -- based on the results of this study.

Supply

9. In 1981 and 1982, generation failures were respectively 73% and 87% of total outages. Low plant availability resulted in the use of expensive fuels and intensive use of power plants with low operating efficiencies. With improved plant availability from 1980 to 1983, JPS could have saved about US$5 million p.a. in fuel costs. The major problem has been the lack of a sound and orderly preventative maintenance program combined with design limitations on some major thermal units which have reduced their availability and output capacity. Before the end of 1985, JPS plans to introduce a preventative maintenance policy for all its units after the installation of two new barge-mounted 20 MW slow-speed diesel generators. The mission recommends that JPS immediately implement a disciplined preventative maintenance program even though margins of reserve might be less than adequate. Random breakdowns of the

efficient units in the system are more costly to industry and the economy than planned interruptions for repairs and maintenance. The major obstacle to a sound maintenance program has been a shortage of foreign exchange to purchase spare parts. The mission recommends that the Government develop an institutional mechanism which will provide the timely supply of spare parts within the current foreign exchange constraints.

System Losses

10. In 1984, system losses were 19.4% of the net power generated. The largest losses relate to "unaccounted for" consumption 5/ which in 1984 caused a revenue loss of approximately J$70 million for JPS. The mission recommends that JPS design a program and timetable for reducing unregistered and illegal consumption. JPS should also set a target to reduce total losses, including in its own consumption, to a maximum level of 15%. The plan for reducing "unaccounted for" consumption should be a continuous effort of disconnecting illegal users, educating the public, and improving measuring and billing procedures (2.16).

Investment

11. JPS, with World Bank financing, commissioned Montreal Engineering (MONENCO) to do a comprehensive system planning study (PSMP). Prior to the MONENCO study, different alternatives were appraised independently on a project-by-project basis, taking as benefits the equivalent fuel saved. The draft PSMP recommends the following program for the period 1984-1994:

(a) Rehabilitation of Hunts Bay gas turbine units No. 1 and 2;

(b) Begin construction of several small hydroelectric developments (Morgans, Wild Cane, Green, Spanish, Yallahs, Rio Grande and Martha Brae rivers);

(c) Conversion to coal of Old Harbour Station units 3 and 4 and construction on the same site of coal reception and handling facilities;

(d) Installation of a new coal-fired plant at Old Harbour, the first unit to start operation in 1990 and the second in 1994; and

(e) Commissioning of two gas-turbines by 1992 and 1993.

12. The mission's conclusions are: (a) rehabilitation of units 1 and 2 of Hunts Bay Station should proceed immediately; and (b) it is

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5/ Unregistered and illegal consumption.

economic to pursue coal generation options. However, the following aspects would require additional analysis to clear up some elements of uncertainty:

(a) Although JPS has expressed a number of concerns regarding the use of coal at Old Harbour, the only relevant questions which must be resolved are the operational reliability of units 3 and 4 after conversion to coal and associated ecological effects.

(b) Although analysis indicates that cogeneration is an economic option, it is not certain if it is better than a new coal fired plant. The issues of concern are arrangements for plant operation and maintenance, and supply arrangements between JPS and the alumina company.

(c) Before proceeding with hydropower, the least cost analysis should include the latest information on the Back Rio Grande project. A Blue Mountain water resource study is also needed.

(d) Although the peat project as considered by MONENCO did not form part of the least cost expansion plan, it may be possible to improve the economics by changing its scale and technical configuration.

Petroleum Subsector

13. Imported petroleum products are the backbone of Jamaica's energy supply and represent 90% of commercial energy. The main issues in the subsector relate to: cross subsidies in retail pricing, distorted relative prices, inefficient distribution, recurring shortages of feedstock for the sole refinery, and failure of the oil exploration program. Available options are constrained by foreign exchange shortages and non-competitive practices in the distribution system.

Pricing

14. The ex-refinery/terminal prices are supposed to be based on the average of Caribbean import parity plus freight (Worldscale/AFRA), insurance and ocean losses. The petroleum pricing structure has become complex, reflecting the Government's efforts to meet several objectives which include: (a) keeping the price of LPG and kerosene low in view of their use by low-income households; (b) generating funds to cover foreign exchange losses incurred by the refinery/PCJ because of the dual exchange rate; and (c) between June 1983 and May 1984, moderating the rise in electricity tariffs by selling fuel oil at a reduced price to JPS. Since the Government takeover of the Esso refinery, the ex-refinery price structure has not been closely monitored by the Government. An accurate pricing structure is required so that policy decisions on matters such as importing refined products can be made. The mission recommends that all

subsidies on petroleum products be removed and taxes rationalized. Further, in the long term, petroleum prices at all levels should be deregulated. The new exchange rate mechanism combined with a relatively constant and significant devaluation has added another dimension to petroleum product pricing. Until recently, market prices have lagged behind exchange rate movements (3.16).

15. Aviation fuel prices at Jamaica's international airports have been low relative to the rest of the Caribbean region. At times, turbo fuel prices were subsidized under the dual exchange rate mechanism by pricing products at the lower official exchange rate. Currently, the Government airline, Air Jamaica, receives a cross subsidy through a mechanism which controls the price of petroleum products. The mission recommends that the cross subsidy to Air Jamaica be discontinued and the price of aviation fuel be allowed to rise to its opportunity cost as determined by regional market trends (3.5).

16. Both LPG and kerosene are subsidized by the Government on the basis of their importance as cooking fuels to low-income households. In January 1984, the retail price of kerosene in Jamaica was slightly more than half that in neighbouring St. Vincent and St. Lucia. Due to the wide price differential between kerosene and automotive fuels, kerosene is used for diesel oil adulteration. The mission estimates that of the 240,000 bbl supplied, 71,000 bbl are consumed domestically while a large percentage of the balance, i.e. 169,000 bbl is directed to other uses including adulteration in diesel oil and gasoline. The mission recommends that the relative price of kerosene be adjusted to reflect its opportunity cost. Due to low margins to the distributors, the product does not reach some of the rural communities. With increasing margins, marketing companies will take an active interest in marketing kerosene. If a specific population segment is to be subsidized, the subsidy should be identifiable and funded from Government revenues.

Marketing and Distribution

17. Jamaica's total inland market of 20,400 barrels/day (Mbd) is shared between three marketing companies: Esso, Shell, and Texaco. Because of a dealer association at the retail level, the market is non-competitive. Similarly, the transport of petroleum products from terminals to retail outlets is non-competitive due to union control of the haulage fleet. There is over-capacity of haulage tankers and each contractor is allocated a percentage of the market. The assured margins provide a disincentive for an efficient marketing and distribution system. If competition were encouraged in the market at the retail level, then consumers would benefit through improved service and lower prices. The mission recommends that the GOJ ensure an open market in the distribution and marketing of petroleum products (3.15). The proposed least cost petroleum supply study should also have a serious look at the marketing/distribution system with an aim to improving its efficiency and saving foreign exchange costs.

Refining

18. Jamaica has one refinery (36,000 bbl/day) which is located in Kingston and owned by the Government. Recently, due to severe foreign exchange shortages, the local refinery has had to purchase spot cargoes of various crude oils which were purchased because of favorable credit terms rather than on the basis of lowest cost.

19. The economic viability of the refinery rests on both short-term and medium to long-term issues. In the short term, uncertainties surrounding the availability of feedstock due to foreign exchange shortages have significantly affected refinery operations in two ways. First, the refinery has lost production efficiency due to frequent shutdowns and changing feedstocks; and secondly, spot purchases have increased the cost of feedstock. In the short term, to reduce the foreign exchange cost of petroleum imports, the Government should make available a budgeted amount of foreign exchange to the refinery so as to ensure consistency in operations and the ability to purchase cheaper feedstocks (3.38). Further, the Government should investigate the potential to optimize the procurement of petroleum supplies under or outside the Venezuela/Mexico Accord.

20. In the absence of sufficient data from the Government, the mission's analysis on the economic viability of the refinery had to rely mainly on current and projected worldwide industry developments and pricing trends. The analysis shows that the Venezuela/Mexico accord, even if it remains in force, is only worth US$1.18/bbl to Jamaica. This compares with purchasing options of products at indexed spot prices which could save Jamaica US$1.61/Bbl. (3.26). The economic viability of the refinery in the medium- to long-term has not been evaluated and the mission recommends that an independent and objective analysis be done to determine the least cost petroleum supply option.

Exploration

21. Jamaica's oil exploration efforts have not been successful, and the results of eleven dry holes as well as the geologic complexity of the country have not produced any evidence of hydrocarbons. While the mission agrees with PCJ that the petroleum prospects of Jamaica should not be totally discounted, the mission believes the complex geology of the offshore shelves warrants additional investigation and research before further capital-intensive exploration drilling is undertaken. The mission agrees that detailed systematic geologic studies of the area could continue which would throw additional light on the unknown geologic aspects of the prospective areas, particularly the offshore prospects. Additional exploration drilling should be dependent upon the result of further studies and should be undertaken by the private sector alone or by private sector risk participation (3.43).

Renewable Energy Subsector

22. Renewable energy resources will not make a significant contribution to Jamaica's future energy supplies. However, in some areas, notably sugar production, renewable resources may have a worthwhile role to play in the energy mix. Within the subsector, the major issues relate to the poorly coordinated research and development efforts, the misallocation of scarce manpower resources to renewable projects with low economic returns, and the need to increase the efficiency of energy use in charcoal and sugar production.

Bagasse

23. In 1983, the sugar industry consumed 803,000 tons of bagasse together with 109,000 bbl of fuel oil. In the early 1970s, the sugar industry was essentially self-sufficient in energy, using bagasse and virtually no oil. Today, outside Jamaica, many modern sugar factories are energy self-sufficient and in some cases are producing excess electric power for sale to local power utilities. The mission studied the largest sugar mill in Jamaica (Frome) and concluded that not only could the mill be energy self-sufficient but there was the possibility of selling excess bagasse to the proposed peat power plant located in an adjacent area. The mission recommends that the GOJ undertake a detailed study of the potential of the sugar industry to supply surplus power to the JPS grid (4.5). Further, the mission recommends that the GOJ immediately implement an energy efficiency program for sugar factories which will become operational after the present rationalization of the industry is complete.

Fuel Ethanol

24. At present, fuel ethanol production is not an economic proposal for Jamaica. The mission recommends that the conversion of existing sugar factories to fuel ethanol distillaries not be considered and no molasses be diverted for fuel ethanol production (4.23). The present proposals for a 1.5 million gallons per year cassava-based ethanol plant should be reviewed as some important economic and operational issues have not been satisfactorily addressed (4.25).

Fuelwood

25. In 1983, the domestic consumption of fuelwood was approximately 188,000 tons, of which 92% was converted into charcoal. The use of fuelwood by the commercial and industrial sectors is small and little growth in fuelwood demand is expected. It is estimated that a total of 1.06 million tons of wood per year can be made available from existing forest reserves. Deforestation is not a major issue; however, active forest management combined with reforestation projects will eliminate the deforestation trends normally associated with increased charcoal utilization in domestic and/or the commercial and industrial sectors.

The mission recommends that the Forestry Department prepare a detailed regional inventory of species, yield measurements, and a harvest-ability analysis to improve the estimates of woodfuel production. An active program to increase the efficiency of charcoal production should be implemented; present production methods are inefficient. Advice on kiln design should be obtained from the U.S. Forest Service and technical assistance from Brazilian experts should be explored through a UN/FAO sponsored program (4.16). The mission also recommends that the present wood gasification program be scaled down until suitable expertise is developed in Jamaica. Before recommending or implementing a gasifier test program, the Scientific Research Council (SRC) should seek technical assistance from wood gasification experts from the U.S. or European countries such as the Netherlands, West Germany or France (4.18).

Solar Thermal Systems

26. There are many groups active in promoting the use of solar energy in Jamaica. The mission found that limited Government resources were being spread over too many projects and consolidation of effort and resources was required. The mission recommends that the commercialization of solar hot water heaters be left to the private sector. The local industry participation in the present solar equipment performance standards (which are undertaken by MMET and the Bureau of Standards (BOS)) should be increased (4.26). The mission further recommends that the GOJ investigate economic incentives, such as investment tax credits, waiving of sales tax, etc., to enhance the ongoing private sector commercialization efforts. The Scientific Research Council (SRC) should concentrate on solar crop drying rather than lumber drying and should actively monitor ongoing pilot and demonstration projects such as those sponsored by USAID (4.27).

Ocean Thermal Energy Conversion (OTEC)

27. The GOJ should closely monitor the ongoing research efforts in the U.S. and other countries (4.28).

Wind Energy Systems

28. Preliminary indications are that low wind speeds in Jamaica will make wind power systems uneconomical (4.29).

Energy Conservation/Efficiency

29. Jamaica's performance in energy demand management has been poor. Both energy intensity and elasticity analysis indicate that energy efficiency has actually fallen since the energy crisis of the mid-1970s. Jamaica's trend is counter to that of most countries where higher oil prices have brought about significant improvements in energy efficiency.

30. Apart from pricing issues, which have been discussed under the power and petroleum subsectors, other major issues are: the lack of a national and Government energy conservation program; the need to improve operational efficiency; and the lack of energy efficiency standards. Due to foreign exchange constraints, Jamaica has not been able to benefit from the latest fuel-efficient equipment. The options available are essentially limited to operational improvement and, where possible, retrofitting equipment which uses outmoded energy technologies.

Management

31. Current energy conservation efforts are confined to the USAID sponsored program which is being implemented through the MMET. So far, the program has been narrowly focused and does not directly include many Government ministries. The mission recommends that an energy cell be established within each GOJ Ministry. The size and the resource requirements will vary depending upon the potential to improve the efficiency of the energy used by each Ministry. In particular, there is an urgent need to establish a cell in the Ministry of Public Utilities and Transport (MPUT). Energy supply utilities such as JPS should develop energy conservation programs which include consumer education and tariff revision to encourage energy conservation.

32. The Government lacks a suitable statistical base by which to analyze energy consumption in the various energy consuming sectors. The mission recommends that the GOJ institute a Management Information System (MIS) which will assist the Government in developing energy policy and investment priorities for the various demand sectors. The Minister of MMET should, in conjunction with selected Cabinet Ministers, annually review the nation's performance using the MIS and identify areas where improvements are required.

Industry

33. The severe foreign exchange constraint calls for improvement in operational efficiency as a major energy saving option for the nation. The mission recommends that the GOJ join with the private sector to develop an energy conservation training program (5.42). Initially, the program should focus on industrial training but, as Jamaica's priorities change, it should have the flexibility to move into particular sectors such as transport.

Transport

34. Second to the alumina sector, transport has the largest demand for petroleum products. It is essential that fuel consuming units operate as economically as practical and that scarce foreign exchange be allocated to achieve this result. Pricing transport fuels at their opportunity cost is the first essential step in a conservation program; however, other policy initiatives are required in those sectors where pricing cannot be effectively used. Therefore, the mission recommends

that all imported motor cars (including externally financed) comply with an appropriate fuel efficiency standard. 'De facto' standards, such as the USA/EPA or Japanese 10 mode test, could be used since it is not practical to develop a specific Jamaican standard (5.20).

35. Government transport taxes can heavily influence the fleet mix and in turn fuel consumption patterns. The mission recommends that the annual licence fee be based on vehicle mass, not engine capacity. The annual fee for diesel-powered vehicles should be lowered to the same level as for gasoline powered vehicles to encourage their use. Because of the higher fuel efficiency in diesel-powered vehicles, priority should be given to importing them rather than gasoline-powered vehicles.

36. High-mileage vehicles such as taxis and tourist vehicles should be the most efficient in the fleet. The mission recommends that the Government implement incentives which will encourage the use of efficient vehicles. Although not ideal, licencing requirements for taxis can be used in the short run to encourage the use of fuel efficient vehicles. 6/ Vehicles which are more than five years old should be phased out of the taxi fleet. Vehicle import priorities should be set such that the limited foreign exchange which is available is allocated to high-mileage vehicles such as taxis and tourist vehicles. The use of motor cars which have a combination of old design and large mass should be discouraged through taxes that increase the annual fixed charges. Private vehicles over ten years old and 1,500 kg mass should be heavily taxed. The Government should encourage the use of private sector van and car pooling in the Kingston area. Given the extensive use of motor cars for transport to work, this option should be actively pursued by the GOJ (5.20).

Trucks and Buses

37. By using existing regulations the Government can help truck and bus owners achieve greater levels of fuel efficiency. The mission recommends that the Government, through the public passenger vehicle (PPV) licencing approval board, issue guidelines to operators on preferred vehicle types and sizes based on the licenced route load and traffic characteristics (5.28). MPUT should determine load freight flows within Jamaica and develop recommendations on the appropriate vehicle size that will optimize economic transport of the freight. This would be a high priority for the energy efficiency cell to be formed in the Ministry. On specialized routes such as Kingston-Montego Bay, integrated rail/truck systems should be investigated. The wide use of trailers should be encouraged on those routes where there are no practical constraints (road width, safety) to their use. Local manufacture with moderate foreign exchange requirements makes trailers an attractive option to offset a

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6/ The present licencing fee of J$75.50/year for taxis could be modified to encourage more efficient vehicles.

declining fleet capacity. Trailers offer flexibility as well as a low cost option for increasing capacity (5.36).

Standards

38. In most industrialized countries energy efficiency standards have made a major contribution towards reducing energy consumption. In Jamaica, considerable baseline research has been done in many areas but the vital step of formulating and proclaiming standards has not taken place. The mission recommends that the Government, in conjunction with the private sector, set a timetable for introducing standards for motor cars, motor cycles, air conditioners, cooking stoves (kerosene), refrigerators, and commercial buildings (5.20, 5.21 and 5.44).

Institutions

39. Institutional weaknesses are the source of major issues in the various energy subsectors. Jamaica's energy sector has received financial and technical assistance from a variety of multilateral and bilateral donors: the United Nations Development Programme (UNDP); International Bank for Reconstruction and Development (IBRD); United States Agency for International Development (USAID); Canadian International Development Agency (CIDA); European Economic Community (EEC); and the Governments of West Germany, Italy, the United Kingdom (UK), and Scandinavian countries.

40. Numerous statal and parastatal agencies are involved in the energy sector - including the Petroleum Corporation of Jamaica (PCJ), Jamaica Public Service Company (JPS), Ministry of Public Utilities and Transport (MPUT), Ministry of Mining, Energy and Tourism (MMET) - but each institution is operating in isolation without an appropriate coordinating link to one agency determining overall energy sector priorities. No single agency is providing the lead role. Although the Energy Division within the MMET is supposed to be the lead organization in the energy sector, it has been unable to execute its mandated role. Regulatory functions within the energy sector are fragmented, and some of the parastatals such as PCJ are self-regulating and effectively controlling important policy instruments such as the refinery's pricing structure.

41. Since the Energy Division's business is energy policy, coordination and monitoring (not project implementation), the mission recommends that the existing USAID-funded Project Implementation Unit (PIU) be

disbanded and made a separate organizational entity. 7/ The Energy Division should be reorganized into a smaller but more effective organization (manned by fewer but high quality staff) comprised of just two branches. The size of the unit should not exceed 8-10 professionals with clearly defined responsibilities and position specifications (6.10).

42. The two main organisations responsible for power development (JPS and PCJ) are not working harmoniously due to conflict over their respective roles. The mission recommends that JPS be provided with the necessary resources to obtain expertise when required for project development and implementation. Resources should also be provided to strengthen JPS system planning, project development and implementation concerning the power sector.

43. The National Advisory Council on Energy Conservation (NACEC) has not contributed to energy conservation policy because of a combination of many factors. However, NACEC has an important role to play in energy policy development. The mission recommends that NACEC be reconstituted as a new, high level National Advisory Council on Energy (NACE) to advise the Minister of MMET on policy. 8/ NACE should be given clear objectives and adequate resources to achieve these objectives. The MMET's Energy Division should be the technical secretariat for this Advisory Council (6.25).

44. Coordination and cooperation among the many ministries associated with energy matters is ad hoc and informal. The mission recommends that the Government establish appropriate inter-ministerial committees. MMET, MPUT, MSTE, and other Ministries should meet on a periodic basis to address outstanding energy issues and problems that are inter-ministerial in nature, e.g. conservation issues, transport fleet policy, least-cost power expansion, etc. Furthermore, at the beginning of a major energy project the Government should establish a well balanced working committee to provide policy guidance and technical advice.

Investment

45. The current energy investment program is characterized by numerous feasibility studies and is complicated by the participation of several donors and executing agencies (Annex Table 1.3). The large number of projects is straining the Government's implementation and supervisory capacity and, more importantly, its ability to set investment

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7/ When the draft report was reviewed in March 1985, the Mission was informed that the GOJ indeed had disbanded this unit and established a National Advisory Committee on energy.

8/ See footnote 7.

priorities for the sector. The Government's efforts need to be more focused and selective than at present. Emphasis needs to be placed on investment in energy efficiency in the productive sectors, which would have a positive impact on industry competitiveness and overall economic performance.

46. The main features of the investment program are: (a) the large investment in the power sector with over one-third of the total investment committed to purchasing two (20 MW) barge-mounted diesel generators; (b) the pursuit of many energy options which have low economic returns and divert resources away from high priority projects; and (c) the rigidity of the program in 1984-85 due to the committed purchase of the two barge-mounted diesel generators.

47. Under the Government's proposed PSIP (1985/86-1987/88) investments in the power and energy sectors represent 20% of the expenditures for the first two years of the program. The proposed energy investments for the Ministry of Mines, Energy and Tourism appear more focused than in previous years. However, some projects were shifted to the Ministry of Science and Technology (rural energy systems and photovoltaics) 9/ whose program is not fully included in the PSIP, and others are pending final negotiations with OLADE and the Italian Government. Also, some alternative energy projects, such as wind mapping, may be consolidated under a USAID project. It is important that only priority projects with demonstrated benefits be included.

48. The major questions in the proposed capital programs concern the: (a) inclusion of some outlays on the project to generate electricity from peat resources because no final decision has been made yet on whether to go ahead with the project; and (b) energy conservation investments for PETROJAM. The major uncertainty in the sector is the investment implications of the recommendations of the power sector master plan. The two projects which are ranked highest are: (a) coal conversion of two units at Old Harbour (JPS management has reservations on this proposal); and (b) a new coal-fired generation facility. Both of these projects are large and therefore could substantially change the investment program. There are also concerns regarding the economic viability of the refinery which should be resolved before proceeding with new investments.

49. As institutional reforms take place, a new energy investment portfolio should be developed on the basis of sound economic evaluation methodologies and adequate review procedures. Many of the projects implemented in the past have not been adequately reviewed, have poor economic returns, and have in the past diverted scarce foreign exchange and manpower resources away from priority projects.

9/ By the end of 1984, this ministry was merged with the Ministry of Agriculture.

I. ENERGY AND THE ECONOMY

Overview

1.1 Jamaica is the largest of the English-speaking Caribbean islands, with a total area of 4,244 square miles. The tropical climate provides excellent conditions for the development of agriculture and tourism. Rainfall is high, with an annual average of 77.1 inches (1.96 m) and up to 200 inches (5.08 m) a year in the Blue Mountains located in the eastern part of the island. The country is dominated by a single large urban center, the Kingston metropolitan area, which houses more than one-fourth of the country's 2.2 million people.

1.2 Apart from indigenous energy supplies the country is fairly well-endowed with natural resources and has a well-educated and skilled labor force. Jamaica is close to North American markets, and there is potential to further develop exports of manufactured goods to these markets. However, the economy is sensitive to international price and demand changes and depends entirely on imported oil for commercial energy supplies.

1.3 The economy is slowly emerging from the declines suffered during the 1970s. In 1980 real GDP stood 18% below the 1973 peak. While consumption expenditures, particularly public expenditures, increased in relative importance (although real per capita consumption fell by almost 30% from the 1974 peak), investment expenditures declined from 22% of GDP in 1974 to about 13% at the end of the decade. Agricultural production for the domestic market increased by 3.8% per annum but export agriculture declined at 4% p.a. with sugar and banana exports suffering the greatest reduction.

1.4 The role of bauxite/alumina as the leading growth sector ended after the Government imposed a bauxite production levy in 1974. Introduction of the levy at a time of recession reduced Jamaica's competitive position and as a result the real value added in the sector fell by 15% over the period 1974/83. Manufacturing production peaked in 1973 but by 1980 it had dropped by 31%. The economic decline caused a significant increase in unemployment during the latter half of the 1970s which reached a level of 27% of the labor force in 1980. During 1973-80 the balance of payments was under continuous pressure because of poor export performance and unfavorable trade conditions. Domestic policies and structural constraints combined with a sharp rise in the oil import bill and a fall in private sector confidence and consequent private capital outflows have resulted in mounting debt service and pressure on the rate of exchange.

Economic Prospects

1.5 In 1982 and 1983 the population of Jamaica increased by 2% a year. This acceleration over the previous few years was not due to a higher birth rate but rather to a slowdown in migration. The modest recovery in output in the last four years has not been enough to alleviate chronic unemployment. The rate of unemployment has remained stubbornly high at an annual average level of 28% in 1982, about the same as in 1980.

1.6 GDP rose by 3.3% in 1981, stagnated in 1982, and increased by 1.8% in 1983. This growth was led by the construction, manufacturing and distribution sectors (Table 1.1). However, two major productive sectors suffered setbacks. Mining output declined by 29% in 1982, reflecting the accumulated effects of the world recession on the demand for Jamaica's bauxite and alumina. After growing at 3% in 1981, the agricultural sector declined by about 8% in 1982. The output of domestic food crops fell by 13% in 1982, primarily due to the increased availability of imported food products. Despite the severity of the adjustment program (significant decline in fiscal and balance of payments deficits and credit restriction), it is estimated that GDP grew in 1984 by only 0.5%. Tourism and agriculture registered strong gains while most other sectors showed little change or small declines.

Table 1.1: OUTPUT TRENDS
(percentage change)

	1973-80 Average	Actual 1981	Actual 1982	Estimate 1983	Provisional 1984
Agriculture	-1.3	3.3	-7.9	5.5	8.2
Mining	1.3	1.3	-29.0	-0.9	-2.5
Manufacturing	-3.9	0.6	6.4	1.9	-5.2
Construction	-9.1	0.4	14.7	3.4	0.6
Non-Government Services	-0.2	5.3	2.5	1.3	1.5
GDP	-2.4	3.3	0.0	1.8	0.5

Source: Mission estimates.

1.7 The bauxite/alumina sector has accounted for about three-quarters of Jamaica's merchandise exports. After the decline in 1982, export earnings virtually stagnated in 1983. Imports have increased rapidly in 1981-1983 in response to years of pent-up demand. The rapid rise in imports coupled with the disappointing performance of the export sector resulted in a sharp widening of the current account deficit on the balance of payments from 6% of GDP in 1980, to 12.8% in 1981, 12.2% in 1982 and was 11.3% of GDP in 1983. It is estimated that the current account deficit fell to about 8% of GDP in 1984 as a result of the fall in imports of consumer goods and oil in response to devaluation, and an impressive gain in tourism. With the high levels of official capital inflow since

1980 there has been a rapid build-up of official external debt. By the end of 1983, it is estimated that external debt (excluding reserve liabilities) had reached a level of US$2.6 billion (89% of GDP) compared with slightly under US$2 billion at the beginning of the decade.

1.8 Economic Growth Scenarios. At the time of the energy assessment mission, two economic growth scenarios were developed to determine the energy requirements during the rest of the decade. The high case projects an average growth of about 4% in GDP during the period 1984-1990. The low case projects an average growth rate of 2%. Both scenarios assume that the GOJ will continue to implement the economic stabilization and structural adjustment programs which are supported by lending from the International Monetary Fund and the World Bank. In particular, it is assumed that the fiscal deficit will gradually be reduced, a competitive exchange rate will be maintained and export development programs will be pursued. Because of the overriding need to improve the balance of payments position, neither of the scenarios would permit an increase in real per capita consumption.

1.9 However, by early 1985, developments in the bauxite/alumina sector indicated that the low case economic growth scenario was the most likely for Jamaica until 1990. First, it became clear that further special barter or U.S. stockpile sales of bauxite could not be relied on for 1985/86. Second, in February 1985, Alcoa announced that it was temporarily halting alumina production in Jamaica until the world market for aluminum had recovered. Given current prospects for aluminum, no production by Alcoa can be assumed before 1987 at the earliest. In addition, continued operation of other facilities in Jamaica is uncertain. The loss of the Alcoa production and other sales means a significant reduction in export proceeds and Central Government revenue. In addition, further strong growth in the tourism sector is less likely because of capacity constraints and a possibly worsened image in the tourism industry as a result of demonstrations in early 1985 over fuel price hikes. Given these factors and the need for major fiscal and balance of payments adjustment in 1985 and onwards, a major decline in GDP in 1985 (on the order of 6%) appears unavoidable. It is projected that thereafter, in 1986-90, a small recovery will be possible.

1.10 The five-year scenario below is drawn on the assumption that the loss of bauxite/alumina earnings is absorbed within 1985/86 by a further massive adjustment of the economy. For the present it is assumed that no further declines in bauxite/alumina will take place. The level of bauxite/alumina exports is projected to be 5.5 million tons of bauxite equivalent, compared with 8.8 million tons in 1984, with no increase anticipated before the end of the period. With large declines in investment in 1984 and 1985, consumption expenditures would be constrained throughout the period, so that most incremental income can be dedicated to increasing investment and further reducing the trade deficit. Non-traditional exports outside the Caribbean region are projected to grow by about 20% a year, permitting only modest increases in the import level over the period.

Table 1.2: GROWTH OF REAL OUTPUT, 1983-90
(percentage change)

	Average 1981-84	Projected 1985	1986-90 High a/	Average Low
Mining	-10.1	-25.5	6.6	0.3
Manufacturing	1.0	-10.0	3.7	3.5
Distributive Trade	1.2	-10.0	5.0	2.0
Other	2.7	2.8	3.5	2.1
Total	0.9	-5.8	4.0	2.2

a/ High scenario averages refer to 1984-1990.

Source: Mission estimates.

Energy Consumption

1.11 Developments in the energy sector significantly affect the overall economic performance and prospects of Jamaica. First, the energy intensity of the economy, i.e., energy consumption per unit of GDP, is relatively high compared to other developing countries at a similar income level, primarily because of the requirements of the bauxite/alumina industry. In 1980, the Jamaican economy consumed 807 toe per US$ million of GDP; excluding bauxite/alumina, the value was 467 toe per US$ million of GDP. Comparable overall figures per US$ million GDP are 268 toe for Costa Rica, 275 toe for the Dominican Republic, 139 toe for Paraguay and 328 for Tunisia. With such a relatively high level of energy consumed per unit of GDP, special attention has to be paid to demand management and efficiency of use in the consuming sectors.

1.12 Second, the weak balance of payments position continues to be the major constraint to economic growth in Jamaica. The current account deficit was equivalent to 11-12% of GDP in 1982-1983. Although the share is estimated to have dropped to 8% in 1984, the level of deficit is still unsustainable. Jamaica depends on petroleum imports for nearly all of its commercial energy. The fuel bill (US$386 million in 1983; US$216 million, excluding bauxite/alumina and international aviation/bunker) represented slightly less than a third of the value of total merchandise imports and a similar share of the proceeds from exports of goods and nonfactor services. Excluding the bauxite/alumina sector and international fuel sales, "domestic" petroleum imports account for nearly a fifth of the total value of "domestic" imports and a quarter of the value of other merchandise exports and nonfactor services.

Energy Consumption Patterns

1.13 Total energy consumption in 1983 was equal to approximately 14.7 million boe. Imported crude and petroleum products represented nearly 90% of the total supply. Bagasse, which is used to generate steam in sugar factories, accounted for about 7%, with the small remainder

comprised of fuelwood and hydropower. The bauxite/alumina sector accounted for nearly 40% of energy use; the remaining 60% is consumed by the domestic sector, including electricity generation, transport, etc. Information on the use of fuelwood, including charcoal, is poor; as a result, the values in the energy balance (Annex Table 1.1) are only estimates of household consumption. In general, energy consumption declined throughout the 1970s because of lower bauxite/alumina production in the latter half of the decade and negative real growth in the economy. In 1981, total energy consumption was 24% below the 1973 level. In 1982, after a sharp drop in bauxite/alumina production, total energy consumption was 34% below the 1973 level.

Petroleum Products

1.14 During 1979-81, the consumption of petroleum products remained at a level of 15.8 million barrels before dropping to 14.9 million barrels in 1982-83 and to 12.6 million in 1984, reflecting the decline in the bauxite/alumina sector, and in the latter the impact of devaluation of the Jamaican dollar which resulted in high fuel prices. All petroleum is imported, either in the form of crude oil to be processed at the Government-owned refinery, or as refined products. In 1983, the fuel import bill was approximately US$386 million, compared to approximately US$447 million in 1980. The breakdown between bauxite/alumina, international aviation/bunkers, and domestic consumption is shown in Table 1.3. In 1984, it is estimated that petroleum imports fell to US$354 million, of which US$256 million were non-bauxite/alumina imports.

Table 1.3: PETROLEUM IMPORTS
(US$ Million)

	1980	1983
Total Fuel Import Bill	446.5	385.5
Bauxite/Alumina	183.8	114.1
International Aviation/Bunkers	40.3	55.7
Other Domestic	222.4	215.7

Source: Mission estimates.

1.15 The bauxite/alumina industry is the largest consumer of petroleum products, consuming primarily fuel oil, which is used in the refining and calcining process to convert bauxite into alumina. During 1980-81, the bauxite/alumina sector consumed slightly over 8 million barrels of oil a year, accounting for slightly over half of the total demand in Jamaica. During 1982-83, the sector used 5.5 million barrels of oil a year and its share correspondingly dropped to about 41% of total petroleum demand. It is estimated that consumption in 1984 fell to 4.9 million barrels.

1.16 Since fuel is the largest single cost component for alumina, efforts have been made by the Jamaican industry to improve the efficiency of fuel use. Since the mid-1970s, fuel consumption per ton of alumina has been reduced from about 3.5 barrels/ton to the current 3.0 barrels. All plants now use the low temperature Bayer process and further energy saving investments are being made (for example, the improvement of heat recoveries in rotary kiln calciners). The move to increase plant capacity utilization will further reduce fuel use per ton as the sector increases output. According to the Jamaica Bauxite Institute, the industry's goal is to bring petroleum consumption down to 2-2.1 barrels/ton. Already one out of the four plants is reported to be operating at 2.25 barrels/ton. However, some experts believe that it would be difficult for the industry average to drop much below 2.5 barrels per ton without substantial capital investment. Reaching the 2.5 barrels/ton level would still mean major fuel savings and a significant improvement in the competitiveness of the industry.

1.17 Inland petroleum consumption fell in 1980 to 6.6 million barrels, but rose to 7.7 million by 1982 and maintained the same level in 1983. Consumption is estimated to have declined to about 7 million barrels in 1984. The main domestic use of imported petroleum products is for power generation (essentially used by the Jamaica Public Service Company), and its share of total petroleum consumption has risen from about 17% during 1978-81 to nearly 25% at present. In 1983, JPS used about 3 million barrels of petroleum, primarily fuel oil, compared to an average of 2.7 million barrels p.a. during 1978-81. Consumption in JPS dropped to about 2.8 million barrels in 1984. The next largest demand sector is transport, whose share of total demand has risen from 12% in 1980 to 16% in 1983. After a period of declining demand, transport consumption rose at a rate of 4% p.a., from 1.9 million barrels in 1980 to 2.2 million barrels in 1983.

1.18 Between 1980 and 1983, out of all petroleum products, gasoline consumption showed the highest average growth of 5.6% per annum. In 1983, gasoline accounted for 12% of total petroleum products consumed. Demand for automotive diesel stagnated, while LPG increased by 4.6%, the former representing 10% of total consumption and the latter 3%. Consumption of fuel oil accounted for nearly two-thirds of the total in 1983 and showed an average annual decline in sales of 6% a year in 1980-1983, largely because of the decline in the bauxite/alumina market. The only other products which showed a decline are kerosene, asphalt, and aviation gasoline. In 1984, the only petroleum product which increased in sales was kerosene (12%). Demand for all other products declined primarily because of the impact of the devaluation of the Jamaican dollar in increasing domestic fuel prices during 1983 and 1984. The drop in sales ranged from 11% for automotive diesel, to 9% for both gasoline and fuel oil, to 6% for LPG.

Electricity

1.19 In 1983, JPS generated 1,458 GWh of electricity and bought 5 GWh. In addition to JPS, there is also a significant amount of captive generating capacity, primarily in the bauxite/alumina, sugar, and cement industries. A breakdown of JPS generation and sales for 1984 is shown in Table 1.4.

Table 1.4: ELECTRIC POWER, JPS GENERATION AND SALES, 1984

Generation	Percent	Sales	Percent
Steam	90.7	Residential	31.8
Hydro	3.6	Commercial and Small Industry	44.5
Diesel	5.7	Commercial and Large Industry	12.3
		Other	11.4
Total	100.0	Total	100.0

Source: Mission estimates.

1.20 In 1984, losses and unaccounted for sales were 19.4% of total requirements, resulting in total sales of 1,157 GWh. After reaching a peak of 1,136 GWh in 1977-78, electricity sales declined at an average rate of 3.6% p.a. through 1981, reflecting the negative growth in the economy and the real increase in tariff. In spite of the decline in sales during 1978-81, the number of customers rose steadily, in part a reflection of the Rural Electrification Program which began in 1975. In both 1982 and 1983 electricity sales increased by 6% and 8.7% respectively. However, in 1984 consumption declined again by 1.3% in response to the 42.1% real average increase in tariffs.

Public Investment in the Energy Sector

1.21 The stated investment strategy of the GOJ stresses research on the means of exploiting indigenous energy resources and conservation of imported energy in order to save on the foreign exchange cost of petroleum imports. In addition, major investments have been made in rehabilitating the generation and transmission equipment of JPS. The rehabilitation investments of JPS support the goal of maintaining essential economic infrastructure so as to facilitate productive activity.

Recent Investments

1.22 During the period FY81-83, the main investments in the energy sector included rehabilitation and expansion of the distribution and transmission systems by JPS; rural electrification; onshore (and a

smaller amount of offshore) oil and gas exploration; energy conservation; and some preliminary work on various indigenous energy resources. Projects in the energy sector accounted for slightly under 10% of the total expenditures in the public sector investment program. A list of projects, together with the donor and responsible GOJ institution, is shown in Annex Table 1.2. During the past few years, feasibility studies have been carried out for several projects which could provide for additional electrical generating capacity or substitute for existing capacity. These studies have included using peat and coal as a fuel, OTEC and small-scale hydro projects.

1.23 When Jamaica started to use the Venezuela/Mexico Oil Facility (3.43), it was thought that it would become a source of project financing for energy and other investments in Jamaica. Under the current terms of the facility, 20% of the oil bill can be converted to concessional project financing (6% interest, 15-year maturity). Currently, a total of about J$200 million is theoretically available for project financing. However, so far GOJ has been unable to use any of the funds because of various restrictions on the facility. For example, the resources cannot be used for co-financing; projects must be labor intensive and use only local funds. Further, so far none of the projects proposed by the GOJ for financing under the facility have been approved. However, the GOJ has recently increased its efforts to use the available project funds.

Future Energy Investment Program

1.24 Proposed investments in the energy sector for the period FY84/85-FY86/87 are shown in Annex Table 1.3. A World Bank Public Sector Investment Program (PSIP) mission visited Jamaica in November-December 1984. Among the main issues considered by the mission were the establishment of priorities within the sectors and the determination of a new ceiling for the overall PSIP (the former ceiling had been 15% of GDP). The mission's conclusions are not yet finalized. However, in general, the PSIP proposed by the Government (together with some items which had been excluded) was judged as a sound core program of investment. Preliminary analysis also indicated that a program equivalent to 10% of GDP was the level financeable in 1985/86. For subsequent years, a determination of the appropriate level of the public sector investment program is difficult. The main uncertainty involves the targeted reduction in the Central Government's outstanding debt to the banking system. These targets are expected to be developed early in 1985 during negotiations between the GOJ and the IMF. Pending the conclusions of the PSIP Review Mission, the following preliminary comments can be made.

1.25 The investment program of JPS accounts for the major share of proposed energy investment (88% in FY84/85, 79% in 85/86, and 64% in 86/87). Major projects include the purchase of two new 20 MW slow-speed diesel generators amounting to J$207 million (approximately US$46 million) and completion of the ongoing rehabilitation program accounting for J$52 million (approximately US$12 million). The projects meet the Government's objectives of providing reliable services in the supporting

infrastructure which are required to facilitate the development and expansion of the productive sectors. The gains expected to be achieved from the rehabilitation program are significant. The available maximum continuous rating for the total system is expected to increase from the current 374 MW to 450 MW (excluding 2 new 20 MW units), an increase of 20%. Completion of the rehabilitation program should be considered the priority investment because it is clearly the cheapest and most efficient way to expand actual generating capacity and to lower operating costs through improved operating efficiency. In addition, it is critical that adequate foreign exchange be made available so that JPS can run an efficient preventative maintenance program.

1.26 As overall economic growth is likely to be modest until the end of the decade (averaging slightly under 3% a year), power demand is not expected to grow rapidly. The gains from the rehabilitation program should be able to cover growth in power demand at least until the end of the decade, after which it is anticipated that additional generating capacity would be needed.

1.27 A draft of the least cost expansion plan prepared by MONENCO has become available. The plan is currently under review by GOJ and its main recommendations are to:

(a) convert two steam generators to burn coal;

(b) construct new coal-fired steam-electric units;

(c) implement several small hydro-electric projects; and

(d) install gas turbine generators.

1.28 The results of the draft report are currently being examined by JPS and the World Bank. This review has given rise to two main issues: (a) JPS has concerns on the advisability of converting two oil-fired steam units to burn coal and on the location of the coal reception and handling facility; and (b) the cost estimates for coal cogeneration are only preliminary. The project also raises critical institutional issues about the arrangements for sharing investment costs and responsibility for operation.

1.29 Implications for the Investment Program, 1985/86-1986/87. The MONENCO study proposes an investment program, including phasing, for the minimum cost sequence. The schedule is quite ambitious, with some studies and preliminary work to begin in early 1985. Given that the recommendations are still being reviewed, this timing is not certain. Although the effect on the proposed PSIP will not be determined until after JPS and other Government agencies evaluate the results of the study, the potential impact (considering only projects recommended for implementation over the next two years) could be significant. Of the program recommended by MONENCO, only the rehabilitation of two gas turbines and a small component of the hydroelectric capacity are now

included in the PSIP. However, it is doubtful that major construction on any of the major projects could begin before 1987. Table 1.5 lists some of the major projects being considered with their associated approximate capital costs.

1.30 Implementation of the program proposed by MONENCO during 1987-89 would mean that energy investments would account for at least 30% of the investment program, a figure which is high compared to the average of 10% during FY81/82-FY83/84. In addition, external financing would be needed for the new projects, and Jamaica's debt service ratio is expected to be about 40% of the receipts from exports of goods and factor services through 1986 before slowing down or falling. External borrowing, particularly on conventional terms, will need to be limited in the medium-term, which could result in a reduction and/or rephasing of the investments proposed by MONENCO. Construction of mini-hydros would be less of a strain on the investment program because project construction would take place over a longer period of time.

Table 1.5: MAJOR POSSIBLE NEW ENERGY PROJECTS

	Cost a/ (US$ millions)
Coal Conversion/Old Harbour (Units 3 and 4)	95.5
Coal Receiving/Handling Facility	36.5
New Coal-Fired Unit (66 MW)	69.6
Five Mini-Hydros (12 MW) b/	38.4
Peat Plant (73 MW net capacity)	77.1
Transmission	15-29 c/
Gas Turbines (22.1 MW)	6.7

a/ Costs are in 1984 US$.
b/ Rio Bueno, Constant Spring, Morant, Great River and Rio Cobre.
c/ Costs depend on project and sites chosen for generation facilities and order of development.

1.31 The mission recommends that no further domestic resources go into high risk drilling (3.44). In view of the recent devaluation of the Jamaican dollar and the fact that a major share of the oil exploration activities is being financed by external sources, PCJ is currently holding all those projects in abeyance. Insufficient information prevented the mission from clearly determining the long-term viability of the local refinery. An analysis based on current trends in the industry shows that the economic viability of the refinery is uncertain. The PSIP has included a project to improve the energy efficiency of the refinery at a cost of US$6 million. The mission recommends that no major investments in the refinery be implemented until the economic viability of the refinery is clearly established (3.31).

II. ELECTRIC POWER

2.1 A major issue in the power subsector is the development of an economically sound power investment program. Various alternative generation schemes have been proposed including solar, wind power, hydro, peat and imported coal; however, at the time of the mission no coherent framework for analysis existed. The PSMP was completed in October 1984 by MONENCO but remains to be finalized (2.22-2.28). Not all the options considered in the report were economically attractive. Aside from the issue of the investment program, major questions concern the tariff structure and the management of labor relations. Although the tariff levels were revised in 1984, the tariff structure remains an important issue. In addition, JPS faces labor and management disputes which are likely to affect the implementation of the least cost expansion plan.

Supply Systems

2.2 The power generation facilities (702.2 MW) are 69.8% in the public sector (JPS) and 31.2% in the private sector (Table 2.1). JPS operates at 50 Hz, whereas private generation is on both 50 and 60 Hz.

Table 2.1: INSTALLED CAPACITY AND GENERATION BY OWNERSHIP (1983)

Ownership	Capacity		Generation b/	
	(MW)	(%)	(GWh)	(%)
Public				
JPS	489.8 a/	69.8	1,458.2	72.4
Private				
Bauxite/Alumina	167.7	23.9	511.0	25.4
Cement	14.0	2.0	22.6	1.1
Sugar	30.2	4.2	23.4	1.2
Others	0.5	0.1	0.0	0.0
Total	702.2	100.0	2,015.2	100.0

a/ Nameplate rating.
b/ Mission estimates of generation.
Source: JPS and the Ministry of Mining and Energy.

JPS and the alumina/bauxite industry are almost totally dependent upon imported oil. The sugar industry uses mainly baggase, while the cement industry is moving from oil to imported coal. Some of the bauxite/alumina plants are interconnected with the JPS grid, but the capacity to interchange power is small. Conversion of all bauxite/alumina plants to 50 Hz, and interconnection with the public supply grid, combined with

economic dispatching, could improve power system reliability and reduce supply costs. Even though JPS has been improving the service, interconnection is not likely to occur because of the aluminium industry's lack of confidence in JPS, and the possibility that investment in frequency conversion is not feasible given the current slump in the aluminum market. The mission considers that there is a strong case for: (a) preventing future private generation at frequencies different from JPS, and (b) studying the costs and benefits of frequency conversion and interconnecting public and private generating systems. 10/

Public System

2.3 Approximately 75% of JPS's installed capacity is fuel-oil fired thermal plants, 19% gas turbines, 2% diesel engines, and the remaining 4% hydroelectric stations. In 1984, power generated was 94.5% oil based with fuel oil accounting for 88.9% and diesel oil 5.6%. The generating capacity of JPS by generator type is shown in Table 2.2 and details of the generating units are shown in Annex Table 2.1.

Table 2.2: JPS's GENERATING CAPACITY
(January 1984)

Generating Unit	Installed a/	Available b/	
	(MW)	(MW)	(%)
Steam	373.5	336.0	75.0
Gas Turbines	101.3	86.0	19.2
Diesel	11.7	11.0	2.4
Hydro	21.0	15.2	3.4
Total	507.5	448.2	100.0

a/ Plate rating.
b/ Continuous maximum rating.
Source: JPS.

2.4 The main generating units are fuel-oil fired plants located at Old Harbour in St. Catherine and at Hunts Bay in the Kingston area with installed capacities of 230 MW and 143.5 MW, respectively. The gas turbines and diesel units are fueled by No. 2 distillate (diesel). Before rehabilitiation, generating capacity available to meet maximum demand was substantially different from the total nameplate rating. This difference was mainly due to age, insufficient maintenance, difficulties

10/ Interconnection with other industries has proven to be economically sound in some small countries, e.g., the Dominican Republic in connection with the sugar industry and the Falconbridge Company.

in obtaining spare parts, inadequate operating practices, and in some cases design deficiencies. Table 2.3 shows that reserve capacity increased during 1983 and 1984 as a result of: (a) the ongoing rehabilitation of the largest thermal units on the system; and (b) an improvement in the management of JPS. However, the operations still need improvement. Old Harbour log sheets show that there still are thermal outages and available capacity has been below rated capacity due to component failures. At the start of 1984 total installed capacity (nameplate rating) was 507.5 MW, of which only 88% was available for continuous maximum rating (Table 2.2).

Table 2.3: AVAILABLE CAPACITY - AT PEAK DEMAND

Year	Demand (MW)	Capacity a/ (MW)	Reserve (%)
1980	223.5	223.5	-
1981	223.6	255.4	12.5
1982	241.2	256.9	6.1
1983	254.1	328.3	22.6
1984	245.9	357.7	45.5

a/ Mission estimate.

Source: JPS.

2.5 The transmission system consists of 119 miles of 138 kV and 382 miles of 69 kV lines. The primary distribution system consists of circuits of 4 kV, 12 kV, 13.8 kV and 24 kV lines, the major portion being 3,898 miles of 12 kV and 806 miles of 13.8 kV lines (IBRD map No. 18307). Although the condition of most transmission lines is generally satisfactory, two problems exist: (a) grillage footings are corroded in some towers on the Old Harbour to Parnassus 138 kV line; and (b) there is lack of maintenance of some access roads, especially in mountainous areas. If these problems are not corrected, they may lead to failure of transmission lines and a reduction in regular maintenance and inspection of lines.

System Reliability

2.6 The JPS system has been characterized by frequent power outages due mainly to failure of the generating units. Plant outages have resulted from inadequate maintenance and lack of proper management. Other consequences of this have been a high system heat rate and a low availability factor. A system heat rate of about 13,500 BTU/kWh is possible and a lower level was achieved in 1978 (13,134 BTU/kWh). It is estimated that during 1980 to 1983, JPS could have saved about US$5 million per year (1983 prices) through higher availability of the main

thermal plants. Savings for the period from 1976 (the year of commissioning of Unit No. 6 Hunts Bay) to 1983 would have amounted to about US$37.0 million (mid-1983 prices -- discount rate at 12%).

2.7 With the rehabilitation program underway, the level (and proportion) of outages due to generating equipment failures declined and the system heat rate improved in 1983. Even with this improvement there is still a need for a comprehensive long-term maintenance strategy. With the exception of the newly rehabilitated units at Old Harbour and Hunts Bay, all thermal units require varying levels of repairs and maintenance.

Table 2.4 STRUCTURE OF OUTAGE TIMES
(percent)

Year	Generation	Transmission	Distribution	Total
1981	72.9	8.1	19.0	100.0
1982	86.8	6.2	7.0	100.0
1983	24.7	34.7	40.6	100.0

Source: Mission estimates based on data from JPS.

2.8 JPS plans to introduce an efficient preventative maintenance policy for all units but only after (in 1985) two new barge-mounted 20 MW slow-speed HFO (heavy fuel oil) generators are installed. The increased reserve margin will allow JPS flexibility to do the needed maintenance. The proposed JPS maintenance plan assumes that by the end of 1985, the existing and rehabilitated thermal units will still be in good operating condition and require a relatively simple annual overhaul. The mission considers that a preventative maintenance program should be implemented immediately and not be delayed until the end of 1985. The past practice of operating the more efficient units intensively for 7 to 8 years and then rehabilitating them is inefficient and expensive.

2.9 JPS, however, is taking steps in the right direction. Currently, Unit 6 of Hunts Bay station is under rehabilitation, as recommended in MONENCO's draft PSMP. In 1985, JPS will continue the intensive maintenance effort started in 1983, for Unit No. 5. Units 1 and 2 (of the five gas turbine-generators) are also planned to be rehabilitated in 1985. This will extend their useful lives until 1995 and halt the current annual decrease in their availability. The mission recommends that in implementing an immediate maintenance program, JPS pay special attention to the following:

(a) disciplined preventative maintenance even during periods of less-than-adequate margins of reserve capacity. Random breakdowns of the efficient units in the system are more costly to the economy than interruptions due to planned maintenance; and

(b) an institutional mechanism for the timely supply of spare parts. Difficulties in obtaining spare parts, especially those which require foreign exchange, lead to longer outage times and higher fuel import costs.

Rural Electrification

2.10 In 1975, it was estimated that 54% of Jamaica's population lived in rural areas. Of this total, only 11% were connected to the grid. In 1975, the Government created the Rural Electrification Programme Limited (REPL), an entity separate from JPS, to administer the rural electrification program. The program consists of distribution extensions from established transmission lines, and the provision of loans to assist homeowners in carrying out house installations. Upon completion of the grid extension, the distribution lines become the property of JPS.

2.11 The first rural electrification program was funded by the GOJ in 1975 and involved the construction of 220 miles of distribution lines and the connection of 4,560 customers. An extensive five-year program was later funded by the Inter-American Development Bank (IDB) and the GOJ. The program had three parts: (a) 670 miles of lines supplying about 11,000 customers; (b) 205 miles of lines supplying approximately 3,800 customers (finished 1979); and (c) 559 miles of single phase distribution lines supplying approximately 12,000 customers. This program now provides connection to about 23% of the rural population. Further electrification of rural areas will become increasingly expensive due to long distances and low density of households.

Electricity Demand

2.12 Electricity consumption is mainly concentrated in the metropolitan areas of Kingston and Montego Bay. The Kingston area, which includes part of St. Catherine and St. Thomas, uses approximately 60% of the total electricity consumption, and Montego Bay about 8% (Annex Table 2.3). Although the overall coverage rate has increased from about 33% in 1975 to about 47% in 1983 (assuming 4.5 members per household), it stills remains low.

2.13 Up until 1972, total electricity consumption grew quickly (12.0% p.a. 1969/1972 (Table 2.5)), reflecting a high rate of GDP growth (8.1% p.a.) and a growing number of consumers (7.5% p.a.). From 1972 to 1981, the rate of growth in demand steadily declined due to a combination of falling real GDP, real tariff increases, and power supply failures. From 1981 to 1983, growth in total consumption recovered because of improved power supplies and a weak upswing in GDP (0.9% p.a. real).

Table 2.5: RATES OF GROWTH, ENERGY CONSUMPTION, GDP, AVERAGE TARIFFS AND NUMBER OF USERS
(percent)

Years	Total Consumption	Average Consumption	Real GDP	Average Real Price	Number Users
1969-72	12.0	4.2	8.1	1.7	7.5
1972-77	3.7	-3.0	-2.5	13.0	6.9
1977-81	-2.7	-7.8	-0.8	4.0	5.5
1981-83	7.4	4.6	0.9	-2.7	2.7

Source: Annex Table 2.7.

2.14 Within the consumer categories, the small commercial and industrial consumers have the largest share of consumption (Table 2.6). In 1970, these two groups consumed 45.8% of the total and 44.7% in 1983. However, the share increases when the "larger users" category is considered. Thus, in 1970 the total share of all commercial and industrial users was 62.1%, declining to 57.2% in 1983. Residential users increased their share of consumption from 27.7% in 1970 to 31.2% in 1983.

Table 2.6: ELECTRICITY CONSUMPTION BY USERS, 1970-83
(GWh)

Year	Residential	Small Commercial and Industrial	Large Commercial and Industrial	Public	Other	Total
1970	203.3	337.6	119.5	75.3	0.0	735.1
1975	327.6	465.2	142.3	119.5	10.8	1065.4
1980	317.5	434.8	133.5	125.8	10.9	1022.5
1983	365.5	524.5	145.9	131.9	4.7	1172.5

Source: Annex Table 2.2.

2.15 Historical demand estimates are affected by outages and "unaccounted for" consumption. 11/ The available data refer to energy sales

11/ Most of the unregistered consumption corresponds to small users illegally connected to the grid.

and do not incorporate the unsatisfied demand during power outages. 12/ Table 2.7 shows that total losses and company use have remained relatively constant. The largest share of losses continues to be "unaccounted for" consumption. The revenue lost by JPS in 1983 due to thefts amounted to about J$38.4 million. 13/

Table 2.7: COMPANY USE, PHYSICAL LOSSES AND UNACCOUNTED CONSUMPTION

Category	1980		1983	
	(GWh)	(%) a/	(GWh)	(%) a/
Company Use	6.2	0.5	6.0	0.4
Transmission	24.2	1.9	21.9	1.5
Transformation	12.7	1.0	14.6	1.0
Distribution	91.8	7.2	105.3	7.2
Unaccounted for Consumption	117.1	9.2	142.5	9.7
Total	252.0	19.8	290.3	19.8
Net Requirements b/	1,274.5		1,463.0	

a/ As a percentage of demand.
b/ This includes purchases by JPS and excludes station use.
Source: Mission estimates and JPS.

2.16 JPS is conscious of the "unaccounted for" problem, and during the mission's visit, JPS personnel, supported by security forces, entered some residential areas to disconnect illegal users. The mission recommends that JPS design a program and timetable for reducing unregistered consumption. JPS should set a target of reducing the percentage of total losses and its own consumption to a maximum of 15% of electricity produced. The plan for reducing "unaccounted for" consumption should be a

12/ JPS data on power outages is limited in that it is not possible to determine the amount of power interrupted per outage period. Unsatisfied demand together with "unaccounted for consumption" is required to adequately forecast future revenue, energy, and power requirements.

13/ The average unit price in 1983 was J$269.5/MWh and total theft was estimated to be 142.5 GWh. This estimate is a simplification, since it assumes: (a) all the users who take electricity by illegal means would become regular customers and illicit consumption will be prevented, and (b) no demand responsiveness to price.

continuous effort of disconnecting illegal users, educating the public, and improving measuring and billing procedures.

Tariffs

2.17 During the month of June 1983, the Government of Jamaica transferred payments for petroleum from the official market (J$1.78/US$1.00) to the parallel market (J$2.76/US$1.00) However, fuel for JPS was cushioned against price increases so that there would be no rise in electricity rates. In 1983, electricity consumers, through low petroleum prices to JPS, received a subsidy of about J$61 million. By late January 1984, the exchange rate moved to J$3.40/US$1.0 and JPS was granted a 40% increase in tariff rates. To prevent a further tariff increase, JPS continued to receive subsidized fuel oil. In May 1984, average tariff levels were increased by another 54% and the subsidy on fuel oil to JPS was eliminated.

2.18 The JPS rate structure was designed in the early 1960s. It has prevailed up to the present with minor modifications. Rate levels, although frequently adjusted to reflect some cost changes, were not based on economic efficiency criteria. This encourages misallocation of resources within the subsector and does not convey correct pricing signals to consumers.

2.19 JPS has five tariff categories which, with the exception of street lighting, are of a declining block structure. This structure penalizes low-income customers. All tariffs are subject to a base adjustment which varies in accordance with the cost of fuel to JPS. Consumers are classified on the basis of kWh usage, which does not reflect the cost of supply.

2.20 An efficient tariff should discriminate among user classes and reflect: (a) the cost differences they impose upon the system, and (b) the behavioral variables that influence their consumption. JPS is aware of the need to change the tariff structure and has commissioned an "Electricity Tariff Study." The study should serve as the basis for the required tariff modifications.

Future Demand

2.21 Power demand is not expected to grow rapidly, thus limiting the need for new plants to come on stream until the early 1990s. Table 2.8 shows a high and a low set of forecasts of energy and power demand which takes into account likely tariff changes and future economic trends. Investment requirements for generation plant during the next three years are somewhat uncertain since the MONENCO study is still being reviewed by JPS, but they are not expected to exceed US$200 million.

Table 2.8: FORECASTED RATES OF GROWTH
(percent)

Period	Sales	Net Requirements	Peak Demand
1973-1983	1.9	2.0	1.7
1983-1993			
Low	2.2	1.6	1.6
Medium	3.3	2.6	2.6
High	4.3	3.7	3.7
1993-2003			
Low	1.6	1.6	1.6
Medium	2.6	2.6	2.6
High	3.9	3.9	3.9

Source: MONENCO and Mission Estimates.

Given the uncertainties affecting the demand variables, JPS should periodically review these forecasts. The mission recommends that this responsibility be assigned to JPS's planning unit.

Power Sector Master Plan (PSMP)

2.22 With World Bank financing, JPS commissioned Montreal Engineering (MONENCO) to prepare a comprehensive planning study for the integrated development of its electric power system. The study includes long-term demand forecasts and a least cost expansion plan. A draft of the study, finished in October 1984, was being reviewed by JPS and the GOJ at the time this report was completed. Before initiating this study, various alternatives were appraised in a piecemeal fashion, taking as benefits the equivalent fuel saved. This approach suffered from the risk of ending up with a sub-optimal mix of supply.

2.23 The least-cost study represents the first step in a continuing planning process that ought to be strengthened and institutionalized. The PSMP will require constant updating and should become the framework for appraising and selecting power supply additions.

2.24 Dependence on imported oil and the prevailing foreign exchange scarcity in Jamaica have prompted concern for the diversification of the fuel supply base. Available options for meeting future demand at the least cost can be classified as follows:

(a) rehabilitation of existing thermal plants;

(b) conversion of existing plants to use cheaper fuels; and

(c) installation of new generating plants with better fuel efficiences and/or more economic fuels, including renewables.

2.25 At present there are studies either completed or underway to develop coal conversion and gasification facilities, mini-hydro stations, peat plants, solar ponds, solar panels, dendrothermal, OTEC projects, biomass plants, municipal waste firing, wind projects, etc. Not all of these technologies are adequate for the conditions and needs of Jamaica.

2.26 The following screening criteria were used by MONENCO to ensure the appropriate technology is used and prevent diffusion of scarce technical and managerial skills and resources:

(a) a generating technology to be considered as a possible candidate should have successfully proven its technical and commercial feasibility; and

(b) the predicted equivalent unit costs (including capital charges, fixed and variable costs) of the proposed unit over its energy life output should not be above the costs of the conventional units.

2.27 These criteria have reduced the number of feasible options to the following order: (a) rehabilitation of gas turbines No. 1 and 2 and thermo-electric units No. 3 and 4 of Hunts Bay Station; (b) coal-conversion of Old Harbour Station Units No. 3 and 4; (c) coal cogeneration; (d) coal-fired new plants; (e) oil-fired units; (f) gas turbine generators fueled with diesel; (g) slow speed diesel generators; (h) mini-hydro stations; and (i) peat-fired plant.

2.28 All other projects currently under examination should be set aside. The MONENCO study considered all of these plus other options which were rejected because of: (a) being impractical; (b) inadequate data; (c) minimal impact on JPS system; and (d) uncertain technologies.

Construction Program

2.29 The draft PSMP recommends the following construction program for the period 1984-1994:

(a) Rehabilitation of Hunts Bay gas turbine Units No. 1 and 2;

(b) Conversion of Old Harbour Station Units 3 and 4 and construction on the same site of a coal reception and handling facility;

(c) Installation of a new coal-fired plant at Old Harbour; the first unit to start operation in 1990 and the second in 1994;

(d) Begin construction of several small hydroelectric developments (Morgans, Wild Cane, Green, Spanish, Yallahs, Rio Grande and Martha Brae Rivers); and

(e) Commission two gas-turbines; one by 1992 and the other by 1993.

Two major conclusions of the MONENCO study are that: (a) rehabilitation of Units 1 and 2 of Hunts Bay Station should proceed immediately; and (b) it may be economic to pursue coal generating options.

2.30 Some aspects require additional analysis to clarify elements of uncertainty: (a) ecological issues relating to ash disposal and coal dust; (b) coal cogeneration; (c) hydro projects; (d) and scale and technical configurations of peat proposal.

2.31 Coal Conversion. The favorable price differential of coal relative to oil on an energy basis has been the main driving force for considering the conversion of existing fuel oil-fired power plants to coal. A feasibility study 14/ by Bechtel concluded that a coal-conversion scheme for Units 3 and 4 at Old Harbour was feasible. The MONENCO study examined this option along with the risks inherent to this proposal. These risks included: (a) serious recurring operational problems (associated with the past use and the design of the stations); (b) the age of the plants to be converted; and (c) coal operation is more complicated than oil. It concluded that despite these risks the coal conversion of Old Harbour Units 3 and 4 was an economic choice.

2.32 However, some additional issues are a source of concern to JPS:

(a) supply would be concentrated at Old Harbour, affecting the security of supply;

(b) in view of labor relations problems at the Old Harbour Station, it might not be convenient to rely on that site for the bulk of the power supply;

(c) the complexity of the operation and maintenance of a coal-fired plant requires higher paid operators, leading to rivalries within the labor force and friction between management and labor; and

(d) the environmental effects of coal dust and ash disposal.

2.33 In the mission's view, management-labor problems should not preclude the optimum solution because these are common to all operations of JPS and should be dealt with accordingly. As for the diversity of supply, the result is the same with or without coal conversion. The problem can be partly resolved by adequate transmission equipment. The

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14/ Coal Feasibility Study Phase I prepared for the coal committee of Jamaica by Bechtel Power Corporation, October 1982, Reference No. 15307.

only valid concerns relate to the reliable operation of units 3 and 4 and environmental issues which should be examined.

2.34 Cogeneration Plant. The efficiency of a coal-fired power plant can be improved by using the cogeneration cycle, i.e., simultaneous generation of electricity and process steam. The only large process steam users in Jamaica are in the alumina/bauxite subsector. ALCAN's alumina plant (Kirkvine) near Mandeville and JAMALCO Alumina refinery near Hayes constitute possible sites for cogeneration plants.

2.35 The economic analysis of this scheme, within MONENCO's study, shows that with the available information it is not possible to state categorically that this is a better choice than a new coal-fired plant. However, the analysis does indicate that cogeneration could be economic.

2.36 Relevant issues concern the arrangements for plant operation and maintenance, and the supply guarantee between JPS and the alumina company. These should be settled in principle before proceeding on this project. The MONENCO study concludes that if Old Harbour Station units are converted to coal, the cogeneration project would probably have marginal benefits. If both projects operate, there will be insufficient additional fuel savings to compensate for additional capital investment required by the second project.

2.37 Hydro. Because of the topographical and geological conditions of Jamaica, no large, and very few medium size, hydro power developments are likely to be feasible. Utilization of hydro potential for power generation is thus limited to small-scale hydropower, essentially the run-of-the-river type. The Back Rio Grande area is an exception, as some relatively larger hydropower schemes with some storage capacity could be developed. The total hydro energy potential is on the order of 658 GWh (Table 2.9); however, not all of the potential is ready for development. Some projects are uneconomic or marginally attractive, while the development of others involves conflict with alternative uses, such as water supply or recreation. Additional studies are required to define in more detail the feasibility of each project.

2.38 Most of the projects that are at the design or feasibility stage are the result of technical cooperation provided by foreign countries (Europe and Canada). Consultants working for CIDA recently completed a comprehensive appraisal of the hydropower potential of the country, performing several screenings and finally conducting prefeasibility studies on the ten most promising projects. Based on preliminary economic appraisal, the consultants recommended that five projects progress to the feasibility level. In addition, a study at the inventory level on the Back Rio Grande Basin found possibilities of developing medium-size projects with significant storage.

Table 2.9: HYDRO POWER POTENTIAL

Level	No. of Projects	Installed Capacity	Annual Average Energy	
		(MW)	(GWh)	(%)
Existing	5	20.8	118.2	18.0
Final Design	3	2.8	15.9	2.4
Feasibility	5	19.2	80.0	12.1
Prefeasibility I a/	5	14.9	75.5	11.4
Prefeasibility II b/	6	14.8	68.0	10.3
Inventory small scale	18	31.2	170.3	25.8
Inventory Med. scale	5	51.5	130.0	20.0
Total		155.2	657.9	100.0

a/ Best projects selected by consultants for further studies.
b/ Projects not selected by consultants.
Source: Mission estimates.

2.39 In the mission's opinion only about 80 MW of new capacity, with an expected generation of 280 GWh, could be economically developed for the remainder of the century. Given that this development represents around 10% to 13% of the total electricity demand at the time of completion, it is clear that power supplies from hydro developments in Jamaica will not be significant in the future.

2.40 To realize this limited potential, a series of actions should be undertaken to provide information to be used at different stages of the decision-making process. First, the ongoing master plan should verify the convenience and timing of the projects available at the feasibility level. The analysis of MONENCO did not include the latest information pertaining to the Back Rio Grande project. Since the scale of the project is larger than the hydro-electric developments included in the study, its inclusion in the least cost sequence, as MONENCO recognizes, if warranted, could make a significant difference in the timing and ranking of the other projects.

2.41 Second, studies are needed, especially in the Blue Mountain area, to define the best use of the water resources within a multiple-purpose framework. The recent decision to supply water to Kingston from the Blue Mountain renders the Blue Mountain project (55 MW) unfeasible. 15/ A comprehensive study is still required to determine: (a) which rivers may or may not be released for power production; and (b) which ones could be developed for multiple use. The mission considers this study necessary because the capacity of the present water supply project can only meet the projected demand for the next five

15/ To incorporate this project would require a major redesign of the water supply.

years, thus requiring another follow-on water supply project. Further, many of the streams in the Blue Mountain area are located within the boundaries of a proposed national park.

2.42 Third, on completion of the Blue Mountain Water Resources Optimization Study, the most attractive among the released prefeasibility projects should be taken to the feasibility level. A prior stream-gauging program should also be conducted on the most promising released inventory projects before they are taken to the prefeasibility level.

2.43 Finally, the Back Rio Grande project (medium size) should be taken to prefeasibility level. A diversion from the Swift River should be first investigated if the Swift River is released for power use in the Blue Mountain Water Resources Optimization Study.

2.44 Peat. Peat is the only indigenous fuel available in relatively significant quantities in Jamaica. Negril and Black River are the two main wetland areas together totalling about 7,700 hectares, of which 6,600 hectares are covered by peat. Another nine smaller coastal wetland sites have an additional 7,700 hectares. Reconnaissance studies have been carried out in eight of these areas by measuring the peat depth at random locations and analyzing the peat characteristics. Two areas, Annotto Bay and Great Morass to the east of Port Morant, have proven peat reserves of approximately 2,060 hectares.

2.45 According to the most recent studies there is a 73 MW potential development at the Negril area with an expected life of 28 years. 16/ The studies also show that, until the ecological problems are solved, the Black River area should be reserved for later analysis. The proposed location of the Negril power plant is at South West Point, near Green Island (IBRD Maps No. 18111 and 18307). Peat will be excavated hydraulically, macerated and pumped from the bog area to the power plant. The proposed drying method of mechanically dewatering and steam drying peat is a new concept. The critical aspect is the performance of the mechanical dewatering press because the steam dryer is sensitive to the incoming dry solids content. It is proposed to install two units each of 36.5 MW capacity. The net output of the plant is estimated at 60 MW; the balance of 13 MW will be for the plant's operation.

2.46 The complete feasibility report was not available to the Mission for reviewing. However, preliminary results were obtained from the consultants. The MONENCO's least-cost expansion plan excludes the peat project. The mission believes that by changing the scale and the technical configurations, the economics of the project may improve. To achieve this, the mission recommends the following:

(a) since the proposed mining and drying concepts have not been proven on a commercial scale, the filter press should be tested

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16/ Based on operating 6,000 hrs/yr.

under normal operating conditions. Based on the results, the performance of the steam dryer should be evaluated;

(b) the economic analysis of a larger-scale power unit (single 60 MW unit) should be compared to the project currently under review. The alternative of solar drying possibilities should also be studied so that, should the assessment of the filter press method prove negative, another option would be available; and

(c) for operational safety and reliability purposes, the option of firing the plant at full rated capacity on fuel oil should be examined. The present project design relies on fuel oil only for start-up and back-up purposes.

III. PETROLEUM

Introduction

3.1 Jamaica relies on Venezuela, Mexico, Aruba, Curacao and Trinidad and Tobago for its petroleum supplies. The petroleum import bill is a major drain on the country's foreign exchange resources. In 1983 it was 14% of GDP, 30% of imports, and 31% of foreign exchange earnings from merchandise exports and non-factor services (Annex Table 3.1). Recently, due to foreign exchange shortages, the refinery has purchased some cargos of light Iranian crude oil on the spot market. The mission understands that these purchases were available on attractive credit terms.

3.2 Bilateral (Canada) and multilateral (IDB and IBRD) sources have provided assistance and credits for the continued search for oil and gas. An exploration program has been in place since 1955. However, so far no commercial discovery has been reported (3.40).

3.3 About 39% of total petroleum products are used by the bauxite/alumina sector, 22% by power generation, 8% by international aviation and bunkers and the balance in the domestic sectors (Table 3.1). The bauxite and alumina industry use export earnings to pay for their imports; these payments are independent of the GOJ's foreign exchange budget.

Demand Trends

3.4 In 1976, per capita petroleum use (including bauxite/alumina) was 7.1 bbl of oil equivalent (boe). In 1980, the per capita demand declined to 6.8 boe, and then to 5.8 boe in 1983. In 1976, the intensity of petroleum use was 8.1 boe per US$1,000 GDP (1974 prices) and 15.9 boe/US$1,000 GDP in 1983. Petroleum demand increased at 0.2% p.a between 1976 and 1980, and declined at 3.4% p.a between 1980 and 1983 (Table 3.2). The primary reason for the decrease in demand was a sharp decline in bauxite/alumina production (Table 3.3). In 1980, the bauxite/alumina sector accounted for about 52% of petroleum use, declining to about 39% in 1983 (Table 3.1). The non-bauxite sector's consumption of petroleum increased from 7.4 million bbls in 1980, to 8.4 million bbls in 1983 (a growth of 4.4% p.a). This was a reversal of the trend experienced between 1976 and 1980 when the non-bauxite demand declined by 3.7% p.a. The main products registering increases were gasoline, LPG and turbo fuel (Table 3.2). The major sectors which reversed their demand trend were transport, cement and power generation (Table 3.1).

Bunkers and Aviation

3.5 Table 3.1 shows that between 1976 and 1980 petroleum uplifts by international bunkers (shipping) declined by about 26.4% p.a. The sharp decline was mainly due to a depressed state of the economy and relatively

high fuel oil prices at Jamaican bunkering ports. Demand in this sector remains low and the growth between 1980 and 1983 has averaged 1.8% p.a., representing an increase of 13,000 bbl of petroleum in three years. This does not reflect a significant change in petroleum uplifts by bunkers.

Table 3.1: PETROLEUM DEMAND BY SECTOR
(1976-83)

Sector	1976		1980		1983		Growth 1976-80	Growth 1980-83
	('000 bbl)	(%)	('000 bbl)	(%)	('000 bbl)	(%)	(%/p.a.)	
Aviation	791	5.2	765	5.0	892	6.5	(0.8)	5.2
Shipping	804	5.3	236	1.5	249	1.8	(26.4)	1.8
Road/Railways	2,468	16.3	1,904	12.4	2,155	15.6	(6.3)	4.2
Cement	407	2.7	200	1.3	391	2.8	(16.3)	25.0
Sugar	305	2.0	195	1.3	104	0.8	(10.6)	(18.9)
Bauxite/Alumina	6,555	43.2	7,887	51.5	5,345	38.8	4.7	(12.2)
Power Generation	2,375	15.6	2,677	17.5	3,090	22.4	3.0	4.9
Cooking Fuels	871	5.7	632	4.1	649	4.7	(7.7)	0.9
Others	614	4.0	820	5.4	915	6.6	7.5	3.7
Total	15,190	100.0	15,316	100.0	13,790	100.0	0.2	(3.4)
FOE	14,778		14,901		13,415		0.2	(3.4)

Note: Figures in brackets indicate negative numbers.

Source: Ministry of Mining, Energy and Tourism.

Table 3.2: PETROLEUM DEMAND BY PRODUCT
(1976-83)

Product	1976	1980	1983	Growth 1976-80	Growth 1980-83
	('000 bbl)			(% per annum)	
Avgas	20	18	15	(2.6)	(5.9)
Turbo Fuel	771	750	877	(0.7)	5.4
Gasoline	1,951	1,445	1,703	(7.2)	5.6
Auto Diesel	1,545	1,410	1,404	(2.3)	(0.1)
Kerosene	442	283	259	(10.5)	(2.9)
L.P.G.	429	349	400	(5.0)	4.6
Marine Diesel	220	155	156	(8.4)	0.2
Fuel Oil	9,812	10,906	8,976	2.7	(6.3)
Total	15,190	15,316	13,790	0.2	(3.4)

Note: Figures in Brackets indicate negative numbers.

Source: Ministry of Mining, Energy and Tourism.

3.6 The uplifts by international airlines declined by 0.8% p.a. during 1976-80. Since 1980 the trend has reversed and aviation demand has continued to increase at 5.2% p.a. This increasing trend reflects: (a) an upturn in tourist arrivals; (b) introduction of new flights to Jamaica; and (c) a cross subsidy to Air Jamaica on turbo fuel.

Bauxite/Alumina Industry

3.7 Table 3.3 shows the production and export trends for bauxite/alumina, and the sector's oil consumption for the period 1976/83. Fluctuation in oil use by this sector is closely linked to alumina production. Between 1976 and 1980 alumina production increased at 10.7% p.a. while the total oil demand increased at 4.8% p.a. Average oil use in this sector decreased from 4.1 bbl per tonne of alumina produced in 1976 to 3.3 bbl per tonne in 1980. In 1980, energy use in the bauxite/alumina sector decreased by 12.3% p.a, from 7.9 million bbls to 5.3 million barrels in 1983. This decrease resulted primarily from a 13% p.a reduction in bauxite production and approximately 9% p.a decrease in alumina production. It is estimated that petroleum consumption in 1984 fell to 4.9 million barrels (1.15) due to a further decline in the industry.

Table 3.3: BAUXITE/ALUMINA PRODUCTION AND PETROLEUM USE (1976-1983)

				ANNUAL PERCENTAGE GROWTH	
	1976	1980	1983	1976-80	1980-83
BAUXITE (Mil. tons)					
Production	10.3	11.8	7.7	3.5	(13.3)
Exports	6.3	6.0	3.0	(1.2)	(20.6)
ALUMINA (Mil. tons)					
Production	1.6	2.4	1.8	10.7	(9.1)
Exports	1.6	2.4	1.9	10.9	(7.5)
PETROLEUM USE (000 Bbl)					
Auto Diesel	316	317	100	0.1	(31.9)
Fuel Oil	6,239	7,587	5,232	5.0	(11.7)
Total	6,555	7,904	5,332	4.8	(12.3)

Source: Jamaica Bauxite Institute and the Ministry of Mining and Energy.

3.8 The bauxite/alumina sector uses foreign exchange from its own exports to pay for oil imports which are arranged through a direct international tendering system. Although a reduced energy consumption per tonne of alumina does not directly improve the balance of payments, improved energy efficiency can increase the competitiveness of the bauxite/alumina industry in world markets.

3.9 The major energy issues in this subsector are how to improve the energy efficiency of alumina production and find a substitute for fuel oil. To achieve higher energy efficiency and fuel oil substitution, Government policy with regard to the bauxite/alumina industry will have to incorporate an element of incentive and encouragement for new fuel-saving investments.

Inland Petroleum Demand

3.10 In 1983, the domestic sector (excluding bunkers and alumina/bauxite) used about 53% of total imported petroleum products. The power sector accounts for more than 42% of this consumption, followed by the transport sector which consumed 30% of petroleum products (Table 3.4). Between 1976 and 1980, the demand for petroleum products by the transport sector decreased by 6.3% p.a. From 1980 to 1983, consumption increased by about 4.2% p.a. from 1.9 million barrels in 1980 to 2.2 million barrels in 1983. The increase in consumption of transport fuels was partly due to an increase in imported motor vehicles and a decline in the real price of gasoline. The increase in oil use in the power sector appears to be in line with increases in power demand. Improved reliability of the JPS system has very likely reduced self-generation and increased the power demand from JPS.

Table 3.4: INLAND PETROLEUM DEMAND BY SECTOR
(percent)

Sector	1976	1980	1983
Inland transport	35.2	29.5	29.5
Cement Industry	5.8	3.1	5.3
Sugar Industry	4.3	3.1	1.5
Power Generation	33.7	41.7	42.3
Cooking Fuels	12.3	9.8	8.9
Others	8.7	12.8	12.5
	100.0	100.0	100.0

Source: Ministry of Mining, Energy and Tourism.

3.11 Increased oil demand by the cement industry was a result of recommissioning of the kiln which had remained closed for approximately one year. The cement company has embarked upon an expansion of the existing plant and the conversion from the wet to dry process. Further, a fuel

substitution program from oil to coal is also underway. 17/ When the process and fuel substitution projects are completed in 1985, oil demand by this industry is expected to decline substantially.

3.12 The demand for oil by the sugar industry has declined due to a decline in sugar production, and the installation at Frome of boiler air controls and air-preheaters financed by an IBRD loan. The mission believes that the efficiency of the sugar industry can be improved and oil consumption in this sector can be fully replaced by bagasse. This industry has the potential to produce excess power which can be supplied to the national grid.

Marketing and Distribution

3.13 A total inland market of 20,400 barrels/day (MBD) is shared between three marketing companies: Esso, Shell and Texaco. In addition to storage at the local refinery, the industry maintains a jointly owned and operated terminal in Kingston at the Norman Manley Airport. In Montego Bay, Shell and Esso own and operate separate terminals. The total storage in the country is around four million bbls, which provides approximately 112 days cover at the 1982 consumption level. This storage is considered sufficient for the country's needs.

3.14 The market is served through a network of about 253 retail outlets. Because of the trade association there is little competition among the dealers. A study conducted by UNDP in 1979 identified major problems in retail outlets. It concluded that about 112 stations were superfluous and recommended that 62 outlets be closed immediately (24 in rural and 38 in urban areas). The study recommended steps to improve the distribution system; however, the recommendations of this study have not been implemented. In the mission's view, the study should be updated and its recommendations followed.

3.15 Similarly, the transport of petroleum products from terminals to retail outlets is controlled by one haulage union. There are about 92 trucks and 40 contractors involved in distribution. This represents over-capacity in haulage tankers and each contractor is allocated capacity for transportation. The fleet is old and in view of assured volumes/margins there are ro incentives to improve efficiency. The mission recommends that the present practice of allocating gallonage to specific contractors be discontinued and marketing companies and distributors be encouraged to seek tenders to achieve a more efficient transport system. The procurement of petroleum supplies for the domestic market is at present through the Government-owned oil refinery. The mission is not

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17/ For the period 1983/84 to 1984/85, total investment in the cement project will be J$88 million, of which J$40.5 million will be foreign exchange. Most of the loan funds will be provided by IDB.

certain if the current petroleum procurement system is the least cost system and therefore recommends that a least cost petroleum supply option study be done to determine if foreign exchange savings can be made. The study should also include a serious look at the marketing, distribution and storage aspects of the industry with a view to: (a) reducing foreign exchange costs, and (b) improving the marketing/distribution system.

Petroleum Pricing Structure

3.16 Prices of petroleum products fall under two categories: (a) controlled; and (b) uncontrolled. The ex-refinery/terminal prices are deemed to be based on the average of Caribbean postings plus freight (Worldscale/AFRA), insurance and ocean losses. 18/ The petroleum pricing structure has become somewhat complex, reflecting the Government's efforts to meet several objectives which include: (a) keeping the price of LPG and kerosene low in view of their use by low income households; (b) generating funds to cover foreign exchange losses incurred by the refinery/ PCJ; and (c) until May 1984, moderating the rise in electricity tariffs by selling fuel at a reduced price to JPS. Decisions on domestic prices also have become complicated because of the exchange rate system. Given the relatively quick devaluation of the Jamaican dollar, it is critical that adjustments in domestic prices (quoted in terms of J$) be made quickly so that the prices faced by consumers reflect the current exchange rate and current cost to the country. Up to now, changes in prices have lagged behind the changes in exchange rates.

3.17 The refinery/terminal billing price has five main components:

(a) Caribbean import parity (mean of the posted f.o.b. prices of a petroleum product from Curacao and Aruba) plus: (i) freight rate based on G.P. vessel Worldscale/AFRA; 19/ (ii) ocean losses; (iii) insurance; and (iv) terminal charges including storage.

(b) Stabilization Factor. This charge was introduced to compensate for short-term movements in import parity prices. The fund now has been broadened to cover also a subsidy on LPG and kerosene, letter of credit charges (3.5%) on petroleum purchases and demurrage costs. The highest stabilization factor falls on premium gasoline (8.4% of the ex-refinery cost). The "factor" for retail automotive diesel is equivalent to 3.9% of the ex-refinery price.

18/ The sum of postings, freight, insurance and losses equals import parity.

19/ The mission believes that until 1982 it was based on a theoretical voyage of multiport loading at Trinidad/Curacao.

(c) Accord Differential. The purpose of this charge is to cover, over a 3-year period, the 1983 losses of the PCJ, amounting to J$123 million, which resulted from the dual exchange rate. After this loss is made up, proceeds from the charge may be used by the Bank of Jamaica to cover the foreign exchange losses which may result when the credits under the San Jose Accord are repaid to Mexico and Venezuela.

(d) Interfuel Subsidy. Between June 1983 and May 1984, an increment on the price of gasoline (43%) and automotive diesel was used to lower the price of fuel oil sold to the Jamaica Public Service Company. The final selling price to JPS was set at J$66.90/barrel, implying a cross-subsidy of J$37.33/barrel. At the 1983 demand level (3.1 million barrels), the total annual value of the cross-subsidy would be about J$115 million. Effective May 1984, JPS began paying market prices for fuel.

(e) Excise Duty. Taxes are levied on all petroleum products except domestic kerosene, turbo fuel, heavy fuel oil and LPG (levy is negligible). The rates differ widely between gasoline, at nearly 70% of the ex-refinery price, and diesel fuels, at about 8% of the ex-refinery price.

The price structure of controlled petroleum products is shown in Annex Table 3.2. Long-run pricing policy and strategy must recognize that distortions in relative prices are likely to convey incorrect pricing signals regarding the cost of certain fuels and result in a misallocation of investments.

Subsidy on LPG and Kerosene

3.18 The consumption of LPG (7%) and kerosene (6%) is a minor portion of the total inland demand for petroleum products. The Government justifies the subsidy on the two products because of their use as basic cooking fuels for low income households, particularly in the rural areas. The extent of the subsidy is significant when prices for these products are compared with the levels in other countries in the region with per capita incomes equal to or lower than that in Jamaica. In terms of US$/gallon, the subsidy has in fact widened since January 1983 because domestic price adjustments have not kept pace with the devaluation of the Jamaican dollar. The kerosene subsidy results in diesel adulteration at a significant cost to the Government.

3.19 The GOJ had commissioned a study to review the structure of prices. The study recommended gradual deregulation of controlled product prices. Under the current system, all elements of prices are fixed by the Government and negotiated by various trade associations, companies and unions (such as gasoline retailers, kerosene peddlers, PCJ, and marketing companies). With prices fixed at the refinery level, liberalizing other elements is not expected to improve either the pricing mechanism or the efficiency and may in fact cause complete chaos. In the mission's

view, liberalization should be done at all levels for all products. If such a system is adopted, products should be procured through the least-cost suppliers, and competition should be encouraged at the retail level. Although the mission supports this strategy, in the short term adoption of such a system may not be practical.

3.20 The mission recommends that:

(a) all subsidies on petroleum products be removed and distortions in relative prices be corrected;

(b) in the short term, the availability of foreign exchange for importing petroleum products should be fixed at a realistic level and made available to PCJ or the marketing companies at the market rate of exchange; and

(c) the Government should simplify taxes on petroleum products and allow the domestic prices to move along with the devaluation of Jamaican dollars.

Refining

3.21 Jamaica has one oil refinery, which is located in Kingston. The refinery was constructed in 1964 pursuant to an agreement between Esso (Exxon Corporation) and the GOJ. The refinery was purchased by the GOJ and is now operated by PCJ through its wholly owned subsidiary Petrojam. 20/

3.22 The refinery initially supplied products to other countries in the Caribbean and the Gulf of Mexico, in addition to the Jamaican market. The export markets were phased out as the Jamaican market grew through 1973. At its current capacity of 36,000 BD, the refinery supplies most of Jamaica's requirements for transportation fuels including gasoline, kerosene/turbo-fuel, and auto-diesel. It also produces LPG and a substantial amount of residual fuel oil. Lubricating oils, spray oils, bunkering fuels, 21/ some solvents, and most fuels for the bauxite and alumina industry are imported.

3.23 There are no processes to convert heavy oils to light products in the refinery and the yield of various products is determined by the characteristics of the crude processed. To meet the product mix required by the market, distillate stocks, called spikes, are added to the crude oil.

20/ Petrojam Ltd. was incorporated in October 1982.

21/ The refinery also supplies some of the bunkering fuels.

3.24 The heart of the gasoline production process is a catalytic reformer which increases the octane quality of virgin naptha while producing hydrogen for desulfurization of distillate products and additional LPG. This process limits the refinery's capacity to produce gasoline. Any gasoline demand above this limit must be met by importation of a suitable blendstock or finished product gasoline. Currently, this capacity is sufficient to meet the country's demand.

Venezuelan/Mexican Oil Facility

3.25 Venezuela and Mexico, through agreement with the Bank of Jamaica, initially financed 30% of Jamaica's oil bill by a five-year promissory note at a 4% annual interest rate. These notes may be converted into long-term loans up to 20 years with five years grace, at a 2% annual interest rate. The loans are to be used to finance energy and other related development projects. 22/

3.26 Venezuela and Mexico implement the accord differently. In the case of Venezuela, a line of credit to Jamaica for crude oil purchases of US$20 million has been exhausted. Mexico has required full cash payment followed by a 20% refund. To date, Jamaica has not succeeded in converting any short-term loans into long-term loans, and some of the 5-year short-term loans will become due in the near future. Current operation of the facility suggests that the benefit received by Jamaica under the Accord has been a loan of 20%-30% of oil purchases at a rate of 8% per annum over a 2-1/2 year average term. Based on a commercial rate of 14% interest, this facility is worth about US$0.73/bbl of product. If Jamaica were able to convert these loans to a long-term, 6% loan at an average term of 7-1/2 years, this facility would be worth US$1.18/barrel. This compares with US$1.61/barrel savings if products could be purchased at spot prices rather than Caribbean postings. 23/

Refinery Margin

3.27 Up to 1982, under the refinery agreement, Jamaica parity product prices were computed based on the mean of Aruba and Curacao posted prices, and Worldscale/AFRA published freight assessments. In order to keep the refinery financially viable, Esso was allowed a US$2.20/bbl

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22/ The terms of the Accord are revised each year. At the time of the mission, terms were that 20% of the oil bill could be financed at 8% for four years and could then be converted to project loans at 6% for 15 years.

23/ Weighted Carribean postings at the time of the mission were US$31.84/bbl. These are compared with weighted Caribbean spot prices of US$30.23/bbl and an estimated accord cost of US$31.41/bbl. In the long run, a contract pricing formula could be based on indexing the purchase prices to spot prices.

small refinery differential 24/ over the Caribbean posting parity. However, in February 1981, the refinery margins were changed to reflect a cost plus basis which at that time equaled US$2.81 bbl. Under PCJ/Petrojam, the Aruba/Curacao postings have been retained and a Petrojam freight survey substituted for Worldscale/AFRA. Additional features introduced by PCJ/Petrojam are US dollar values for terminal and truck rack operation. A comparison of refinery margins is shown in Table 3.5.

3.28 Table 3.5 shows that the new formula for ex-refinery price determination has been modified to provide the small refinery differential sought by the refinery. A differential between the maximum anticipated price and the new Jamaica parity price has been added to the US$ refinery margin. A round-island movements (RIM) factor which was previously included in the marketer's margin is now added to the refinery margins. This factor, although applied to all controlled products, covers the cost of moving gasoline, auto diesel and domestic kerosene to Montego Bay and is expressed in US dollars.

Table 3.5: REFINERY MARGINS a/
(US$/bbl product)

	Under ESSO	Under PCJ	Change
Jamaica parity	1.59	2.13	0.54
Terminal fee	-	1.14 b/	1.14
Esso throughput	-	0.08	0.08
Rack fee	-	0.44	0.44
Price formula	2.20	-	(2.20)
Total Margin	3.79	3.79	0.00

a/ These margins relate to clean products only.

b/ Petrojam reports an average foreign currency operating cost component of US$0.55 per barrel. No detail was given as to its content but it is less than half of the terminal fee of US$1.14 charged on all refinery products.

Source: Ministry of Mining, Energy and Tourism.

3.29 Estimated revenues from the differential between price ceiling and the new Jamaica parity are shown in Table 3.7. The refinery says that these collections are used for offsetting subsidies and other price movements.

24/ The term 'small refinery differential' refers to the size of the Kingston refinery as compared to Caribbean export refineries.

Table 3.6: RIM FACTOR

	bbl/yr	US$/bbl	US$/yr
	('000)		('000)
Premium gasoline	1,655	0.3012	498
Regular gasoline	50	0.5438	27
Domestic kerosene	320	0.3618	116
Auto diesel	1,380	0.489	675
Total			1,316

Source: Petrojam.

Table 3.7: CEILING PARITY AND STABILIZATION FUND

Product	bbl/yr	Jamaica Parity	Ceiling	Stabilization Accord Difference	US$/yr
	('000)	(US$/bbl)	(US$/bbl)		('000)
LPG	400	41.02	41.795	0.775	310
Premium	1,650	37.637	40.654	3.017	4,978
Regular	50	36.613	39.09	2.477	124
Kerosene	320	38.321	40.805	2.484	795
Auto Diesel	1,380	36.343	39.5	3.157	4,357
Total					10,564

Source: Ministry of Mining, Energy and Tourism, and Petrojam.

3.30 Table 3.5 shows that the new refinery pricing formula gives the refinery a flexibility to obtain the margin sought by it. The formula provides cash inflow of about US$12 million from RIM and ceiling parity differential (Table 3.6 and 3.7). The new pricing formula has increased the financial profitability of the refinery. However, the medium to long-term economic viability of the refinery has not been evaluated and requires an objective evaluation within the context of a least-cost petroleum supply option.

Energy Conservation

3.31 Petrojam has identified several energy conservation projects as a result of the recently completed "ENCON" program. Petrojam is currently seeking a US$5.82 million loan to finance three energy conservation projects. This program should await the results of the least-cost petroleum supply study.

Crude Oil Supplies

3.32 Petrojam has identified the optimum crude oil feed with the aid of a linear program refinery model. 25/ These are selected from Venezuelan and Mexican crudes which are purchased under the Accord. An alternative to processing Accord crudes would be to purchase other crudes for processing at Kingston. These crudes include, for example, Nigerian light crude purchased from the producer, or Iranian crude purchased on the spot market. Petrojam in the past has processed Iranian crude at Kingston and PCJ has processed Nigerian crude offshore. Iranian crude has been imported on those occasions when Accord crude was not available. In the absence of heavy oil conversion and the availability of only limited reforming capacity, the Kingston refinery cannot process non-Accord crudes as efficiently as other more complex Caribbean refineries. The advantage of Petrojam over other Caribbean refineries is to efficiently hydro-skim regional crudes procured under favorable terms such as those of the Accord and to import the efficiences of other larger refineries through spikes and blendstocks.

Product Slate

3.33 The annual demand for regular gasoline in Jamaica is about 50,000 barrels. The production of regular gasoline requires dedicated tankage and a working inventory. Few motorists use regular gasoline; the main use is for the fishing industry. If the production of regular gasoline were to be discontinued only premium gasoline (95 RON) would be available. Since many service stations have discontinued selling the regular grade, its elimination would not yield any reduction in service station investment. Most of the benefit from eliminating regular gasoline would be in the refinery while the fishing industry would have to switch to the more costly premium grade. These benefits, however, must be evaluated against the additional foreign exchange cost of importing TEL. 26/

Product Exports

3.34 While evaluating the refinery economics, one may investigate the potential for exporting or re-exporting products to some of the small countries in the Caribbean or Central America. Jamaica cannot compete with the large Caribbean export refineries for the U.S. and European market. PCJ should examine the small Caribbean and Central American countries which have no refinery of their own, require small volumes of product and possibly qualify for economic assistance from Venezuela and Mexico. Being geographically closer to Jamaica than to Venezuela, it may be less costly to transport crude in large tankers to Jamaica. The

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25/ The program is able to select from 25 commonly traded crude oils.

26/ At the time of draft report review in February 1985, the mission was informed that sales of regular gasoline had been discontinued.

Petrojam refinery would export finished products in small tankers to the Central American country rather than for them to import directly from Venezuela or the Netherland Antilles. In this situation Jamaica would provide refining if none is available to process the destination country's Accord crude. Furthermore, virgin fuel oil has quality premiums that are attractive to Caribbean export refineries. The Kingston refinery could benefit by increasing crude oil through-put and selling fuel oil directly or swapping it with lower quality fuel oil and earning a premium.

3.35 In some instances, small product demand, inadequate tankage and shallow draft prevent these countries from buying on the spot market. Petrojam could, for example, buy large single product cargoes (e.g. 150,000 barrels of each product) on the spot market and take these cargoes into Kingston. At Kingston these cargoes would be broken down to smaller parcels (e.g., 30,000 barrels of ADO), combined with small parcels of other products (e.g., 10,000 barrels of kerosene, 15,000 barrels of regular gasoline and 20,000 barrels of premium gasoline) as required and loaded onto smaller multi-product speciality (e.g., shallow draft) tankers for export (IBRD Map 17800). Assuming that Jamaica's short-term currency stringency can be rectified, the proposed mechanism of spot product imports and exports could reduce the cost of petroleum products to Jamaica while still taking advantage of the San Jose Accord. 27/

Reducing the Cost of Oil Imports

3.36 The calculated product price on the Caribbean spot market, adjusted for freight, averaged US$30.23/bbl and was US$1.61 lower than the Jamaica parity based on posted product prices. The mission believes that there is a clear incentive for a close examination of the refinery's incremental product cost. The last increments of higher-cost production should be substituted with spot product purchases.

3.37 The AFRA freight cost is estimated to be US$0.18/bbl less than that paid by Petrojam. Based on the estimated annual product volume, this represents a US$1.5 million potential for reducing crude oil freight cost. The foregoing points to potential savings which could be achieved from long-term chartering of crude oil shipping. There are a number of factors which should be considered in long-term chartering, including utilization.

Foreign Exchange

3.38 Notwithstanding the economic viability of the refinery, in the short run, insufficient foreign exchange affects the procurement of petroleum supplies by causing unusual and costly purchasing arrangements. Crude oil shortages are expensive and affect the refinery through

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27/ Under which Mexico and Venezuela provide petroleum to Central America and the Caribbean countries on credit.

increased energy cost, own fuel loss, and safety risks. A system of budgeting scarce foreign exchange would enable Petrojam to plan a smooth operation, anticipate shortfalls, and avoid unscheduled shutdowns due to shortages of crude oil.

Regulatory Function

3.39 Before the refinery was acquired from Esso, the Energy Division was responsible for monitoring ex-refinery prices that maintained a formula relationship to postings at Curacao and Aruba refineries. After Jamaica acquired the refinery, the policing function ceased and has been assumed by PCJ. It is impossible for the refining industry to regulate itself. This shift in regulatory function has manifested itself in the following manner:

(a) ex-refinery pricing is no longer being monitored. Freight rates used to adjust postings for location appear to have been increased from their former levels. 28/ If these adjustments are increased above their market level, they will fail to provide the needed guideline for estimating the alternative cost of imports. Setting parity prices at elevated levels misdirects internal refinery optimization and project analysis;

(b) if refinery billings are changed from the present standard of 60°F to some higher temperature such as ambient, this will in effect transfer income from the marketers to the refinery. This will naturally benefit the refinery and it is therefore in the interest of the refinery to recommend that this be done. Increasing the billing temperature will not reduce the cost of oil imports;

(c) direct contracts between the Government and the refinery may be used to circumvent competitive bidding and may encourage inefficiency; and

(d) the practice of using product prices to subsidize other products puts the refinery in the position of redistributing income. While this is a normal role for the Government, it is not the correct role of the refinery.

28/ Before GOJ took over the refinery, the freight was based on AFRA. PCJ now computes parity by using its own freight assessment. The freight assessment has been consistently higher (e.g., US$1.13/bbl-kerosene) than AFRA (US$0.66/bbl kerosene). This has provided the refinery with an additional US$1.9 million/year.

Exploration

Exploration History

3.40 Since 1955, eleven exploratory wells (IBRD map 18266) have been drilled in Jamaica. A total of about 7,000 lines-km of seismic have been shot on the offshore prospects and about 400 lines-km onshore. Offshore, 16 structures were mapped. Due to excessive water depth only two of the offshore prospects are drillable: the New Bank and Pedro Bank. Onshore, three structures were mapped, two of which are identified as drillable prospects; the Ecclesdown and Montego Bay anticlines, with 1,500 and 6,500 acres of closure respectively. The third one, Duskenfield, requires further work for better definition of the structure and stratigraphy. Five international companies have drilled six wells onshore and two offshore. All wells were completed as dry holes. Onshore exploration, particularly after drilling of six dry holes, lost its appeal to international oil companies. In 1979, PCJ decided to start a program of exploratory drilling and seismic and geologic investigations. This program was made possible through an IDB loan of US$29 million. Currently, close to US$8 million of the IDB loan is undisbursed awaiting a final decision on whether further exploration should continue. Several consultants have reviewed the hydrocarbon prospects of Jamaica.

PCJ's Exploration Strategy

3.41 PCJ has recognized that the private sector, rather than the Government, should be involved in the exploration activity of the country, particularly the offshore. Toward this goal, a promotion seminar was organized in Houston, Texas, in January 1984. PCJ received three proposals, none of which was acceptable, as none of them put sufficient up-front funds. Petro Canada had proposed a joint venture in the offshore, New Bank prospect, for drilling one exploratory well at an estimated cost of about US$8 million. Petro Canada was to operate the project and fund about US$4 million (50% of the project cost) in the form of grant assistance. PCJ was asked to recruit a partner for the remaining half of the project cost. Since PCJ was unable to meet these conditions in time, Petro Canada's offer has now lapsed.

PCJ's Exploration Program

3.42 Notwithstanding the petroleum promotion strategy, PCJ has formulated an exploration program for the medium-term. The salient features of the program are that:

(a) exploration should continue;

(b) new seismic surveys and further interpretation of existing data for the offshore are not recommended;

(c) additional seismic in the onshore areas as well as shallow core holes or stratigraphic tests for further evaluation of structures and for calibration of seismic data with check shot surveys and sonic logs should be prepared;

(d) a series of studies, analytical research, and reevaluation of existing data are planned by PCJ to elucidate the complex stratigraphy of the region and its relation to the structural development of each prospect. There are a number of other leads which need further work;

(e) offshore, the New Bank structure would be the next location for drilling, followed by a second well at Pedro Bank; and

(f) according to PCJ, the onshore Ecclesdown and East Montego Bay prospects should be drilled.

Recommendations

3.43 It is PCJ's view that the complex geology of the offshore shelves warrants additional investigation. The mission agrees that additional detailed studies of the offshore would throw further light on the prospective areas, particularly offshore prospects, by undertaking the following:

(a) structural definition of reef margin lead in the Negril area;

(b) further definition of Moneague Play Trend for both the concept and structure;

(c) a detailed stratigraphic and faces analysis of all the recognized sedimentary formations including bio-stratigraphy, geochemical and lithologic analysis; and

(d) further definition of source rocks and reservoir rock development in greater Jamaica area and the area's tectonic activity and its impact on the hydrocarbon prospects.

3.44 The mission recommends and the Government agrees that additional exploration drilling should be dependent on the result of studies and should be undertaken by the private sector alone or by private sector risk participation.

IV. RENEWABLES

Energy Potential From Bagasse

4.1 Sugarcane cultivation is one of the oldest major agricultural activities in Jamaica. In recent years, the sugar industry and state-run mills in particular have faced falling production and consequently have incurred heavy financial losses. 29/ During the 1983 crushing season, about 11 sugar mills (seven state-run, and four privately owned) were in operation, and produced approximately 197,000 tons of sugar for that year. Table 4.1 gives the breakdown of sugar production and the associated bagasse production for all the mills. The 1983 production was slightly (about 2%) lower than that of the previous year. All bagasse, along with supplemental fuel oil, was used to generate steam and electric power for sugar production.

4.2 During the early 1970s, Jamaican sugar factories were producing sufficient bagasse to provide all the steam and electric power required by their mills. However, the introduction of mechanical loading of the cane in 1974 increased the amount of dirt, stones, and other extraneous material delivered to the mill. The presence of significant quantities of extraneous material deteriorates the quality of bagasse, i.e. lesser quantities of combustibles, and the mill operators had to install oil burners to supplement bagasse firing. 30/

4.3 In addition to poor bagasse quality, other factors have contributed to the increased consumption of fuel oil: (a) lack of a consistent supply of cane to the mill; (b) inefficient steam boilers and low-pressure power generation systems; and (c) the poor operating condition of the equipment in the sugar factories. The high cost of fuel oil has induced some measures to improve boiler efficiency at the larger state-owned sugar mills. For example, as a part of an IBRD-financed project, air preheaters have already been installed on boilers at the Bernard Lodge sugar factory. The Monymusk and Frome factories have also received air preheaters and preliminary indications are that the equipment will soon be installed. The Bernard Lodge factory is also firing wood waste in the boilers to reduce the fuel oil consumption.

4.4 The mission selected the West Indies sugar mill in Frome to carry out a prefeasibility study for improving the overall energy and operational efficiency of the existing mills to make them net exporters of energy. For the most part, the results of this assessment can be

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29/ Three state-run mills are to be shut down in 1984 (Table 4.1).

30/ Most of the modern sugar factories around the world are energy self-sufficient and in some cases are producing excess electric power for sale to local power utilities.

applied to the other two relatively large mills (i.e., Monymusk and Bernard Lodge) owned by the GOJ. The Frome mill was selected because it is Jamica's largest mill and in addition, the mill is near the proposed site of a peat-fired power plant. Also, the future possibility of selling excess bagasse to the peat plant was studied.

Table 4.1 TOTAL SUGAR AND BAGASSE PRODUCTION IN 1983

Factories a/	Tons Sugar Produced	Tons Bagasse Produced
Frome	55,864	199,464
Monymusk	32,071	152,632
Bernard Lodge	16,870	99,253
Duckenfield	8,785	46,768
Long Pond	7,021	29,799
Innswood b/	10,421	52,187
Grays Inn	5,006	28,289
New Yarmouth	19,399	73,058
Appleton	13,749	36,154
Hampden	10,239	36,742
Worthy Park	17,495	48,172
Total	196,920	802,518

a/ Preliminary indications are that Long Pond, Grays Inn, and Duckenfield will be shut down at the end of the 1984 grinding season.

b/ This mill was shut down after the 1983 grinding season.

4.5 The mission concluded that the Frome plant could be a net exporter of energy to JPS 31/ and that a detailed study on the industry's potential to supply power should be undertaken.

Energy Potential from Wood

4.6 A recent USAID-funded study 32/ estimated that there were approximately 276,000 hectares (ha) of forestland in Jamaica. Of this area, a total of about 111,000 hectares are owned by the GOJ and reserved as forest estate. It was further estimated that 14,500 ha of the forest estate have been established as plantation forest and the remaining

31/ The estimated output was 5 MW in the grinding season and 7.4 MW during off-season. Oil savings are 109,000 bbl/yr. Total capital cost would be US$12.3 million with a payback of approximately 4 years.

32/ USAID/GOJ Forestry Reserve Project by Agroncane, Ltd. Kingston, September 27, 1983.

reserve retained as natural forests. The Forest Department is the principal agency responsible for the management of the forest estate. The Forest Industrial Development Company (FIDCO) was established in the latter part of 1978 with the principal objective of developing commercial forestry and forest industries in Jamaica. During the last five years, the company has established 3,970 ha of commercial pine plantations. The Forest Department and FIDCO are the two major agencies involved in forestry.

4.7 The existing major forest reserves are located in the parishes of Portland, Trelawny, St. Thomas, St. Andrews, St. Ann, St. Catherine, and Clarendon. Large areas of Portland and Trelawny involve rugged terrain with poor accessibility. Detailed yield information is not available from which to make accurate estimates of wood availability. On the basis of available information the mission estimated that a total of 1.06 million tons (wet basis) of wood per year could be available from existing forest reserves. 33/

4.8 In addition to the forest reserves, significant quantities of wood are also estimated to be available from existing forestry and forest industry-related activities. These include: (a) land clearing; (b) harvesting; and (c) saw milling. It is estimated that over the next five years the above forestry-related activities will yield about 4.8 million tons of wood per year. However, it should be recognized that the fuelwood resulting from the above operations is normally dispersed over a wide area. Therefore, collection and transportation of this material to end-use locations will be difficult. This is particularly true for the waste available from harvesting, and in some degree, from land-clearing operations, although some of the wastes such as from saw milling and land clearing are currently used for charcoal, firewood, and some industrial applications. Detailed site-specific assessments should be done to determine the economically recoverable potential for different end-use applications.

4.9 The trunks of dead coconut trees also provide a potential wood resource. It is estimated that nearly half a million trees of the "Jamaica Tall" variety are dead, because of the lethal "yellow" disease. A large portion of the affected trees is located in the St. Anne and St. Mary areas. This resource represents approximately 125,000 tons of usable material for charcoal production. A small fraction of this resource is currently being sawed to produce parquet floor tiles. The slabs and off-cuts from the sawmills are converted to charcoal.

4.10 Fast-growing tree species such as Leucaena and Calliandra are currently being tested on small-scale research plots by the Forest Department staff. It is reported that approximately 23 ha of such fuel

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33/ Based on: (a) 14% of reserves yield 8 ton/ha, i.e., 304,000 tons/year, and (b) 190,000 ha yields four ton/ha/yr, i.e., 760,000 tons/year.

wood research plantations have already been established. Approximately 405,000 ha of land have been identified as suitable areas for establishing fuelwood plantations; however, of this area, only 381,000 ha are estimated to be accessible. Based on the limited fuelwood tree species, it is projected that an annual yield of 10 tons of dry wood/ha/year can be achieved under Jamaican growing conditions.

Existing Demand for Fuelwood

4.11 The major existing demand for fuelwood comes from the domestic sector where it is used mainly as a cooking fuel. Based on the 1983 household energy use survey, 34/ it is estimated that the total equivalent fuelwood demand by the domestic sector was approximately 138,000 tons p.a. Of this, 92% of the fuelwood was converted to charcoal and the remainder was used directly. This estimate does not include the charcoal and/or fuelwood demand of the commercial sector.

4.12 In order to estimate the maximum fuelwood demand for the household sector, the mission made some theoretical calculations. The maximum fuelwood demand scenario assumed that all the kerosene and LPG used for residential cooking would be substituted by charcoal and/or direct fuelwood. The amount of charcoal/wood required per year to displace 100% of the kerosene and LPG consumption was estimated at 1.1 million tons 35/ of additional fuelwood, including the existing fuelwood demand. the total fuel demand under this scenario is 1.3 million tons. The complete substitution scenario is 20% higher than the mean annual increment or the average annual yield expected from the existing forests. However, if it is assumed that fuelwood from plantations would be the main source for charcoal, then approximately 130,000 ha of fuelwood plantation will be required to sustain such an annual fuelwood demand. If direct fuelwood utilization is assumed, then the total fuelwood demand under the above substitution scenario would be reduced to about 830,000 tons per year. This amount is less than 80% of the total annual yield of existing forest reserves.

4.13 The above estimates are based on the premise of 100% substitution; they do not take into consideration the socio-economic and severe

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34/ Gordon, D. and Barnwell, D., Household Energy Use and Transportation 1983: A preliminary report, MMET, 1983.

35/ The following energy values and conversion efficiences were used:

Kerosene: HHV = 5.6×10^6 Btu/bbl, kerosene stove efficiency = 0.40
LPG: 21,435 Btu/lb, LPG stove efficiency = 0.45
Charcoal: HHV = 11,000 Btu/lb, charcoal stove efficiency = 0.12
Wood: HHV = 6,112 Btu/lb, wood stove efficiency = 0.08

logistical constraints associated with such a large-scale substitution. However, the numbers do illustrate that the existing forest reserves are capable of providing significant quantities of fuelwood to sustain a growing domestic charcoal demand. Active forest management, combined with reforestation projects, would eliminate the deforestation possibilities normally associated with any increased charcoal utilization in the domestic and/or commercial sector. At a future date, when Government resources are not so severely strained, a fuelwood substitution program should be investigated.

Charcoal Production

4.14 At present charcoal is produced either in small metal kilns or earthmound/pit kilns. The metal kiln operators use the wastewood generated from the Forest Department's land-clearing activities. A large number of the metal kilns associated with the land-clearing projects are not working for lack of auxiliary equipment such as chain saws, wood splitters, etc. for land-clearing; lack of adequate operator training; and in some cases, poor kiln fabrication. Pit kilns, therefore, still account for a large percentage of charcoal produced in Jamaica. Both the metal and earthmound kilns have limited charcoal production capacities (i.e., about 1,000-2,500 lbs of charcoal per load). Also, their conversion efficiencies (calorific value of charcoal out, divided by calorific value of wood in) are lower when compared with more efficient and larger capacity brick beehive kilns. Depending on the operating conditions and resource type, the efficiency of earth kilns and metal kilns ranges from 30 to 45% (the higher number is more typical of the metal kiln). The brick beehive kiln can achieve efficiencies higher than 50%.

4.15 The mission recommends that the Forest Department initiate an active program for testing brick beehive kilns. The designs for beehive kilns can be obtained from the U.S. Forest Service. Successful testing and implementation of beehive kilns could facilitate large-scale production of commercial-grade charcoal in Jamaica. For example, in Brazil, a subsidiary of Brazilian Steel Company supplies the steel plant with approximately 450,000 tons of commercial-grade charcoal per year. The Brazilian operating experience could provide valuable inputs to any beehive kiln testing program to be implemented in Jamaica. The mission also recommends that the possibility be explored of obtaining technical inputs from Brazilian experts through a UN/FAO-sponsored program.

Wood Gasification

4.16 Two specific proposals have been made recently for installing relatively large (250-1,000 kW) wood gasifier and internal combustion sets. The first proposal involves the installation of a 1-MW gasifier/engine generator system at the FIDCO sawmill in Spanish Town. The objective of this project is to convert part of the 17,000 tons of wood waste generated at the mill into electric power, via gasification and a dual-

fuel diesel engine-generator. It is estimated that about half the power generated would be consumed in the mill. The balance would be available for the JPS grid. The second gasifier demonstration project is proposed by SRC. This project involves the demonstration of a wood/rice-husk gasifier system to run a 250-kW diesel engine driven irrigation pump. Under the proposed project, one of the diesel engine driven irrigation pump sets at the Black River Upper Morass Development Corporation (BRUMDEC) rice fields will be converted to burn producer gas.

4.17 Because of the lack of wood gasifier operating experience in Jamaica, it is recommended that a small, 30- to 35-kW wood gasifier engine/generator system first be procured and tested under field operating conditions. The testing program should be designed with particular attention given to operator training. Either of the proposed gasifier demonstration sites (i.e., FIDCO mill or BRUMDEC rice fields) can be selected for implementing the field testing program. Lack of prior wood/biomass gasification experience in Jamaica would hamper the effective monitoring of the wood gasification testing program. The mission therefore recommends that adequate technical manpower resources be made available at SRC before initiating any wood gasifier pilot and/or field test work. Technical assistance from wood gasification experts from the U.S. or European countries, such as the Netherlands, West Germany, or France, should be sought to assist the SRC staff in designing and implementing a gasifier testing program. The results of such a testing program would provide adequate technical and economic information for making a decision with respect to the implementation of any large-scale wood gasification plants. Jamaica should also exchange information with Seychelles, where a test program has been in operation for some time. 36/

Dendrothermal Project

4.18 The mission visited several sites to explore the possibility of wood-fired power, or a dendrothermal plant. The dendrothermal plant would need to be located near or within a fuelwood plantation area. The mission carried out a prefeasibility study on the West Indies Pulp and Paper Company and found that this site could support a dendrothermal plant. 37/

Fuel Ethanol Production

4.19 The potential market demand for fuel ethanol in Jamaica is estimated to be about six million imperial gallons per year. This demand

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36/ See IBRD Report No. 4693-SEY; Seychelles: Issues and Options in the Energy Sector, January 1984.

37/ Estimated output to JPS of 12 million kWh/yr (3 MW), capital cost of US$6.1 million, oil savings of 52,000 bbl/yr. Power cost estimated at US¢6-7/kWh.

is estimated by assuming that 10% of the total gasoline volume consumed in 1983 could be replaced by fuel ethanol. 38/

4.20 In Jamaica, sugar cane, molasses, and cassava are the three major biomass resources that can be converted to fuel ethanol. Typical ethanol yields from these feedstocks are: sugar cane, 66 liters/ton; molasses, 245 liters/ton; cassava, 174 liters/ton.

4.21 In order to satisfy the potential market demand, approximately 409,000 tons of sugar cane, 110,000 tons of molasses, or 155,000 tons of cassava would be required. The production of fuel ethanol from the above feedstocks in Jamaica involves certain economic, technical, and resource constraints. These are discussed below.

Sugarcane

4.22 A recent study 39/ has indicated that the conversion of an existing sugar factory to a fuel ethanol production distillery is uneconomical. The major reason for the poor economic performance of an ethanol distillery is the high sugar price (i.e. US$300 per ton) guaranteed for Jamaican sugar in US and EEC markets. If the Jamaican sugar is valued at the world market price (US$140/ton), conversion of an existing sugar factory makes economic sense. However, since Jamaica is currently exporting less sugar than it can sell under the EEC and US quotas, the mission recommends that the conversion of existing sugar factories to fuel ethanol distilleries not be considered.

Molasses

4.23 The bulk of molasses, about 88,000 tons, 40/ is used for rum and other spirits production. It does not appear that any surplus molasses is available in Jamaica for fuel ethanol conversion. Since the rum and other spirits industry is profitable, the mission recommends that no molasses should be diverted for fuel ethanol production.

38/ A 90:10 gasoline/fuel ethanol blend is assumed.

39/ "Review of Potential for Renewable Energy Source in Jamaica - Case Study and Appendices" prepared for MMET by META Systems USA.

40/ The National Sugar Group estimates that 95% of the total molasses production is used to produce rum and other spirits.

Cassava

4.24 A 1.5 million gallon per year cassava-based ethanol plant has been recently proposed for Jamaica. 41/ The mission reviewed the proposal and concluded that:

(a) the ethanol economics presented in the proposal are based on high yields (25 tons/ha as opposed to 15 tons/ha) of cassava; consequently, low feedstock costs are estimated; and

(b) the issues relating to harvesting and further processing of large quantities of cassava are not adequately addressed. 42/ Cassava supply constraints have been experienced at a cassava-based flour mill in St. Elizabeth, Jamaica. This mill was put into operation in 1980 but had to shut down in July 1981 for lack of sufficient cassava supplies.

4.25 The mission recommends that the impact of lower cassava yields on the projected ethanol economics be evaluated. In addition, the difficulties involved with respect to harvesting and preprocessing large quantities of cassava should be studied before any serious consideration is given to implementing the proposed project.

Other Renewable Energy Options

Solar Thermal Systems

4.26 The application of solar hot water heaters in commercial and institutional buildings is being demonstrated under a USAID project. MMET and BOS are undertaking a project to set up equipment performance standards for the solar water-heating industry. The mission supports this project and recommends that the project also include local industry participation. Local industry has an established manufacturing base and the commercialization of solar hot water heaters and other devices should be left to the private sector. However, the Government should investigate economic incentives, such as investment tax credits, waiving sales tax, etc., to enhance the private sector commercialization efforts.

4.27 Small solar crop dryers have been built and tested by the SRC staff; a solar lumber kiln is currently being tested. The specific

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41/ Proposed by Osmond Welsh and Associates of Los Angeles, California USA.

42/ In this regard, it is worthwhile to mention that a 60,000 liter/day cassava-to-ethanol plant in Minas Gerais, Brazil, had to curtail or shut down ethanol production because of lack of sufficient cassava deliveries to the plant.

drying requirement for commercial lumber will be difficult to achieve in a solar kiln. The mission recommends that SRC focus only on crop drying. It is also recommended that the SRC staff actively monitor ongoing solar pilot and/or demonstration projects.

Ocean Thermal Energy Conversion

4.28 Ocean Thermal Energy Conversion (OTEC) technology has not been tested on a scale of operation that allows an estimate of the costs associated with operating a commercial plant. The mission recommends that the GOJ only monitor the ongoing R&D and testing efforts in the U.S. and other countries and not waste time and resources on testing this technology.

Wind Energy Systems

4.29 The wind mapping efforts are currently underway. Preliminary indications are that the low wind speeds will make the application of a wind power generation system uneconomical.

V. ENERGY CONSERVATION

Demand Management

Country Performance

5.1 Since the 1974 oil crisis, Jamaica has not made any appreciable improvement in energy consumption per unit of value added. Table 5.1 shows that the energy intensity index of Jamaica 43/ has remained high. An analysis of energy elasticity (Table 5.2) confirms that Jamaica is generally an inefficient user of energy. In the late 1970s, the elasticity was high by world standards while in the early 1980s no clear trend can be established because power shortages have distorted the numerator values. Generally, it would appear that elasticity values in the 2-2½ range could be expected if improvements in pricing policies and energy efficiency are not made: most developed countries have elasticity values of less than half that of Jamaica. Jamaica must make a substantial effort to improve energy demand management for, with a projected 3% annual growth rate of GDP, oil imports could rise by approximately 6% p.a. (in real terms), thus adding substantially to the balance of payments deficit. To monitor the country's progress the mission recommends that a reporting system on energy demand management and efficiency be instituted and the results annually reviewed by the Government.

5.2 Energy intensity per unit of production can be reduced by: (a) lowering demand through higher energy prices; (b) achieving higher levels of energy efficiency; and (c) structural adjustment towards less energy intensive processes. The first step in a successful energy conservation program is to ensure that the price of all energy consumed at the retail level reflects their opportunity costs. Currently, substantial amounts of energy are sold below their opportunity costs. Adjustments in energy pricing are a necessary first step for a successful demand management program and are essential if options (b) and (c) above are to be pursued.

43/ The energy intensity index is an indicator used to monitor the efficiency of energy use at the macro level. The index is defined as:

$$\frac{\text{Index of Energy Consumed}}{\text{Index of GDP}}$$

For the base year of 1974, the index is 100.

Table 5.1: ENERGY INTENSITY INDEX a/

Year	Jamaica	Japan
1974 (Base Year)	100.0	100
1975	109.5	95
1976	103.5	93
1977	97.4	90
1978	95.3	88
1979	109.9	88

Ratio: $\frac{\text{Index of Energy Consumed}}{\text{Index of GDP}}$

a/ Excludes the Alumina/Bauxite industry. The index is not relevant for the years after 1979 due to power supply shortages in Jamaica.

Source: Mission estimates.

Table 5.2: ENERGY ELASTICITY (E) a/

1975	1976	1977	1978	1979	1980	1981	1982	1983
+7.4	+2.0	+2.6	-12.2	+11.2	+3.4	-1.8	+4.4	-10.5

a/ (excludes bauxite/alumina industry).

$$E = \frac{\%\text{ change in energy consumed}}{\%\text{ change in GDP (constant prices)}}$$

Source: Mission estimates.

5.3 In Jamaica, option (b) above has considerable scope, and some success in improving energy efficiency is being achieved through the USAID/GOJ Energy Sector Assistance Project. However, a much broader based approach is required. The third option, (c), of moving to less energy-intensive processes, is limited for two reasons. First, excluding the bauxite/alumina sector, Jamaica does not have an industrial base which is energy-intensive; second, the critical role of the bauxite/alumina sector in earning foreign exchange combined with existing plant investment makes it unlikely that alumina processing will move offshore. Thus, the most promising options to pursue are (a) and (b) above. Apart from the usual political constraints, option (a) is rather straightforward. Option (b) is more complex due to the organizational and foreign exchange constraints within Jamaica (organizational constraints are discussed in detail in Chapter VI). Foreign exchange constraints limit the

importation of the latest energy-efficient equipment. Thus, retrofitting and improvements in operational efficiency are the two most important options for energy saving in Jamaica.

Sector Performance

Alumina/Bauxite Industry

5.4 In 1983, the alumina/bauxite industry consumed 57% of imported petroleum products and dominated energy demand (Table 5.3). The industry finances its own imports and has tended to be isolated from the Government's energy conservation programs. Within the industry, the Bayer process is the major user of energy. Nothing new, technologically, is expected to replace this process; therefore, the two options available are process improvement and/or fuel substitution. As all companies in the sector are multinational, decisions regarding investments to reduce energy consumption or costs will be influenced by the parent company's policies. Parent company policies influence those options available to the GOJ to encourage energy conservation within each company. World market pressures influence process improvements while indigenous cost structures influence fuel substitution and plant expansion plans. In Jamaica, reducing the cost of alumina production through a fuel substitution program (coal replacing fuel oil) is an option which the Government should actively pursue with the companies concerned. Although energy efficiency could fall, economic efficiency would improve and thus put Jamaica in a better position to compete with Australia, Brazil, and other producers in the alumina market.

5.5 To date, process improvements have been the main source of reductions in energy use. The two main companies presently consume between 2.8 to 3.6 bbl/ton alumina and a projected consumption of 2-2.1 bbl/ton is expected to be achieved under the companies' existing energy conservation programs. The major benefits as far as Jamaica is concerned are yet to be achieved. The most important technological feature of the Bayer process 44/ is its ability to use substitute fuels such as coal. Present indications are that production costs could be reduced by US$25/ton by converting to coal. Coal substitution by the alumina industry also has potentially large advantages for other sectors such as power and cement in that unit importation costs are lowered and coal purchasing power is improved.

44/ Process for converting bauxite to alumina.

Table 5.3: ENERGY DEMAND - 1983
(MBOE)

	Petroleum Products	Percent	Electricity
Alumina/Bauxite	5,340	57	-
Transport			
Aviation/Bunker	70	<1	-
Rail/Public Transport	44	<1	-
Private Transport			
Urban	987	11	-
Rural	907	10-	
Industry			
Cement	338	4	-
Sugar	104	1	400
Other Manufacturers	306	3	-
Commercial	85	1	-
Government	186	2	79
Domestic			
Urban	212	2	218
Rural	177	2	-
Others	502	5	-
	9,258	100	

Source: Mission estimates.

5.6 From an energy demand management perspective, the Government should investigate the incentives necessary to accelerate the coal substitution program of the alumina industry (3.9).

Transport Sector

5.7 Fuel Consumption Trends. Apart from the alumina/bauxite industry, the transport sector dominates the use of petroleum products. 45/ Table 5.4 shows that in 1983 51% of petroleum products were used by the transport sector. The recent upward trend in both gasoline and diesel consumption indicates that there are substantial opportunities for energy conservation in the transport sector. Transport fuel consumption has grown at more than double the rate of GDP growth (Table 5.5), which indicates that low levels of transport efficiency are occurring. Further, the 2.5 ratio of gasoline to automotive diesel in 1983 indicates that substantial opportunities exist for introducing fuel-efficient diesel engines.

45/ By definition, JPS is considered to be in the supply sector.

Table 5.4: ENERGY DEMAND, 1983 - PETROLEUM PRODUCTS a/
(excluding the bauxite/alumina subsector)

	MBOE	%
Transport		
Aviation/Bunker	70	2
Rail/Public Transport	44	1
Private Transport		
Urban	987	25
Rural	907	23
Industry		
Cement	338	9
Sugar	104	3
Other Manufacturers	306	8
Commercial	85	2
Government	186	5
Domestic		
Urban	212	5
Rural	177	4
Others	502	13
	3,918	100

a/ Energy consumed for conversion purposes such as power generation is excluded.

Source: MMET.

Table 5.5: TRANSPORT FUEL CONSUMPTION TRENDS a/
('000 bbl)

Year	Gasoline	Automotive Diesel	GDP (J$ 1974)
1976	1,936	517	1,892.0
1980	1,430	459	1,678.6
1981	1,497	446	1,737.2
1982	1,664	601	1,788.6
1983	1,690	678	1,816.7
Average Growth			
80/83	5.5%	19.2%	2.7%

a/ Excludes the Alumina/Bauxite Industry.

Source: Mission estimates.

5.8 Table 5.6 shows that the consumption of the major petroleum fuels by the private transport sector is fairly evenly spread over the island with 53% being consumed in urban areas and the balance (47%) being consumed in rural areas. This even dispersal of the consumption pattern requires a broad-based approach for a transport sector energy conservation program.

Table 5.6: CONSUMPTION OF GASOLINE AND AUTOMOTIVE DIESEL, 1983
('000 Barrels)

	Gasoline		Automotive Diesel	
	('000 bbl)	(%)	('000 bbl)	(%)
Rail/Public Transport	1	1	44	4
Private Transport				
Urban	893	52	214	19
Rural	667	39	336	29
Alumina/Bauxite	13	1	100	9
Industry	27	2	125	11
Government	79	5	84	7
Others	23	1	241	21
	1,703	101	1,144	100

Source: MMET and mission estimates.

5.9 Pricing. Pricing transport fuels at their opportunity cost is the first essential step in a conservation program. Correct pricing facilitates economic efficiency; however, other policy initiatives may be required where severe market distortions exist. The relatively high growth rates in gasoline and auto diesel consumption are explained by the past failure of the GOJ to use pricing to control demand. As shown in Table 5.7, from December 1978 to June 1983, the real price of gasoline fell and even though diesel rose steadily in real terms, its retail price was 33% less than that of gasoline in January 1984. Recently, retail prices have increased in real terms and the GOJ is making greater use of pricing as a demand determinant.

Table 5.7: RETAIL PRICE TRENDS
(per US Gallon)

	Gasoline a/			Auto Diesel a/		
	(US¢)	(J¢)	(Constant)	(US¢)	(J¢)	(Constant)
Dec. 78	139.69	248.79	248.79	40.98	72.99	72.99
Dec. 79	179.28	319.30	247.90	79.16	140.98	109.45
Dec. 80	216.71	385.96	233.77	135.15	240.70	145.79
Dec. 81	217.49	387.34	196.72	135.64	241.58	122.69
June 83	168.57	498.96	239.31	112.29	332.37	159.41
Jan. 84	226.93	748.90	342.11	151.20	498.96	227.62

a/ Deflated by CPI.

Source: MMET.

5.10 The move to more efficient diesel-powered vehicles in the late 1970s has been retarded by the fall in the real price of gasoline, the increase in the real price of diesel and the decreasing absolute differential between gasoline and auto diesel (J$1.76 in 1978 and J$1.67 June 1983). Since 1982, the real price of gasoline has increased and the absolute differential between gasoline and auto diesel increased from J$1.45 in December 1982 to J$2.49 in January 1984. As a result of these changing cost structures, auto diesel fuel has become more attractive to transport operators and for 1982/83 diesel consumption increased 13% against 1.6% for gasoline. The estimated short-term price elasticity 46/ for gasoline is -0.16, which indicates that higher absolute price levels will be necessary to have any significant impact on restraining demand. Compared to countries with similar GNP per capita, the absolute price levels for gasoline and diesel in Jamaica were reasonable in 1982 (Table 5.8) and indicate that further substantial price increases may meet political resistance, particularly as revenue from road users far exceeds public sector expenditures on the road infrastructure. In summary, although pricing is central to an energy demand policy, Jamaica will have to develop other policy options if the rate of growth in gasoline and auto diesel consumption is to be brought down. Vehicle fuel efficiency standards, higher load factors, larger trucks, and a more efficient public transport system are some of the options yet to be exploited.

Table 5.8: INTERNATIONAL COMPARISON OF DOMESTIC RETAIL FUEL PRICES, 1981 (US$/US Gallon)

Country	GNP/Capita	Gasoline	Percent a/	Diesel	Percent
	($US 1980)				
Jamaica	1,090	2.17	219	1.35	145
Ecuador	1,100	0.80	82	0.44	48
Guatemala	1,080	2.00	211	1.03	112
Peru	1,080	1.10	112	0.58	64
Dominican Republic	1,190	2.57	260	1.15	125

a/ Domestic retail prices as a percentage of border prices, 1981.

Source: World Bank Atlas and World Bank Publication, "The Energy Transition in Developing Countries."

5.11 Fleet Characteristics. The vehicle fleet in Jamaica is characterized by a lengthening of the average vehicle age and inefficiency in fuel use due to the lack of spare parts and poor vehicle maintenance.

46/ Defined as $\frac{\text{\% change in quantity consumed}}{\text{\% change in price}}$ (for the same period)

The basic problem causing the inefficiency is the lack of foreign exchange required to re-equip and maintain the existing fleet. Over the period 1973/1980, the number of vehicles fell from 72,778 to 60,505.

5.12 As shown in Table 5.9, motor cars are the dominant vehicles, with 56% operating in the Kingston and adjacent St. Andrew parish area. The next largest concentration is in the St. James area (the tourist area of Montego Bay) where 7% of all vehicles operate. The balance of 37% is fairly evenly spread over the rest of the island.

Table 5.9: VEHICLES CERTIFIED FOR ANNUAL INSPECTION BY THE ISLAND TRAFFIC AUTHORITY ALL JAMAICA, 1979-1980

	Motors Cars	Buses, Trucks and Tractors	Motorcycles	Trailers
Country Total	40,174	13,282	6,335	694
Total KMR a/	25,000	4,970	1,800	
% Total (KMR)	64%	34%	28%	

a/ Kingston Metropolitan Region.

Source: A study of the Modal Distribution of Non-Urban Traffic in Jamaica by Delcande International Ltd. for MPUT.

5.13 In the period 1972/73 to 1979/80, the motor car population fell 20%. In the three years preceding import restrictions, the average vehicle life was 5.1 years. However, by 1980 the average vehicle life had grown to 11.4 years. Motor car imports had fallen from 10,882 in 72/73 to 5,139 in 1980. Thus, the inflow of modern, fuel-efficient cars has slowed down significantly. Over the same period (1973-1980), the average fuel consumption of Japanese-manufactured vehicles fell from 10.41 liters/100 km to 8.33 liters/100 km (i.e., 20% reduction). Thus, because of lower vehicle imports Jamaica has not been able to take full advantage of technological improvements which would have resulted in reduced fuel imports, if new vehicles replaced aged ones.

5.14 Over the period 1978/81, only 4.4% of new motor vehicles registered were diesel-powered; the balance (95.6%) was gasoline-fueled. Incentives should be provided to encourage importing diesel-fueled cars which can save up to 30% on fuel over a gasoline-powered vehicle. Diesel vehicles are better suited for inter-parish travel. Due to the traffic congestion in the Kingston area, only marginal fuel savings would be achieved by using diesel vehicles.

5.15 The use of motor cars in the Kingston Metropolitan Region (KMR) is an important focal point for energy conservation. In 1980, an

estimated 63% of all gasoline was consumed in the KMR. A recent traffic survey indicated that private cars, of which approximately 96% are gasoline-fueled, made up 59% of the average road traffic. As shown in Table 5.10, private cars are being used for transportation that could be achieved more efficiently by a fuel-efficient public transport system. Over 56% of private car trips are made for work and school purposes and therefore a large potential fuel savings would be achieved by shifting commuters to public transport.

Table 5.10 MODEL SPLIT BY TRIP PURPOSE, KINGSTON METROPOLITAN AREA 1980 ('000 per day)

	Bus (JOS)	%	Minibus	%	Private Car	%	Walk	%	Other	%
Total	208	100	313	100	225	100	318	100	38	100
Work	80	38	149	47	90	40	58	18	12	32
Private Business	14	7	103	33	51	239	60	19	16	42
School	105	51	12	4	36	16	167	53	-	-
Leisure	9	4	49	16	48	21	33	10	10	26

Source: Kingston Metropolitan Region Urban Transport Project by Dorsch and Jentech for GOJ Ministry of Finance and Planning, May 1981.

5.16 To achieve fuel savings within existing foreign exchange constraints, operational improvements would be required. Capital stock improvements through importing more fuel efficient vehicles is preferred because their modern technology results in fuel savings and is essentially independent of the operators' driving habits. Savings through operational improvements are difficult to maintain over time, and therefore a comprehensive monitoring and management program is essential.

5.17 Fuel savings through improvements in the road infrastructure of KMR have been recognized and a World Bank project to improve traffic management is under way. Savings of approximately one million gallons per year are expected (approximately 3% of KMR fuel use). Better traffic flow brings with it the problem of greater use of the private car which is substantially less fuel-efficient than other options such as minibuses and buses. The Government would have to develop policies resulting in a move from the private car to greater use of public transport.

5.18 To achieve fuel savings in the use of motor cars, the mission recommends that:

(a) all imported (including externally-financed) motor cars should comply with an appropriate fuel-efficiency standard such as the U.S. EPA or Japanese 10 mode test;

(b) priority should be given to importing diesel, rather than gasoline powered, vehicles;

(c) annual license fees should be based on vehicle mass rather than engine capacity. The present system of fees based on engine capacity encourages the use of small engines in larger vehicles and does not encourage fuel-efficient vehicles;

(d) high-mileage vehicles such as taxis and tourist vehicles should be the most efficient in the fleet. Licencing requirements for taxis should encourage the use of fuel-efficient vehicles; and vehicles which are more than five years old should be phased out of the taxi fleet;

(e) import priorities should be set such that the limited foreign exchange is available for high-mileage vehicles such as taxis and tourist vehicles;

(f) the use of motor cars which have a combination of old design and large mass should be discouraged through taxes that increase the annual fixed charges. Private cars over ten years old and 1,500 kg mass should be heavily taxed; and

(g) the Government should encourage the use of private sector van and car pooling in the Kingston area. With such a high use of motor cars for work-oriented travel, this option needs to be actively pursued by the GOJ.

5.19 Passenger Travel: Motorcycles. The ratio of motorcycles to motor cars in Jamaica is reasonably well balanced. Jamaica has 16 motorcycles per 100 motor cars; the world average is 21. Motorcycles are generally a more fuel-efficient transport mode than motor cars; however, two-stroke motorcycles can use up to 20% more fuel than an equivalent four-stroke powered motorcycle. The mission recommends that all imported motorcycles should comply to 1980 U.S. EPA exhaust emission standards; the net effect is improved fuel efficiency.

5.20 Passenger Transport: Buses. Road transport is predominantly passenger transport. The major concentration of passenger movement is in KMR, where in 1980 about 2,540 buses operated. The largest bus operation, JOS, was phased out towards the end of 1983 because of its poor financial performance, and replaced by private operators. However, poor financial performance is a common occurrence for transit systems where transport charges are held below their financial cost for political reasons. In KMR, buses carry approximately 50% of total passenger

traffic yet only form 12% of traffic congestion; 47/ thus, buses play an important role in passenger travel while adding only marginally to traffic congestion.

5.21 Because of JOS's poor performance, growth in the use of low capital-cost minibuses has been strong while the use of larger buses has slightly fallen. By 1980, there were 1,720 minibuses and 820 buses operating in KMR.

5.22 Presently, there is no matching of optimum bus size with passenger flows. Further, the multitude of bus types needs to be rationalized to reduce spare part inventories which are essentially funded by foreign exchange.

5.23 There is a need for the MPUT to evaluate whether the move to minibuses is economically viable. In Jamaica, fuel costs are only 13% of basic bus operating expenses while total petroleum imports represent nearly a third of imports; the foreign exchange impact on the nation may have been overlooked in the decision to use a greater number of minibuses.

5.24 As the GOJ licenses all bus routes, it has a major role to play in reduced petroleum imports through a more efficient transport system. The Government, through the public passenger vehicle (PPV) licensing system, can greatly improve the fuel efficiency and foreign exchange savings to be achieved by the bus sector. The approval board should issue guidelines to operators on preferred vehicle types and sizes, based on the licensed route load and traffic characteristics.

5.25 Freight Transport: Trucks. As in the case of the motor car subsector, the foreign exchange constraint has been a major impediment to improving the truck fleet performance. Truck imports fell from a high of 2,041 in 1975/76 to 322 in 1980/81. In new trucks over 3.75 ton net weight (NVW) diesel engine vehicles predominate; however, in the under-2.75 ton category, gasoline-fuelled trucks predominate (1978/1981 65% of new trucks, buses and tractors less than 3.75 ton NVW were gasoline-powered). There is a need to substantially reduce the number of gasoline-fueled trucks being added to the fleet. Diesel-powered trucks under ideal conditions are up to 30% more fuel-efficient. However, their slightly higher capital cost may be causing the shifts to the cheaper, but less efficient gasoline truck. As a short-term measure, importation of gasoline-powered trucks should be discouraged. Small truck operations appear to be marginal in Jamaica, with little provision for depreciation or the implicit hourly wage of owner/drivers. In this environment the lower-cost, gasoline-powered vehicle is attractive to the private

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47/ The larger 40-seat buses carry about 20% of passengers and form about 4% of traffic congestion while the 15-seat minibuses carry 30% of passengers but represent 8% of traffic congestion because of their larger number.

operator; however, at the national level the economic returns of a diesel-powered vehicle are higher.

5.26 The private operator is further influenced to use less efficient gasoline-powered trucks because of the significantly higher annual license cost of a diesel truck. For example, in the over 3-1/2 ton category, the fee for a gasoline truck is J$160.50/year compared to J$409.50 for a diesel truck. The scale of fees should be revised such that gasoline trucks pay the same fee as diesel-powered trucks of the same axle loading.

5.27 The present licencing system does not encourage better utilization of the transport fleet. Of the two license categories, R1 (public carriers licencee) and R2 (private carriers licencee), R2 vehicles predominate. In 1979/80, for KMR 27% of licencees were public R1, while for Jamaica as a whole 37% of licencees were of the R1 category. Trucks with R2 licences traditionally have poor load factors (little or no backload capability) compared with well organized public R1 carriers. The Government should discourage R2 vehicles while encouraging the wider use of the more fuel-efficient (due to higher load factor) R1 operators.

5.28 Experiments in France to better match freight flows through better operator communications have resulted in a 26% fuel savings for a 400-truck fleet. Similar opportunities exist in Jamaica; for example, computer modelling of the Kingston-Montego Bay route indicated a possible 50% reduction in fuel usage.

5.29 The fuel savings using larger trucks are significant and, as shown in Table 5.11, a smaller vehicle can use up to 300% more fuel to move the same amount of freight.

Table 5.11: FUEL USAGE IN TRUCKS

Type	Payload	liters/100 km Payload Ton a/
Ford Trader/1980	2.56 tons	6.0
Mack R612 RST/1980	9.08 tons	4.6
Mack R686/1981	21.62 tons	2.0

a/ Highway Cycle 853 km urban cycle 121 km.

Source: British Petroleum Commercial Vehicle's Economy Run 1981.

5.30 The MPUT should determine load freight flows within Jamaica and develop recommendations on the appropriate vehicle size which will optimize the economic transport of freight. There is an urgent need for MPUT to develop an energy efficiency unit within the ministry.

5.31 Although rail is up to 10 times more energy efficient than road transport, the generally small lead distances indicate that substantial substitution by rail is not a practical possibility for Jamaica. However, on specialized routes such as Kingston-Montego Bay, integrated rail/truck systems should be investigated.

5.32 The widespread use of trailers should be encouraged on those routes where there are no practical constraints (road width, safety) to their use. The possibility of local manufacture and moderate foreign exchange requirements make trailers an attractive option to offset the declining fleet capacity. Trailers offer flexibility as well as a low-cost option to increase capacity.

Industrial and Commercial

5.33 Industrial and commercial energy conservation in Jamaica has been heavily influenced by, and generally confined to, the USAID Energy Sector Assistance Project. The USAID Project was started in early 1981 and was originally designed as a US$14 million package. The package was later changed to a two-phased program. The first stage dealt with GOJ institution building combined with a public sector energy conservation program and some alternative energy activities. Phase II is concerned with the establishment or upgrading of local energy-related industries.

5.34 The USAID program is being implemented through MMET and has resulted in other ministries and agencies assuming that they have little or no responsibility for energy conservation. There is a need to broaden the base of the GOJ Energy Conservation Program so that other ministries are responsible for conserving energy. The lack of private sector inputs to influence the energy conservation program should be rectified through an appropriate coordinating mechanism. This approach needs to be carefully researched as the past failure of the NACEC is an indication of the complexities surrounding coordinating organizations. The fact that a major energy supplier such as JPS does not have a customer energy-conservation program in operation a decade after the first oil crisis gives cause for concern. Further, the lack of involvement of the other large energy supplier PCJ requires review. The three private oil companies have no coordinated energy conservation program which is necessary because of the foreign exchange consequences associated with the products they sell.

Conservation Investments

5.35 A survey of 49 companies in Jamaica indicates that, for 1982/84 alone, estimated investment requirements for energy conservation totalled J$17.8 million (USAID survey). Obviously, existing funds (US$5.9 million/J$22 million, USAID) will be inadequate for all conservation opportunities. The GOJ will have to set stringent loan requirements for the limited foreign exchange available. The USAID survey results indicate that industry would wish to use funds for power generation which, with the improving performance of JPS, is unnecessary. The GOJ should not

necessarily accept the normal financial criteria for the disbursement of loan funds. Export industries that earn foreign exchange should be given a high priority, which is not the case under the proposed arrangements.

5.36 USAID loan funds have been concentrated on capital stock improvement (retrofitting), whereas given Jamaica's limited foreign exchange availability, some funds should be directed towards operational improvements in existing plants.

5.37 Operational improvement is the least-cost approach to saving energy and increasing the efficiency of energy use. This approach usually results in a 10-15% reduction in energy, essentially through good "housekeeping" operations. Developing an energy saving and cost reduction technique requires detailed training of plant operators. Normally, a short 10-day program is needed which emphasizes the practical aspects of plant operation and reporting on energy efficiency performance. The proposed course at the College of Arts, Science and Technology is not aimed at the plant operator. Also, lecturers should be continuously involved with industry's operations.

5.38 The essential component of widespread operator training has been overlooked mainly because the program has focused on the USAID project. The USAID program focuses on the second stage of the energy conservation cycle which is capital-intensive. The assessment mission did not identify the most suitable organizational arrangement for training plant operators and recommends that the GOJ join with the private sector to develop an appropriate organization.

Domestic Sector

5.39 In the domestic sector, correct energy pricing is the most important policy instrument for promoting energy conservation. Consumers have been subsidized in many important energy-related areas. Electricity, kerosene, and public transport have been supplied at prices below their economic cost. Energy consumption in some sectors has fallen but this has mainly been the result of falling real income. Lack of involvement of retail energy suppliers is a notable shortcoming of the GOJ energy conservation program for the domestic sector. JPS should develop an energy conservation program which includes consumer education and rate revision.

5.40 There is a need to introduce appliance standards, particularly for air conditioners, kerosene cooking stoves, and refrigeration units. As in many developing countries, the impact of public education through advertising and other media is not well-established. Before committing funds to advertising programs which follow the techniques used in developed countries, a careful analysis of the program's costs and benefits should be made.

VI. INSTITUTIONAL ISSUES

Overview

6.1 Recognizing that one agency in the Government should have the main responsibility for energy policy planning and coordination, the Government in 1977 established an Energy Division within the Ministry of Mining, Energy and Tourism. However, over the years the Energy Division has been unable to carry out its national responsibilities in a satisfactory manner because: (a) it is not properly structured; (b) it lacks sufficient high-calibre staff; (c) it suffers from various institutional problems such as low pay, low staff morale, lack of career paths, high turnover, and difficulties in the areas of internal communication, leadership, 48/ and delegation of responsibility; and (d) there is a lack of proper coordination and consultation in the energy sector, especially among its three principal institutions (the Energy Division, PCJ and JPS and their respective parent Ministries -- the MMET and MPUT).

6.2 The Energy Division's inability to carry out its mandated role as lead organization in the energy sector is of the greatest significance to Jamaica; it has meant that only halting progress has been made towards the nation's stated goals of reducing its dependency on imported petroleum and developing indigenous energy resources.

6.3 The main issue is not primarily one of lack of financial resources. On the contrary, Jamaica's energy sector has been provided with a great deal of financing and technical assistance by a wide variety of multilateral and bilateral donors (UNDP, IBRD, IDB, USAID, Canada, Scandinavian countries, West Germany, Italy, and others). At present, for example, USAID is providing US$7.5 million in project funding and technical assistance directly to the Energy Division to build its institutional capability, and its conservation and alternative energy programs. The assessment mission has found that the overriding issues in the energy sector are of an institutional nature and require a focus on:

(a) helping the Energy Division to overcome its organizational weaknesses and assume its designated central role; and

(b) promoting better linkages and coordination of efforts among all energy-related bodies, whether public or private. Furthermore, unless these institutional problems are remedied, there is a

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48/ There was a serious leadership vacuum in the Energy Division as of April 1984 since the former Director was promoted to Permanent Secretary and transferred in January, 1984. A new Director has not been selected yet, even though this appointment is a high priority matter.

danger that the proper selection and implementation of investment projects will continue to be impeded as will the proper allocation of financial resources and manpower in the sector.

Institutions in the Energy Sector

Ministry of Mining, Energy and Tourism (MMET) and the Energy Division (ED)

6.4 Role and Objectives. The Energy Division of the MMET was established in 1977 and is charged under the law with responsibility for formulating and overseeing the implementation of a National Energy Policy and Plan for Jamaica.

6.5 A review of the Energy Division's work programs reveals that, with the benefit of USAID Project funding, it has been devoting an extraordinary amount of time, energy, and money not on policy and planning work, but rather on day-to-day project implementation and development work, especially in the areas of conservation and alternative energy. This imbalance in its activities needs to be remedied and, in the opinion of the mission, the Energy Division should adhere more closely to its legally defined role and national responsibilities for energy policy, planning, monitoring, coordination, and public information and education.

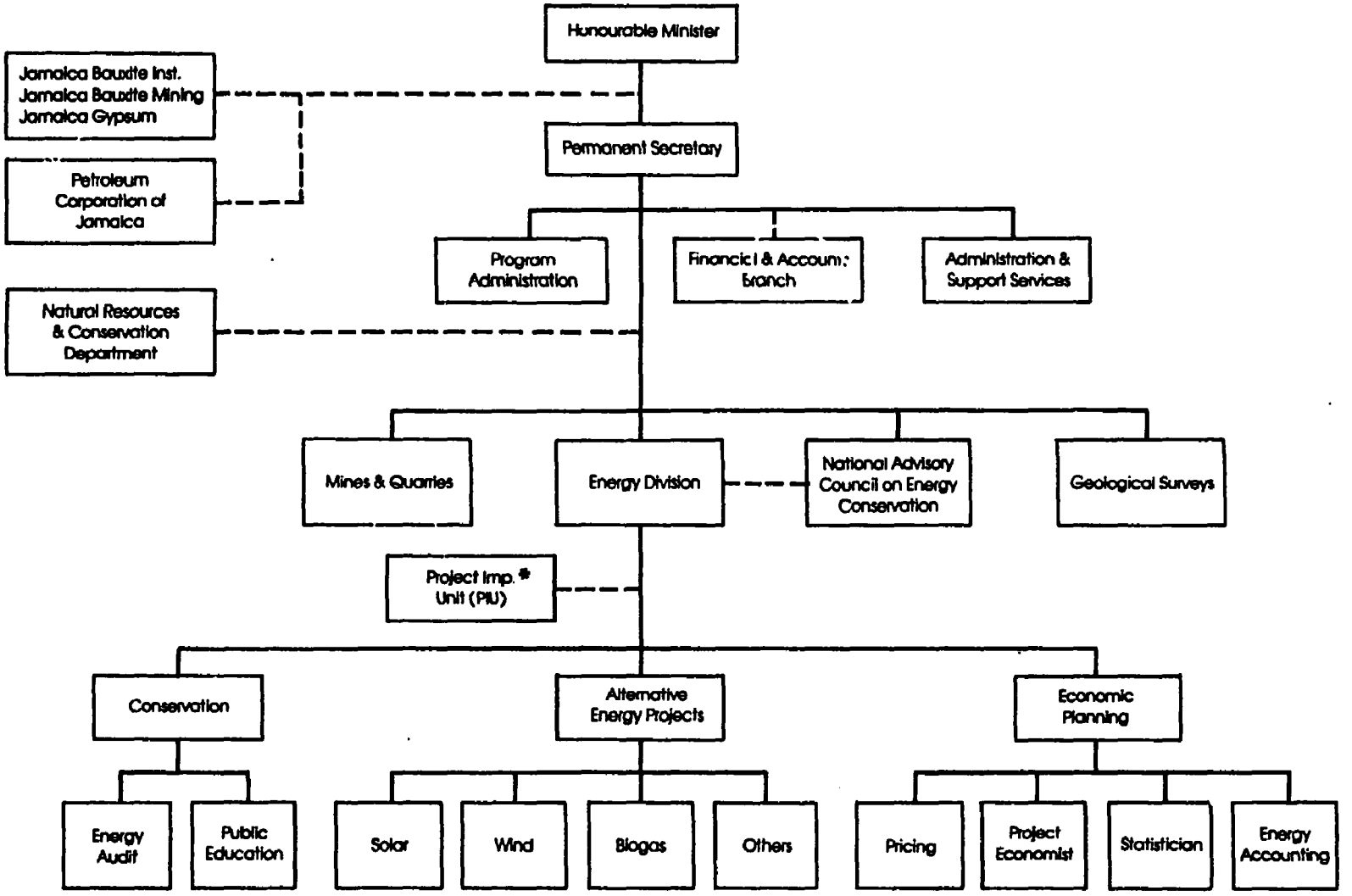
6.6 Structure. The present organizational structure of the Energy Division of the Ministry of Mining, Energy and Tourism (with its main branches of Economic Planning, Conservation and Alternative Energy) is shown in Chart 6.1. This structure has basically been in existence since 1980 except that in the 1981-82 period it had grafted onto it a Project Implementation Unit (funded by the USAID Energy Project). In 1984 the GOJ discontinued this unit.

6.7 The required structural changes that are recommended by the mission are the following: 49/

49/ Recommendations (a) and (c) are also those of the Energy Division's Local Consultant, W. Boyne, and are contained in his March 1984 report. However, as explained in recommendation (b), the mission does not support the recommendation of merging the Conservation Branch and Alternative Energy Branch into a new Energy Development Branch.

Chart 6.1

Ministry of Mining, Energy and Tourism
Energy Division
Organizational Chart



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(a) Since the Energy Division's business is energy policy, coordination and monitoring (not project implementation), the existing USAID-funded Project Implementation Unit (PIU) should be disbanded as a separate organizational entity. 50/ Those PIU staff who have the appropriate skills should be integrated into the regular establishment of the Energy Division. This restructuring is of the highest priority since the PIU, despite doing useful work, has evolved over time into a parallel organization duplicating functions of the regular Energy Division branches (especially Conservation and Alternative Energy). Furthermore, the existence of this almost autonomous unit has caused morale problems because of its access to and power over the USAID funds administered by the Energy Division, and because PIU staff (although doing similar work) received better remuneration due to the USAID funding and topping-off of salaries.

(b) The Energy Division should be reorganized into a smaller, but more effective organization (manned by fewer, but good quality, staff) comprised of just two branches. The main branch would be the Energy Policy and Project Analysis Branch - comprised of the present Economic Planning Branch plus elements of the present Conservation and Alternative Energy Branches (in the form of two engineering positions that would be transferred to perform the policy and planning support functions of monitoring and evaluating conservation programs and assessing alternative energy project proposals and technology). The idea here would be to pool resources and thus make better use of scarce skills.

(c) The second branch, a support branch, would be a new and upgraded Energy Information and Education Branch to serve not only energy conservation, but the entire energy sector in Jamaica. This new Branch should result from amalgamation of the present Energy Education Unit of the Conservation Branch and the new Energy Information Centre (of the Ministry of Mining and Energy Library).

6.8 Staffing. Manning of the Energy Division is weak (as is true in most of the Government ministries) since most of its professional staff are young, inexperienced, and junior in status.

6.9 The Energy Division is receiving technical assistance through a resident UNDP-funded Energy Economist and a resident USAID-funded Conservation Specialist; USAID is also scheduled under its Energy Project to provide additional short-and long-term technical assistance. However, since the problem is more one of quality rather than quantity of staff, a restructured and more streamlined Energy Division would not require a

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50/ At the time the draft report was reviewed in March 1985, the mission was informed that PIU has been discontinued.

staff of 28 professional and technical personnel as is currently recommended in the March 1984 report of the Energy Division's local consultant. The mission recommends that the division should divest itself of any research-oriented or project implementation work. The Energy Division should carry out its functions with a much smaller, but highly qualified staff of about one-half the size mentioned above - that is with some 10 professionals (economists, engineers, information specialists, statistician/computer specialist). Of this number, about five should be senior professionals (the core group) well respected by Government statutory bodies and the private sector for their competence in the energy field. These five senior professionals should be supported and assisted by about five professional staff at junior or intermediate levels of competence and experience, who themselves should be groomed to assume higher-level responsibilities.

Recommended Reorganization of Energy Division

6.10 The mission recommends that the Energy Division be restructured as follows:

Professional Staff
1 Director of Energy Division (SMG III)

Energy Policy and Project Analysis Branch	Energy Information and Education Branch
1 Director (SMG I)	1 Director (PMA V)
1 Senior Economist (NPS IV & III)	1 Senior Information Officer (PMA IV)
1 Senior Engineer (ASG IV & III)	2 Information Officers or Junior Information Officers (PMA III & II)
2 Economists or Junior Economists (NPS II & I)	
1 Engineer or Junior Engineer (ASG II & I)	
Total: 6	4
Grand Total: 11 (Including Director)	

6.11 If the Ministry has difficulty in filling the senior posts in the Energy Division it should consider the option of utilizing the recruitment and contract officer mechanism operated by Jamaica National Investment Company for several ministries. Considering the weakness on the petroleum side, the mission finds it vital that UNDP's energy project in the form of an energy economist experienced in the petroleum industry should continue for some time. This position is more important for the ministry than the provision of an energy planner.

Petroleum Corporation of Jamaica

6.12 The Petroleum Corporation of Jamaica (PCJ) is a wholly-owned state corporation established under the Petroleum Act of 1979. As an important institution in the energy sector PCJ's main functions have been to supply and operate Jamaica's only refinery. Other important functions include petroleum exploration and investment studies of various energy related projects.

6.13 The extension of the functions of PCJ into energy resources other than petroleum is allowed for by the Petroleum Act through the Minister responsible. The extension of PCJ's role in non-petroleum areas carries certain project implementation functions (e.g., as regards hydropower, peat, and coal) that normally should be assigned to the agency that would eventually operate the new power plants to be constructed. It can be further argued that, in the long run, the agency that must live and work with the new facility to be created should be the one to acquire the technical know-how and expertise that is gained at all stages of project development: pre-feasibility, feasibility project review, design, and construction. Furthermore, JPS has considerable in-house expertise and experience in managing large projects in transmission and power plant rehabilitation, and can acquire, develop, or contract for whatever additional technical project management skills are required. The mission recommends:

(a) that resources should be provided to JPS to strengthen its project development and implementation capabilities; and

(b) that for those projects at the feasibility study stage PCJ transfer responsibility to JPS at the most appropriate time.

Jamaica Public Service Company Limited (JPS)

6.14 JPS, originally founded in 1923, is the only electric utility in Jamaica and supplies the island with electric power under a 39-year All-Island Electric License granted by the Government of Jamaica in 1978. JPS was formerly owned by private interests (American, Canadian, and British). It operated under the control of Stone Webster Corporation until the Government acquired Stone Webster's controlling interest in 1971 and completed acquisition of 99 percent ownership of JPS in 1975.

6.15 Over a period of several years--especially during the 1979-1982 period -- JPS was plagued with severe financial losses, labor disputes, and frequent and very disruptive power outages. Following further injections of technical and financial assistance and follow-up of the recommendations of the 1982 management audit coordinated by JNIC the management of JPS succeeded in greatly improving its performance. In 1983, JPS showed a profit for the first time in several years; power outages declined and an improvement was evident in its management and financial system.

6.16 At present, JPS management is frustrated; although it will be the eventual operator of the plants to be constructed in the future, it is not playing a significant role in the development and implementation of new electric power-related projects such as peat, coal, and especially mini-hydropower. The mission supports the position that it is in the national interest that JPS, as eventual operator, be assigned the responsibility for developing and implementing all electric power-related projects. JPS has demonstrated that it has a project development and implementation capability and this capacity should be utilized and developed further.

6.17 To further strengthen JPS manpower in system planning and project development, the mission recommends that a power economist be recruited to work with the two overburdened engineering professionals in the System Planning Unit.

6.18 Although the MMET is the central body for national energy policy and planning, the MPUT is also a key ministry in the sector. The JPS and some of the main users of energy, especially utilities and organizations in the transport sector, fall within its portfolio. Furthermore, MPUT officials are the first to admit that the Ministry and its agencies are not energy (conservation) conscious and that they need closer linkages and coordination with MMET on a regular basis to address energy issues and to determine policies, priorities, and programs for action. The mission endorses such closer linkages and joint action programs.

6.19 A manpower constraint exists, however, which prevents the Advisory and Monitoring Unit (AMU) of MPUT from carrying out its analytical and policy advisory work, including a proper examination of the electricity tariff and the JPS investment program. The AMU has lost staff over the years and now has only two senior professionals to do the monitoring and advisory work concerned with a large number of official utilities and transport agencies. The mission therefore recommends that MPUT recruit for its Advisory and Monitoring Unit three additional professionals in economics or business administration, one senior professional, and two professionals or junior professionals. Further, these additional staff should be responsible for developing and monitoring an energy conservation program for those units under MPUT control.

Other Energy Related Institutions

6.20 The MMET (Energy Division and PCJ) and MPUT (and JPS) need to provide data to and coordinate their policies and plans with the Planning Institute of Jamaica (PIOJ) to ensure proper integration of energy sector planning within national economic planning. However, PIOJ does not have a full-time person assigned to energy sector planning. Only a part-time person (an industrial engineer with other responsibilities) is assigned to monitor the energy sector and receive data from energy sector institutions. The mission consequently recommends that PIOJ strengthen its institutional capacity in the area of energy sector planning and also

strengthen its linkages with the principal energy sector institutions: MMET, MPUT, JPS, and PCJ.

6.21 Other institutions involved in research and development studies and project implementation for the energy sector are the following:

- Scientific Research Council	(bioenergy including biogas, fuel alcohol, fuel wood)
- College of Arts, Science & Technology (CAST)	(solar; also to be site of new USAID-funded Solar Energy Institute)
- University of the West Indies (UWI)	(wind)
- Bureau of Standards	(solar)
- Ministries of Agriculture & Youth & Community Development	(bioenergy, solar)
- Sugar Industry Research Institute (of Sugar Industry Authority)	(fuel alcohol)
- Jamaica Manufacturers Association	(energy consumption study; building code manual)
- Forestry Department	(fuel wood)
- Planning Institute of Jamaica	(project management and contract management in solar)

6.22 The MMET Energy Division should be the focal point for monitoring (and coordinating as appropriate) any energy-related R&D or project implementation work carried out by these or other institutions.

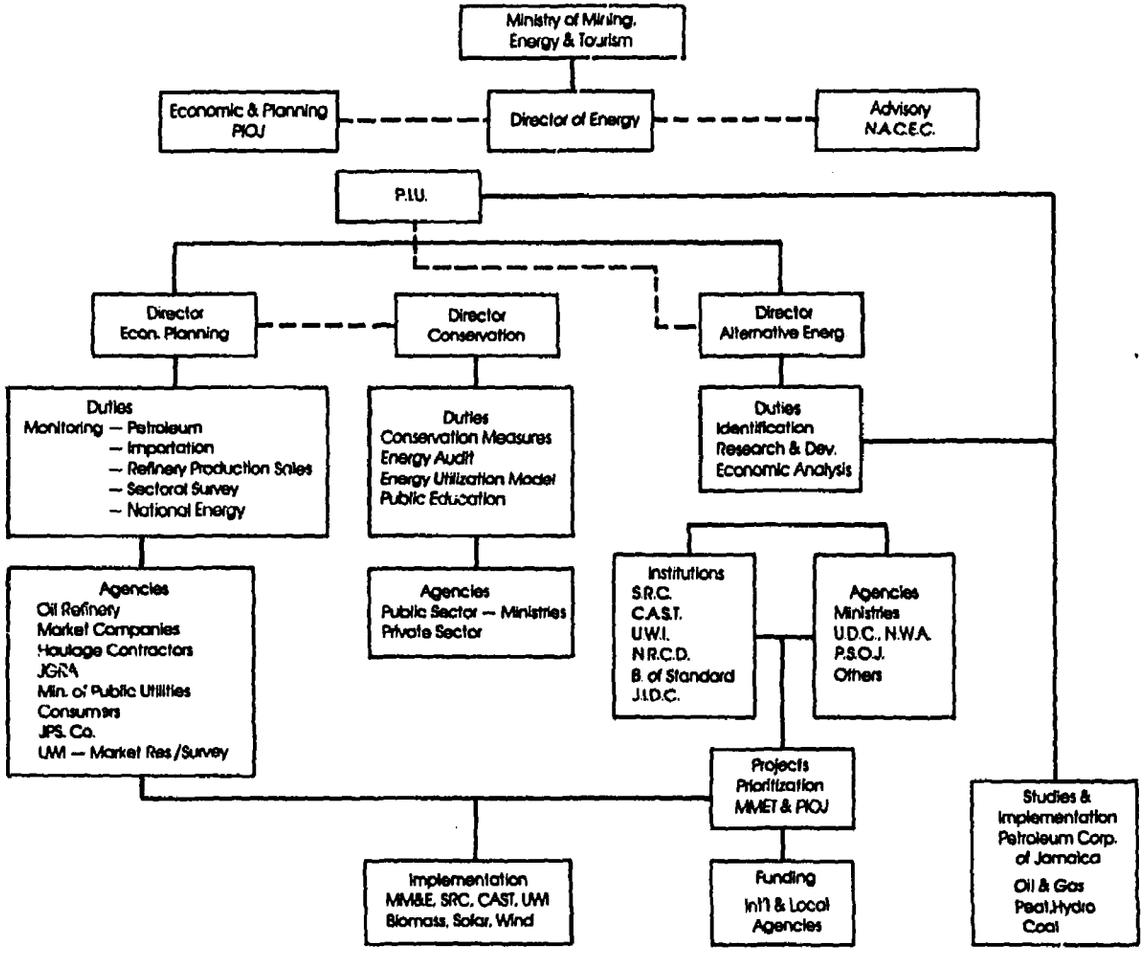
Problems of Coordination in the Energy Sector

6.23 MMET's Energy Division has not been able to promote and maintain sound close working relationships with and among the public and private energy sector institutions. The relationship between institutions within the energy sector is shown in Chart 6.2.

6.24 Decisions on energy matters have tended too often to be made individually and in an ad hoc and isolated manner unrelated to the guidelines and framework of an overall national energy policy and plan.

Chart 6.2

Interrelationship Between Ministry of Mining, Energy and Tourism and Others



JIS — Jamaica Information Service
CAST — College of Arts, Science & Technology
JGRA — Jamaica Gasolene Retailers Association
JIDC — Jamaica Industrial Development Corp.
JNIC — Jamaica National Investment Co.
JPSC — Jamaica Public Service Co.

NRCD — National Resources Conservation Dept.
NWA — National Water Authority
MMET — Ministry of Mining, Energy & Tourism
PIOJ — Planning Institute of Jamaica
PIU — Project Implementation Unit

PSOJ — Private Sector Organ. of Jamaica
SIA — Sugar Industry Authority
SIRI — Sugar Ind. Research Inst.
SRC — Scientific Research Coun.
UDC — Urban Development Corp.

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6.25 The management responsibility for coordinating Jamaica's energy sector efforts must be dealt with to ensure proper management of the energy sector investment programs as well as appropiate allocation of financial and manpower resources. The mission recommends that the following measures be implemented:

(a) Reconstitute NACEC as a new and revitalized high level National Advisory Council on Energy to advise the Minister of Mining and Energy on policy and serve as a forum for public and private agencies on all energy-related matters and issues (not only conservation). The MMET's Energy Division should be the technical secretariat for this new Advisory Council and provide support services. 51/

(b) Establish an inter-ministerial committee or committees. MMET, MPUT, MSTE, and other Ministries should meet on a periodic basis to address outstanding energy issues and problems that are inter-ministerial in nature -- e.g., conservation issues, transport fleet policy, least-cost power expansion, etc.

(c) Establish a well balanced working committee (for policy guidance and technical advice) at the beginning of any new major energy project to ensure efficient resource utilization through representation, involvement, and coordination of all directly related agencies and parties.

51/ At the time the draft report was reviewed in March 1985, the mission was informed that the GOJ had indeed established such a committee which works closely with the minister and the Energy Division in the MMET acts as its technical secretariat.

JAMAICA ENERGY BALANCE, 1983
('000 barrels of fuel oil equivalent)

	Fuelwood	Charcoal	Bagasse	Sub-Total Non-Commercial	Power	Crude Oil	LPG	Avgas	Mogas	Kerosene	Automotive Diesel	Marine Diesel	Fuel Oil	Others	Sub-Total Petroleum	Total Energy
SUPPLIES																
Production	466		1070	1536	46 a/											1,582
Imports						7189	136	12	317	133	173	17	5933		13910	13,910
Gains/(Losses)						(47)	(2)		(1)						(50)	(50)
Exports (-)											(67)		(452)		(519)	(519)
Bunkers/Aviation								(2)		(815)	(23)	(58)	(114)		(1012)	(1,012)
Stock (increases)/Dec.						175			91	56	22	(41)	520		823	823
Supplies	466		1070	1536	46	7317	134	10	407	(626)	105	(82)	5887		13152	14,734
CONVERSION																
Refining																
Charge to Refinery						(7304)									(7304)	
Own Use (-)							(2)					(4)	(281)			
Losses (-)													(22)			
Refined Products							143		1092	872	1224	177	3403	84	6995	
Statistical Adjustment						(13)									(13)	
Power Generation b/																
Fuel Use					3217						(227)		(2990)		(3217)	
Generation Losses					(2385)											
T&D Losses					(162)											
Own Use					(3)											
Power Output					621											
Biomass																
Input	(428)	428														
Conversion Losses		(235)	(514)													
Output		193	556													
Net Availability	38	193	556	787	667		277	10	1499	246	1102	95	6300	84	9613	11,067
DEMAND																
Bauxite/Alumina									11		96		5482			
Bunkers/Aviation								10	1	4	15	14	28			
Railways/Public Transport											42					
Private Transport																
Urban									786		206					
Rural									587		321					
Cement											2	63	341			
Sugar Industry			556	556	13								109			
Other Manufacturing					1359		3		24	4	118	9	131	25		
Commercial					1		85									
Government							3		70		81	4	23	6		
Households					208											
Urban							113			100						
Rural	38	193		231			42			137						
Others					87		31		20	1	218	5	186	53		
TOTAL DEMAND	38	193	556	787	667		277	10	1499	246	1102	95	6300	84	9613	11,067

a/ Hydropower only.
b/ Jamaica Public Service Company only.

Annex Table 1.2

ENERGY PROJECTS IN THE PUBLIC SECTOR INVESTMENT PROGRAM (FY81/82 - 84/85)
(million J$)

	Donor	Responsible Agency	1981/82	1982/83	1983/84
Rural electrification	IDB	JPS	6.5	1.5	4.5
Wind mapping for energy assessment		MMET	1.0	.1	
Alternative energy research development		MMET			.3
Ocean thermal energy conversion (OETC)		PCJ	.1	1.0	.7
Mini-hydro electricity project	KFW	PCJ	.3	.1	.1
Onshore oil and gas exploration	IDB	PCJ	10.1	25.6	1.9
Offshore oil and gas exploration	IBRD	PCJ		4.2	
JPS - Rehabilitation	IBRD	JPS	10.9	18.0	16.9
JPS - Other	Italy/Japan	JPS	47.8	33.2	30.0
Peat reserves utilization	Finland/Sweden	PCJ	.6	1.4	1.4
Energy sector assistance		MMET		1.7	
Energy conservation & alternative usage	USAID	MMET		3.6	3.8
Feasibility study YS river	Italy	PCJ			
Photovoltaic study	Italy	MMET			.1
Rural energy system	Italy	MMET			.2
Small-scale hydro inventory	CIDA	MMET	1.0		.1
Energy development		MMET		.2	.1
Solar energy			.2		
Geothermal	OLADE			.1	.1
Alternative energy demonstration	USAID			.1	.1
TOTAL			78.5	90.8	60.3
Memorandum Items					
Total public sector investment program (PSIP)			779.3	794.5	755.8
Power and energy as % of total PSIP			10.1	11.4	8.0

JPS - Jamaica Public Service Company
MMET - Ministry of Mining, Energy and Tourism
PCJ - Petroleum Corporation of Jamaica

Annex Table 1.3

PROPOSED ONGOING/NEW ENERGY PROJECTS IN THE PUBLIC SECTOR INVESTMENT PROGRAM
(FY84/85-FY86/87)
(J$ million)

	Donor/ Financing Source	Responsible Agency	(Preliminary) 1984/85	1985/86	1986/87
Energy Conservation and Alternative Usage	USAID	MMET	6.7	7.3	10.0
Rural Electrification	EEC	JPS	6.7	3.6	
Wind mapping for energy assessment	USAID/EEC	MMET	.1		
Alternative energy research & develoment	USAID/EEC	MMET	1.3		
Oil and gas exploration	IDB/IBRD	PCJ	11.0		
Back Rio Grande Hydropower Dev.	IBRD/Italy	MMET	1.0	1.7	1.7
Jamaica Public Service Company					
Rehabilitation	IBRD/Italy	JPS	52.1		
Slow Speed Diesel	Japan	JPS	102.0	81.7	23.6
Substation	Ven/IBRD		18.0	13.1	11.5
Transmission & Distribution	EDC/Canada/Ven	JPS	37.3	50.6	42.0
Hydros (JPS contribution only)	KFW/Germany	PCJ			28.0
Other			73.0	34.6	36.8
Petrojam Refinery (Energy Conservation)				5.2	21.0
Mini-hydro electricity project	KFW/CIDA	PCJ		15.1	7.5
Peat reserves utilization	Sweden/Finland	PCJ	2.7		31.5
Alternate energy demonstration	USAID	MMET	(.1)		
Rural energy systems	Italy	MMET	.3		
Small-scale hydro	CIDA	MMET	6.8	15.1	7.5
Photovoltaic Study	Italy	MMET	.3		
Total a/			319.4	228.0	221.1
Memorandum Item					
Total public sector investment program (PSIP)			1068	1228.4	1031.6
Power and energy as % of total PSIP			29.9	18.6	21.4

a/ Does not include cement company expansion project, which includes a major component for coal conversion; US$90 million is expected to be spent on the project over the 3-year period.

Notes: Estimates assume exchange rate of J$4.5 = US$1.

JPS - Jamaica Public Service Company
MMET - Ministry of Mining, Energy and Tourism
PCJ - Petroleum Corporation of Jamaica

INSTALLED GENERATING UNITS AS OF DECEMBER 31, 1983

Type	Station/Unit		Brand Name Boiler	Brand Name Turbine	Date of Commissioning	Name Plate M.W. Rating	Normal CMR (MW)	Difference Due to	Totals Based Normal CMR (MW)
S	O/H	#1	Francotosi	Francotosi	1968	33.0	27*	*Boiler Capacity	
		2	Mitsubishi	Hitachi	1970	60.0	54		
T		3	Foster Wheeler	General Electric	1972	68.5	60*	*Boiler Deficiency	
		4	Foster Wheeler	General Electric	1973	68.5	65		206
E	H/B	#1	Babcok and Wilcox	Brush	1953	12.5	9.5*	*Boiler Capacity	
A		2	-	-	1955	12.5	9.5*	-	
		3	-	Parsons	1958	15.0	13.5		
M		4	-	-	1960	15.0	13.5		
		5	-	Associated Electrical Ind.	1962	20.0	19.0		130
		6	Foster Wheeler	General Electric	1976	68.5	65.0		
G	G.T.	#1		General Electric	1968	16.5*	13.0	*Peak in for short periods only	
A	H/B	2		General Electric	1969	16.5*	13.0		
		3		John Brown	1973	22.75*	20.0		
S		4		" "	1974	22.75*	20.0		
		5		" "	1974	22.75*	20.0		86
H	Maggotty			Harland Engineering	1959	6.37	2.5	Hydro output varies with stream flow	
Y	L.W. River			" "	1952	4.75	4.0		
D	Roaring River			" "	1949	4.05	3.6		
R	U.W. River			Dominion Engineering	1945	3.60	2.8		
O	Rio Bueno			Harland Engineering	1966	2.50	2.3	15.20	
	Bogue	#1		General Motors	1965	1.71*	1.50		
D									
		3		" "	1966	1.70*	1.50		
I									
E		6		" "	1966	2.10*	2.00		
		7		" "	1966	2.10*	2.00		
S		8		" "	1966	2.10*	2.00		
E		10		Mirrlees	1959	2.00	2.00		
		11		General Motors	1945	0.75	0.60	Due for retirement	
L									
S	Port Antonio	#1				0.36	0.36	'Standby' use only	
		2				0.50	0.50		
		3				0.35	0.35		
		4				0.50	0.50		
		5				0.50	0.40		

ELECTRICITY CONSUMPTION BY USER, 1970-83
(GWh)

Year	Residen-tial	Small Commercial and Industrial	Large Commercial and Industrial	Public	Other	Total
1970	203.3	337.0	119.5	75.3	0.0	735.1
1971	222.1	379.6	134.6	90.2	0.0	826.4
1972	282.5	436.3	131.6	94.9	2.0	947.4
1973	294.5	430.4	141.9	102.2	1.4	970.3
1974	297.6	433.8	141.5	110.3	6.5	989.6
1975	327.6	465.2	142.3	119.5	10.8	1065.4
1976	345.8	482.9	156.9	126.2	8.3	1120.0
1977	346.8	485.5	149.1	139.8	14.9	1136.1
1978	350.6	478.8	155.9	133.9	17.1	1136.2
1979	329.9	447.4	140.9	133.3	8.5	1060.0
1980	317.5	434.8	133.5	125.8	10.9	1022.6
1981	314.9	431.5	125.7	128.9	16.0	1017.0
1982	328.6	466.9	138.6	137.7	6.9	1078.8
1983	365.5	524.5	145.9	131.9	4.7	1172.5

Source: JPS.

DISTRIBUTION OF CONSUMPTION BY PARISH

Parish	1977		1983		Growth Rate
	GWh	(%)	GWh	(%)	(%)
KSA	611.9	53.9	588.0	50.1	-0.7
St. Thomas	14.9	1.3	21.7	1.8	6.5
Portland	11.7	1.0	14.4	1.2	3.5
St. Mary's	72.4	6.4	82.8	7.1	2.3
Trelawny	12.6	1.1	19.0	1.6	7.1
St. James	81.4	7.2	95.0	8.1	2.6
Hanover, West.	26.1	2.3	30.2	2.6	2.5
St. Elizabeth	19.7	1.7	20.8	1.8	0.9
Manchester	39.5	3.5	40.0	3.4	0.2
Clarendon	86.0	7.6	83.2	7.1	-0.6
St. Catherine	158.4	14.0	178.5	15.2	2.0
Total	1134.6	100.0	1173.6	100.0	0.6

Source: JPS.

ENERGY BALANCE, 1972-83
(GWh)

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Demand												
Consumption	947.4	970.3	989.6	1065.4	1120.0	1136.1	1136.2	1060.0	1022.6	1017.0	1078.8	1172.5
Losses	159.2	228.2	203.1	229.5	205.0	190.6	207.1	234.7	251.9	264.7	259.6	290.4
Requirements	1106.7	1198.5	1192.8	1294.8	1325.0	1326.7	1343.4	1294.7	1274.5	1281.7	1338.4	1463.0
Supply												
Purchases	0.5	1.0	.0	.0	1.9	1.9	0.	0.1	0.1	0.7	2.9	4.8
Generation	1106.1	1197.5	1192.8	1294.8	1323.1	1324.8	1343.8	1294.5	1274.4	1281.0	1335.5	1458.2
Steam												
Hunts Bay	189.2	277.2	202.0	190.7	409.9	563.0	533.3	506.9	539.4	456.4	633.1	490.7
Old Harbour	678.7	668.9	736.1	794.3	690.7	485.3	586.5	491.4	523.4	639.5	371.0	805.0
Gas Turbines												
Hunts Bay	51.5	63.5	40.8	86.5	47.2	83.9	72.1	94.4	27.7	42.6	181.7	48.6
Bogue	.0	28.9	31.9	39.2	13.4	48.8	.0	62.3	32.8	0.0	16.6	32.6
Diesel	46.2	60.7	60.2	52.9	51.6	34.7	36.7	31.0	17.4	9.8	5.[illegible]	0.8
Hydro	140.5	98.5	121.8	131.2	110.4	109.1	114.7	108.3	133.6	132.8	127.4	80.5
Total	1106.7	1198.5	1192.8	1294.8	1325.0	1326.7	1343.4	1294.7	1274.5	1281.7	1338.4	1463.0

Source: Mission estimates based on data from JPS.

GENERATION COSTS: HISTORICAL AND ESTIMATED
(Thousand)

Generating Costs	1976	1977	1978	1979	1980	1981	1982	1983	PV a/
Observed (J$)	28654.2	36413.9	51828.1	91905.9	130528.3	167102.0	193486.6	166315.3	
Assumed (J$)									
Lower Heat Rates	26931.1	34192.8	51685.8	84811.8	111779.1	151490.9	170165.2	155046.5	
Better Availability	28312.3	34818.1	50754.3	86444.0	128464.8	165587.7	174859.9	160378.2	
Both	25986.8	31954.0	50650.7	76775.3	107642.9	150187.4	152212.2	150767.1	
Current Savings (J$)									
Lower Heat Rates	1723.0	2221.1	142.3	7094.1	18749.2	15611.1	23321.5	11268.8	
Better Availability	341.8	1595.9	1073.8	7239.9	2063.6	1514.3	18626.8	5937.2	
Both	2667.4	4460.0	1177.4	15130.5	22885.4	16914.6	41274.4	15548.2	
Constant Savings b/ (US$)									
Lower Heat Rates	3142.2	3815.2	143.7	5168.7	11882.7	9068.6	13267.9	5832.0	75842.1
Better Availability	623.4	2741.2	1084.5	5274.9	1307.8	879.6	10597.0	3073.0	36977.1
Both	4864.5	7660.9	1189.0	11023.9	14504.1	9825.8	23481.6	8047.0	118973.3

a/ Deflated with the USA wholesale price index, base 1983, and using the official exchange rate.
b/ Discounted with a 12% rate to the end of 1983.

Source: Mission estimates.

ENERGY AND POWER DEMAND FORECASTS

	Sales	Net Requir.	Peak Demand
	(GWh)	(GWh)	(MW)
Historical			
1973	970.3	1,198.5	204
1983	1,172.5	1,463	242
Forecasts			
1993			
Low	1,459	1,717	284
Medium	1,615	1,900	314
High	1,783	2,098	347
2003			
Low	1,706	2,007	332
Medium	2,083	2,450	405
High	2,621	3,083	510

Source: MONENCO and Mission Estimates.

Assumes:
(a) customer growth at 1-3.5% (1983-1993) and 2-4% (1993-2003);
(b) real tariff increases 0-1% (1983-93)
(c) income/capita growth at 0.3-1.6% (1983-1993) and 1.0-2.3% (1993-2003); and
(d) price elasticity at -0.35 and income elasticity at 0.6.

Annex Table 2.7

RATES OF GROWTH, ENERGY CONSUMPTION, GDP, AVERAGE TARIFFS AND NUMBER OF USERS

Year	Total Consumption	Average Consumption	Real GDP	Average Real Price	Number of Users
1970	9.1	1.9	12.2	3.5	7.1
1971	12.4	5.1	3.1	-4.4	6.9
1972	14.6	5.7	9.2	6.4	8.5
1973	2.4	-4.5	0.4	6.8	7.2
1974	-1.3	-2.1	0.5	42.1	0.8
1975	7.7	0.7	-0.4	4.5	7.0
1976	5.1	-1.9	-6.3	16.4	7.1
1977	1.4	-4.6	-2.4	4.3	6.3
1978	.0	-6.9	0.3	-1.6	7.5
1979	-6.7	-12.2	-1.4	8.3	6.3
1980	-3.5	-7.6	-5.3	1.1	4.4
1981	-0.5	-4.4	3.3	8.7	4.0
1982	6.1	2.4	0.2	-0.8	3.5
1983	8.7	6.7	1.7	-4.5	1.8

Source: JPS, IDB and IMF.

JAMAICA: GDP AND PETROLEUM IMPORT BILL

	1976		1980		1983		Growth Rate	
	US$ Million	J$ Million	US$ Million	J$ Million	US$ Million	J$ Million	1976-80	1980-83
GDP (Current Prices)	2,449.4	2,694.3	2,660.4	4,738.2	2,878.7	6,620.9		
GDP (Constant 1974 Prices)	1,826.8	2,009.5	1,031.7	1,837.5	838.9	1,929.4	-1.9	1.5
Total Merchandise Imports	907.9		1,159.6		1,335.0			
bauxite/alumina	104.6		272.5		229.2			
Total Exports of Merchandise and Non-factor Services	887.9		1,361.7		1,305.5			
bauxite/alumina	425.3		732.1		508.3			
Petroleum Import Bill								
Bauxite/Alumina	60.4		183.8		142.3			
International Aviation/Bunkers	21.5		40.3		55.7			
Other Domestic	121.6		222.4		205.1			
Total	203.5		446.5		403.1			
Ratios								
Total Petroleum								
as a % of GDP	8.3		16.8		14.0			
as a % of Imports	22.4		38.5		30.2			
as a % of Exports of Merchandise and Non-factor Services	22.9		32.8		30.9			
Other Domestic Petroleum Imports								
as a % of GDP (excluding bauxite/alumina)	4.2		6.6		7.6			
as a % of Imports (excluding bauxite/alumina) a/	15.1		25.1		18.5			
as a % of Exports of Merchandise and Non-factor Services (excluding bauxite/alumina)	26.3		35.3		25.7			

a/ Excludes international aviation/bunkers.

CONTROLLED PETROLEUM PRODUCTS, PRICE STRUCTURE, MARCH 1984
(J$ per Imperial Gallon)

Cost Sector	Premium Gasoline	Regular Gasoline	Kerosene	Diesel Retail	Diesel Consumer	Liquified Petroleum	Heavy Fuel Oil (JPS)
Ex-Refinery Cost	3.551	3.455	3.6855	3.6395	3.6395	3.871	2.7196
Stabilization Factor	0.2998	0.1187	(0.0155)	0.1434	0.0311	0.073	
Accord Differential	0.3730	0.3800		0.1320	0.5220		
Interfuel Subsidy	1.4910	1.4810	(1.1500)	1.0810	1.0910	(0.9440)	(1.1267)
Excise Duty	2.4100	2.4100		0.3000	0.3000	0.0250	
Refinery Billing Price	8.1248	7.8447	2.5200	5.2959	5.5836	3.0250	
Marketers' Margin	0.3343	0.2899	0.1060	0.2234	0.2235		0.3200
Transportation Factor	0.1008	0.2003		0.1256	0.0925		
Marketers' Selling Price	8.5599	8.3349	2.6260	5.6449	5.90		
Dealers' Margin	0.4301	0.4151	0.3340 a/ 0.4440 b/	0.3451			
Maximum Selling Price	8.99	8.75	2.960 a/ 3.07 b/	5.99	5.90		1.9129 c/
US$/US Gallon (at J$3.3 = JS$1) (March 12, 1984)	2.27	2.21	0.75 a/ 0.77 b/	1.51	2.15	0.76	0.48
US$/US Gallon (at J$3.96 = US$1) (April 26, 1984)	1.89	1.84	0.62 a/ 0.65 b/	1.26	1.24	0.64	0.40

a/ Urban
b/ Rural
c/ Classified as a minimum selling price.

Note: As of May 1984 the following changes were made:
- interfuel subsidy was eliminated;
- ex-refinery prices showed an increase because of the exchange rate depreciation, but refinery billing price did not change because of compensating changes made in stabilization factor and accord differential.

In January 1985, the maximum selling price of most fuels was increased by about 20%.

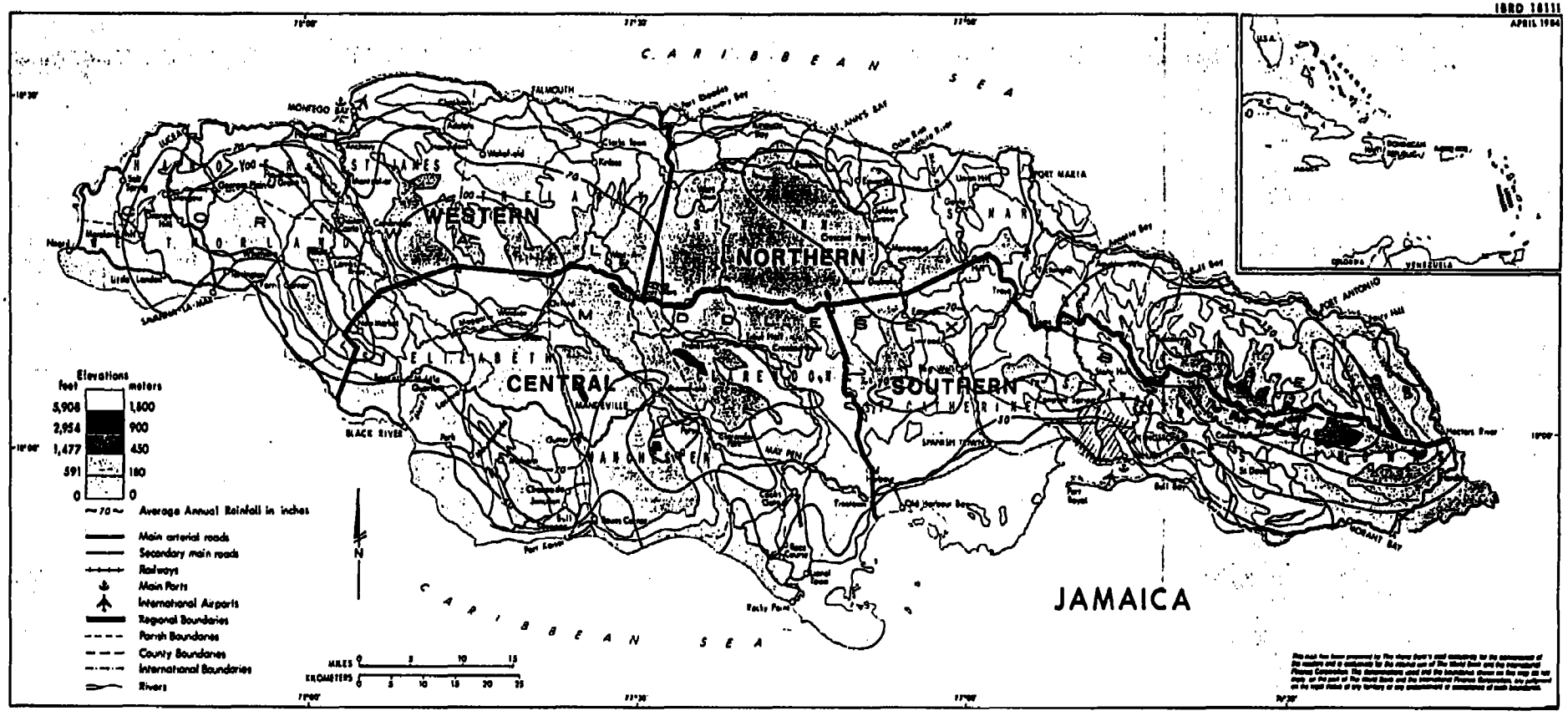
Annex Table 3.3

REGIONAL COMPARISON OF LPG AND KEROSENE PRICES
(US¢/US Gallon)

	January 1983		January 1984	
	Kerosene	LPG	Kerosene	LPG
Jamaica				
Ex-Refinery or Terminal	101.73	95.88	63.61	76.36
Final Selling Price	116.93		74.72	
Dominica				
Ex-Refinery or Terminal	87.87			
Final Selling Price	149.17			
St. Kitts-Nevis				
Ex-Refinery or Terminal	89.77	99.97		
Final Selling Price	123.15	174.93		
St. Vincent				
Ex-Refinery or Terminal	87.87	99.97	111.60	
Final Selling Price	133.49	180.76	140.07	
St. Lucia				
Ex-Refinery or Terminal	93.48	99.97	105.51	114.31
Final Selling Price	134.51	171.27	131.12	195.49

Source: Ministry of Mining, Energy and Tourism and information from marketing companies and governments.

IBRD 18111
APRIL 1984



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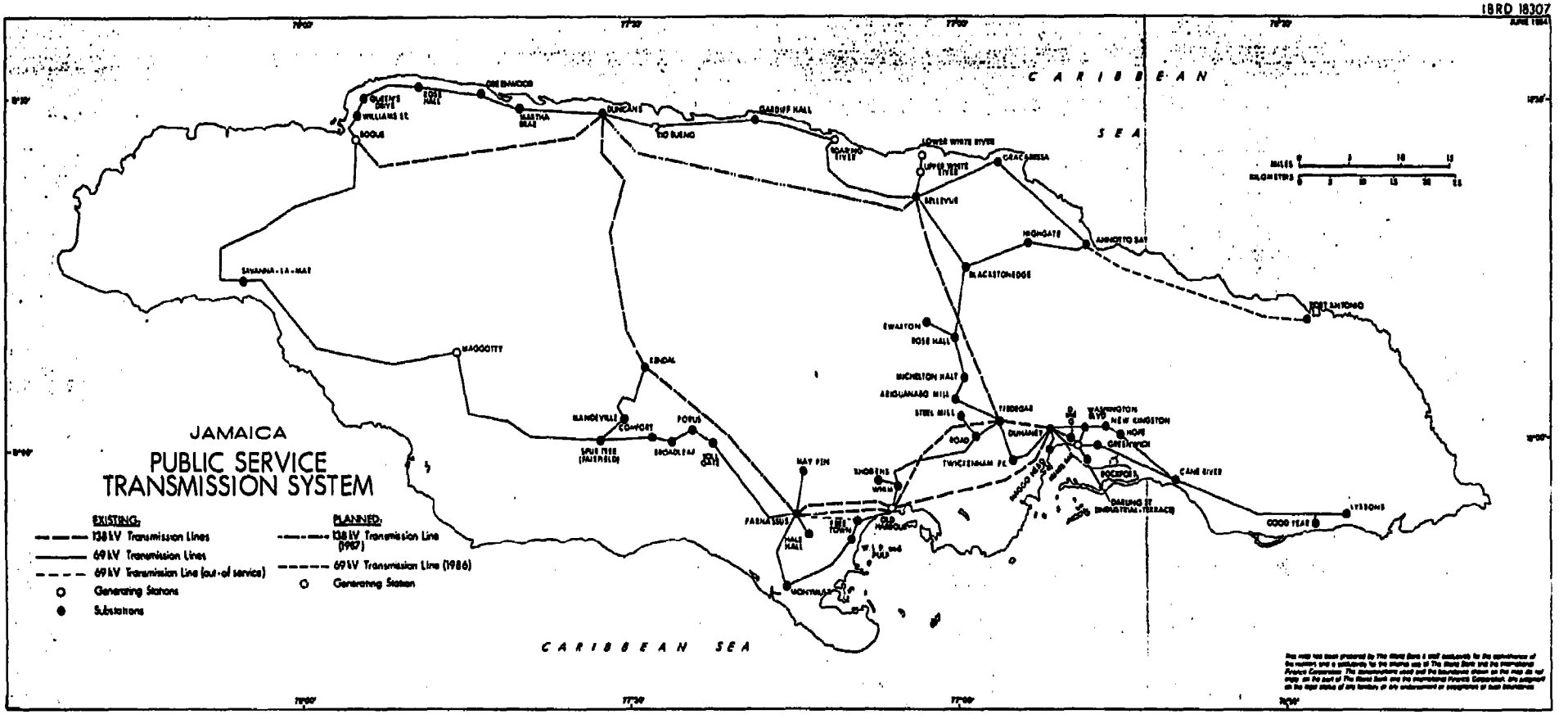

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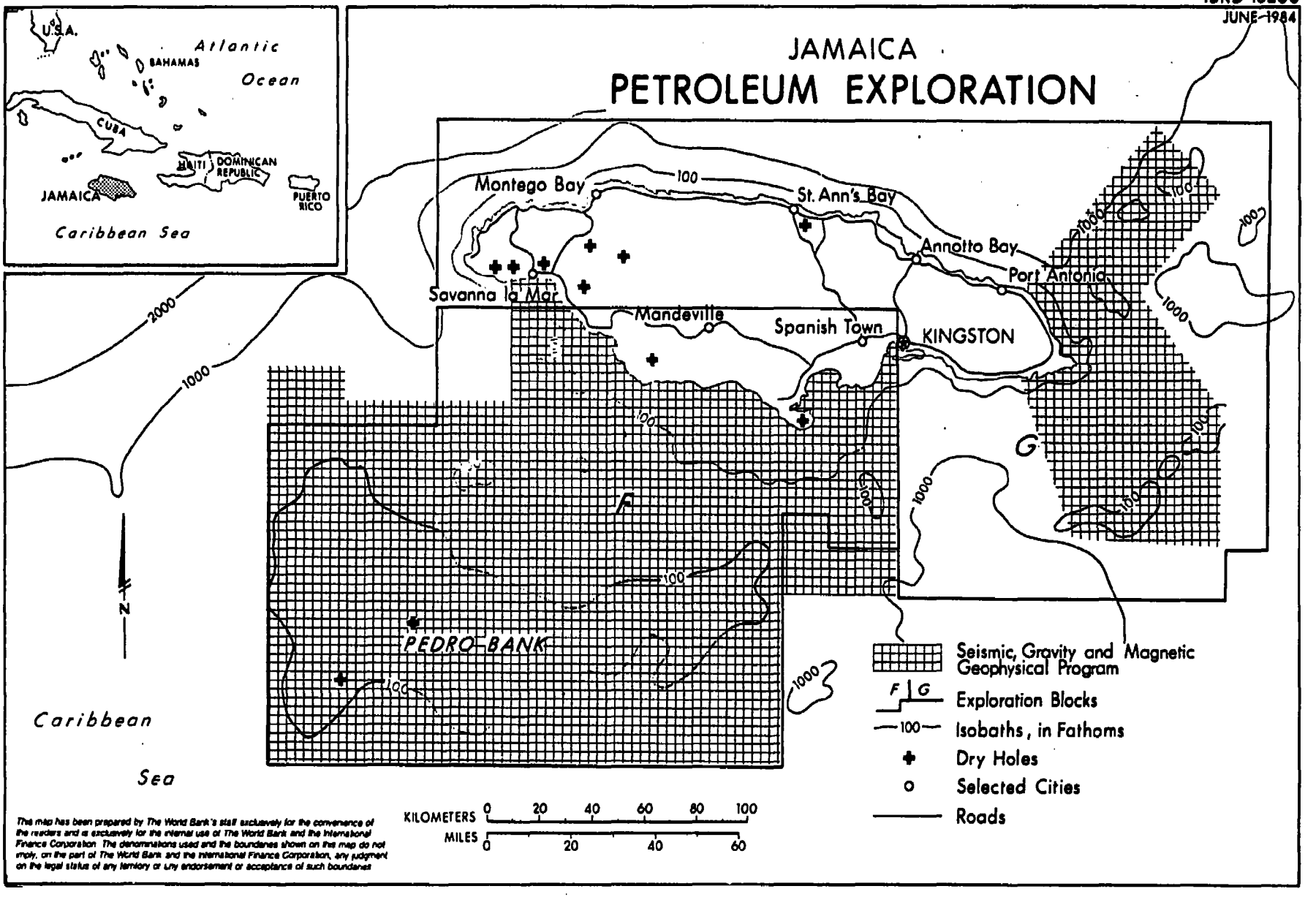
IBRD 18266
JUNE 1984

JAMAICA
PETROLEUM EXPLORATION



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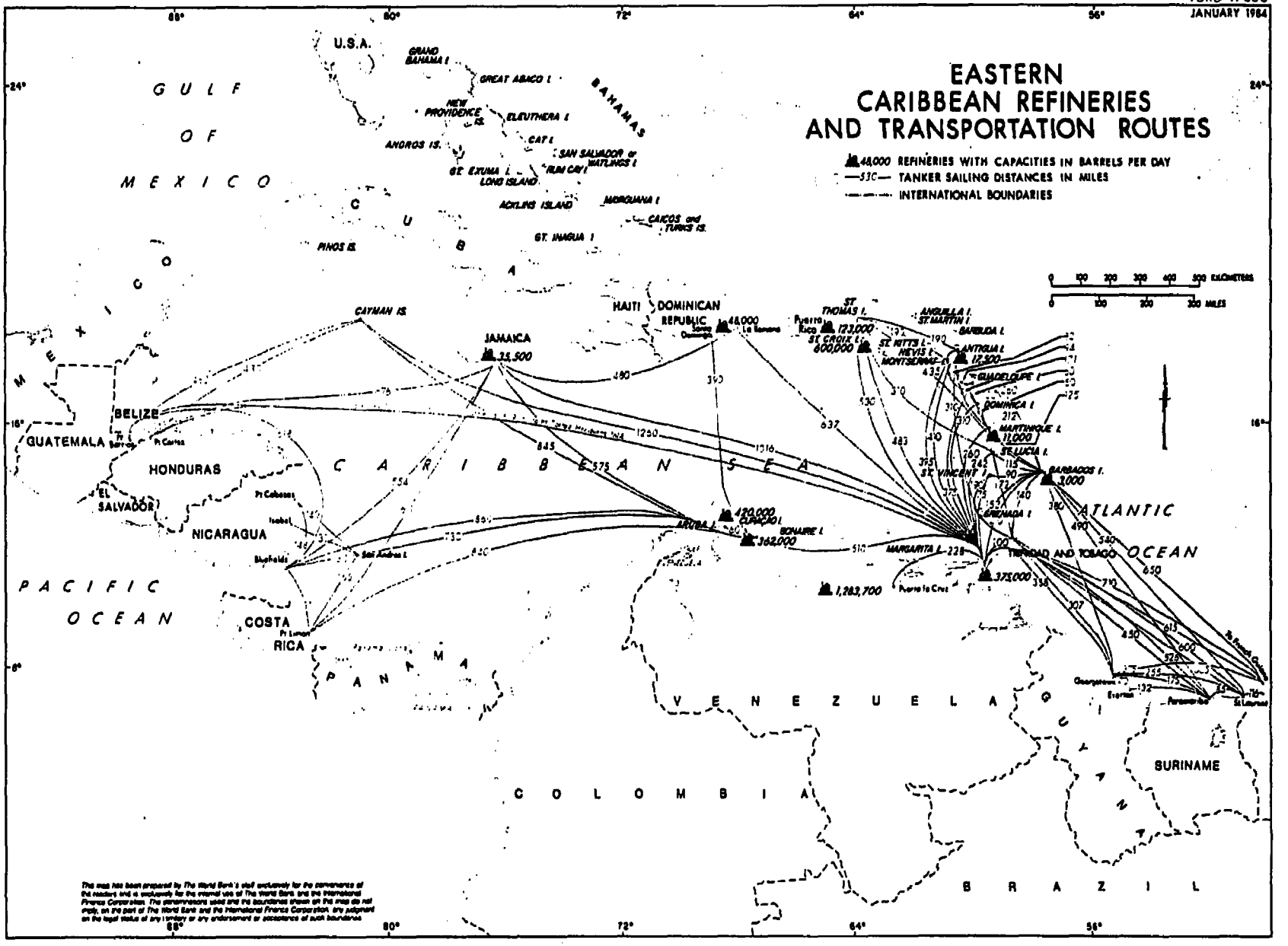
IBRD 17800
JANUARY 1984

EASTERN CARIBBEAN REFINERIES AND TRANSPORTATION ROUTES

48,000 REFINERIES WITH CAPACITIES IN BARRELS PER DAY
—530— TANKER SAILING DISTANCES IN MILES
INTERNATIONAL BOUNDARIES



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