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Central Intelligence Agency

DATE 3/20/86

DOC NO GIM 20046

OCR 3

P&PD 1

1-file 1-SOURCED

Washington, D.C. 20505

DIRECTORATE OF INTELLIGENCE

MEMORANDUM FOR: Robert J. Blohm
Jamaican Desk Officer
ARA/CAR
Department of State

FROM: [redacted] 25X1
Chief, Strategic Resources Division
Office of Global Issues

SUBJECT: Economic Evaluation of Coal Conversion in the Jamaican Electric Power Sector [redacted] 25X1

1. Attached is our economic analysis of the use of coal in selected power plants in Jamaica. Prior to his departure for Kingston, the Honorable Michael Sotirhos, United States Ambassador to Jamaica, suggested that he might find it useful to have a detailed analysis of the economic benefits of switching some portion of the electric power sector in Jamaica from oil to coal. If you believe he might still find this report interesting, please feel free to forward it to him. [redacted] 25X1

2. Our results suggest that the proposed use of coal is only marginally economic. Despite the substantial cost advantage of coal over oil as a fuel for electricity generation, the capital costs of conversion to coal and of construction for the size of the generating facilities under consideration are probably too large to merit the expenditure. [redacted] 25X1

Attachment:
Jamaican Power Generation Facilities:
Conversion to Coal too Expensive?
GI M-20046, February 1986 [redacted] 25X1

[redacted] 25X1

[redacted] 25X1

SUBJECT: Jamaican Power Generation Facilities:
Conversion to Coal too Expensive? [redacted] 25X1

OGI/SRD/EM, [redacted] (10 February 1986) 25X1

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DIRECTORATE OF INTELLIGENCE

10 February 1986

Jamaican Power Generation Facilities: Conversion to Coal too Expensive?

Summary

Despite the availability of significant coal deposits within short distances of Jamaica and the relatively high costs of generating electricity from oil relative to coal, the conversion of certain existing generating plants to coal and the construction of a new coal-fired power plant appear marginal when judged solely on economic grounds. While the current cost of coal is less then half the cost of oil on a heat-equivalent basis, the cost of construction, conversion, and receiving and handling facilities make coal uneconomic even for the largest installations in Jamaica. Other oil-fired plants, even though some are located at water's edge and could receive imported coal, are too small to justify the high capital costs of conversion and handling. A July 1985 report of the Petroleum Corporation of Jamaica forecasts that Jamaica will be using coal to generate electricity beginning in 1988, but we believe the authorities have yet to make final decision on coal use. 25X1

This memorandum was prepared by [redacted] Energy Markets Branch, Office of Global Issues. The information contained herein is updated to 8 February 1986. Comments may be directed to [redacted] Chief, Strategic Resources Division [redacted]

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Introduction

Over the past ten years, the Jamaican economy has been under continuous pressure, mainly due to stagnating bauxite/alumina exports, falling tourism receipts, private capital outflows and a mounting oil import bill. Imported oil is the main energy source for the Jamaican economy, accounting for over 90 percent of energy supply. In 1984, oil imports cost the country $392 million or about one-third the value of total merchandise imports. The country's external debt of nearly $3 billion, which required payment of $400 million in 1984, provides the impetus for Jamaica to look for an energy alternative which is cheaper than oil. In a study released in April 1985, the World Bank recommended that Kingston reduce its dependence on imported oil, primarily by converting part of the electric power generation sector--which is heavily dependent on imported oil--to relatively inexpensive coal.

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Jamaican Energy Demand and Supply

Jamaica's energy consumption totaled about 13.8 million barrels of oil equivalent in 1984. Of this amount, indigenous resources--including bagasse (a residue from sugar manufacturing), fuelwood, and hydropower--accounted for less than 10 percent, while 12.5 million barrels of imported oil supplied the remainder. The electric power sector is the second largest consumer of petroleum on the island--surpassed only by the alumina industry--accounting for about one-fifth of all petroleum demand. The World Bank has estimated that oil demand for power generation could grow at a rate as high as 4.3 percent annually to 1993, and as high as 3.9 percent annually to 2003, thus adding to foreign exchange burdens, unless a concerted effort to exploit coal substitution opportunities, improve maintenance, and decrease losses and theft is undertaken. In addition, the Bank found that energy efficiency in power generation in Jamaica has actually decreased since the mid-1970s, running counter to the trend in most other countries where higher oil prices have brought about significant improvement. Substitution of indigenous energy resources for oil used in power generation 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, according to the Bank.

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The power generation facilities in Jamaica are about 70 percent in the public sector, operated by Jamaica Public Service Company (JPS), and 30 percent in the private sector, operated primarily by the bauxite/alumina, cement and sugar industries for their own use. The systems operate on different cycles and are not interconnected. The alumina/bauxite industry is almost totally dependent upon imported oil. The sugar industry uses mainly bagasse, while the cement industry is reportedly moving from oil to imported coal. The World Bank has recommended that the public power sector follow the lead of the cement industry and switch to coal.

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The Public Power Sector in Jamaica

As of 31 December 1983, the latest year for which data are available, installed generating capacity of the Jamaica Public Service Company amounted to about 511 megawatts (MW). Of this capacity, 73 percent is fired by residual fuel oil and 2.5 percent by diesel fuel oil, consuming 2.8 million barrels of petroleum in 1984. The remaining capacity was provided by gas and hydro power, with the former used for peaking purposes, and the latter's actual use dependent on seasonal river flow. The largest individual units were three oil-fired generating plants of 68.5 MW. While this is the largest size generating plant in Jamaica, most coal-using plants elsewhere in the world are in the neighborhood of 300-600 MW capacity, thus permitting lower unit costs of operation.

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The World Bank proposal calls for the conversion of two of the 68.5-MW facilities located at Old Harbour, and the construction of a new 66-MW coal-fired unit at that location. If the recommendations are completely implemented, coal would be the fuel source for about 35 percent of total JPS electricity generating capacity. The proposal would reduce JPS dependence on oil as a fuel from 75 percent to about 40 percent.

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The World Bank estimated that the proposed conversions would cost about $95.5 million in 1984 dollars, in addition to its estimate of another $36.5 million for the coal receiving and handling facility at Old Harbour. The cost of the new plant was placed at $69.6 million. Total outlays would therefore be about $202 million.

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Economics of the Proposed Coal Conversion and Construction

While the World Bank recommends the use of coal for the three power plants, and cites feasibility studies that suggest the facilities could be put in place, nowhere does it present an economic analysis of its recommendations. It is unclear at this time whether the World Bank proposal calls for conversion to coal as the single source of fuel for the two existing plants, or for retention of dual-fired oil and coal capability. A 1982 study by a US engineering firm recommended retention of the oil burners.

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In most industrialized countries, the cost of generating a unit of electricity from oil is far more costly than from coal. On a Btu basis, recent industry estimates suggest that steam coal prices may be as low as $1.50 per million Btu (MMBtu), while heavy fuel oil may cost about $3.30 per MMBtu. Assuming that this relationship continues to hold, then on the surface the savings from the use of coal rather than oil appear extremely attractive.

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These operating savings, however, would be deferred until completion of the construction of the receiving and handling facilities, as well as plant conversion and construction. [redacted] 25X1
the construction leadtime for the two existing plants, the new plant, and the port facilities could be from three to five years, so any operating savings would not begin to accrue until the end of this decade even were the project to move forward immediately. [redacted] 25X1

One way of estimating the operating savings is to calculate the net difference between the cost of the oil displaced and that of the substituted coal. We separate the project into two parts: first, the conversion of the two existing plants and second, the construction of both the new plant and the receiving and handling facilities. In this instance, it is assumed that the receiving facilities would have to be built for the new plant, and that none of these capital costs need be attributed to the converted plants. [redacted] 25X1

The two 68.5-MW units are estimated to consume, at a 60-percent capacity factor, about 3,630 barrels per day of oil equivalent, or 1.3 million barrels of oil a year.1/ When converted to coal and operating at the same capacity factor, the units are estimated to consume 268 thousand tons of coal per year. These estimates, provided in the Technical Appendix, rely on standard industry conversion factors for megawatts, barrels per day of oil equivalent, and metric tons of coal. [redacted] 25X1

Using a recent price of about $21 per barrel for residual fuel oil from the Caribbean area, annual oil expenditures would be about $27.8 million.2/ The coal trade press [redacted] report that Colombian coal could be 25X1
delivered at about $36 per ton, resulting in outlays of about $9.7 million per year. [redacted] 25X1

Although the oil price estimate does not incorporate any transportation charges, these estimates nevertheless suggest that, if the two existing plants were operating on coal, the savings would amount to about $18 million per year at today's relative fuel prices. If this real relationship or spread between the two fuels' prices were to hold over the 21 year life of the plants (length of life used by one engineering firm), then the undiscounted total savings would amount to some $380 million. Discounting at a real rate of

1/ Electric power generating plants normally operate at an annual base-load factor of about 60 percent of name-plate capacity, so as to allow increased output to meet periods of peak demand.

2/ Jamaica relies primarily on Venezuela for its petroleum supplies.

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5 percent (since we are not forecasting an inflation rate), and assuming that realization of the annual fuel savings of $18 million does not occur until after a three-year construction period, this project pays back in about 10.5 years after the initial commencement of expenditures, with no allowance for the capital and operating costs of the coal receiving and handling facilities. 25X1 25X1

The calculation above is extremely sensitive not only to the assumed spread between residual fuel oil and coal prices, but also to the length of the construction period and the capacity factor.

- A one-year reduction in the construction period shortens the payback period by about a year and one-half.
- A rise in the capacity factor to 70 percent reduces the payback period by about one year.
- A 25 percent increase in the annual fuel savings reduces the payback period by two years. 25X1

The second part of the project--the construction of the new coal plant and its associated receiving and handling facilities--involves estimated capital expenditures of $106 million. If the new 66-MW plant were constructed to run on oil, its cost would be about 30 percent less, or about $74 million, since an oil-fired plant does not require the special equipment needed at a coal plant. The problem then becomes whether the extra $32 million in construction costs is more than offset by the savings arising from use of cheaper coal. 25X1 25X1

If the new 66-MW plant were oil-fired, it would consume--at a 60-percent capacity factor--about 1,750 barrels per day of oil equivalent, or about 638 thousand barrels per year. At $21 per barrel, annual expenditures would amount to $13.4 million. Operated on coal, this unit would consume about 129 thousand tons of coal annually. At $36 per ton, annual expenditures on coal would amount to $4.6 million, for a savings of $8.8 million. Again assuming that the current spread between oil and coal prices continues to hold, and discounting at 5 percent, this proposal pays out in eight years. If the construction period were shortened by a year, it would pay back in just over six years; were it lengthened by a year, payback would occur in a little over nine years after the beginning of construction. 25X1

It should be noted that these projected savings could disappear with the inclusion of interest costs, translation of costs into current dollars at the time of commencement of the project, unanticipated cost overruns in construction and conversion, maintenance expenditures, and/or potential labor difficulties delaying completion of the project. Factors tending to point to greater savings would include a widening of the differential between oil and

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coal prices, a higher capacity factor, and the inclusion of revenues from cogeneration if steam or electricity could in the future be sold to the private sector. Table 1 shows how the payback timetable changes with the capacity factor and an assumed 25 percent increase in fuel savings beyond those calculated using the current price data. In this analysis, neither interest rates nor future oil and coal prices are predicted, plant life is not extended given the past failure of JPS to retain a competent and reliable labor force and to maintain its facilities in good repair, and revenues from cogeneration have been ruled out in view of the depressed state of Jamaican industry and the absence of linkage between the public and private power grids. 25X1

Other Factors for Consideration

There are additional issues that should be of concern to JPS, in our view, rather than just coal's attractiveness for electricity generation.

- The World Bank proposal is considered controversial at this time because of the possible impact on Jamaica's oil refinery. To the extent that coal penetrates the electricity sector, the refinery will develop surplus fuel oil production capacity. Disposal of excess fuel oil would then become a major issue, and might even lead to the shutdown of that refinery, according to views presented at the November 1985 Coal Symposium in Jamaica.

- Were the recommendations followed, 35 percent of JPS capacity would be located at Old Harbour, in opposition to JPS's desire to diversify supply away from Old Harbour, and posing an increased vulnerability to potential sabotage.

- In view of labor relations problems at Old Harbour, it might not be either convenient or wise to rely on that site for the bulk of JPS power supply. Since coal operation and maintenance is more complicated than oil, higher-paid operators would be required, possibly leading to rivalries within the labor force and friction between management and labor.

- In view of the historic inability of JPS employees to maintain adequate quality control and the chronic shortage of foreign exchange with which to purchase repair parts for any of its units regardless of fuel type, the preferred solution might be to encourage the private sector--particularly the bauxite/alumina producers--to take steps to switch their generating facilities from oil to coal. It is widely believed that the labor force is far more highly motivated and knowledgable in the private sector, and while we have no current information on the size of the installed generating facilities in that sector, it is possible that they might be sufficient to make coal conversion more economic. The immediacy with which the

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TABLE 1

Years to Pay Back for Selected Jamaican Electric Power Plants[1]

	Estimated Capital Costs ($ Million)	Capacity Factor 60%	70%	60% 25 Percent Hypothetical Increase in Projected Fuel Savings	70%
Two Existing Plants	$95.5	10+	9+	8+	7+
New Plant[2]	$32.0	8	7+	7	6+

[1]Three year construction period, 5 percent real discount factor.
[2]Incremental capital expenditures required for coal plant.

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bauxite/alumina industry might turn to fuels other than oil, however, clearly depends on the outlook for that industry. Given the current depressed state of demand, with several plants closed, we judge that the industry would be unwilling to commit to major new fuel projects unless bauxite demand projections were to improve substantially.

Conclusions

The economics of coal over oil in electric generation are extremely favorable for new large base-load facilities in the 300-600 MW size, but not for plants one-tenth that capacity. Big coal-fired generating plants, properly maintained, offer large economies of scale and permit lower unit costs of operation. They also require far less than proportionate increases in expenditures on receiving and handling facilities. Two 500-MW plants, operated at a capacity factor of 60 percent, would provide adequately for all of the currently anticipated power needs of the whole JPS system. Normal industry practice, however, requires that no more than 10 to 15 percent of total system capacity be provided by any one generating facility. This provides a margin for scheduled downtime for maintenance as well as for unanticipated outages. Consequently, while two such plants would be economic for JPS, they present an unacceptable commercial risk.

At a 5 percent discount factor, most capital projects are expected to pay back in no more than seven years to be economically justifiable; the earlier the payback, the more attractive the proposed investment. Of the alternatives considered in the above analysis, only the incremental cost of the new coal-fired facility, operated at a 70-percent capacity factor, results in a payback period of seven years. The other alternatives take 1-3 years longer for capital expenditures to be recovered.

These conclusions are consistent with revised industry findings, whose results recently have been updated to reflect current market conditions. In that study, an 80-percent capacity factor was used, which made the projects examined profitable in 1982 and marginally profitable from today's vantage point. The company now believes a four-year construction period is more realistic, which of course defers realization of fuel savings one year further into the future with concomitant reductions in the net present value of the capital expenditures. Most however, believe an 80 percent capacity factor is unrealistically optimistic. Papers presented at the November 1985 Coal Symposium in Jamaica suggest that the coal conversion project now carries real economic risk in view of both the softening of world oil prices and the historically poor turbine reliability of the Old Harbour units. Moreover, papers presented at the Coal Symposium raise doubts as to whether a wholly new generating facility designed to burn coal is needed at this time, given that installed capacity is well above peak demand, and that improvements in efficiency have accompanied the rehabilitation of major generating units of JPS. New capacity may not be required until the mid to

late 1990s. These papers recommend that the Old Harbour facilities plans be implemented only if and when they offer a minimum annual rate of return equal to that on all public sector investment projects and that they be considered again if and when residual fuel prices exhibit a rising trend. What all of this suggests is that the $202 million could be used more economically in alternative public investments that would pay back in a shorter period.

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Technical Appendix [redacted] 25X1

Calculations of consumption of oil and coal for given sizes of electric generating plants were estimated according to industry standards using the following rules:

Rule 1: A 1,000 MW plant operated at a 60-percent capacity factor for one year consumes 26,500 barrels per day of oil equivalent (bdoe).

Rule 2: 1,000,000 metric tons of coal per year equals 13,541 bdoe. Assumptions used in estimating annual fuel savings: three-year construction period and 5 percent real discount factor. [redacted] 25X1

A. Conversion to coal of the two exiting oil-fired plants only (137 MW), with no inclusion of the costs necessary for coal handling and receiving facilities:

Applying Rule 1: $137/1,000 = x/26,500$

$x = 3,630$ bdoe or 1,324,950 barrels per year

Applying Rule 2: $3,630/13,541 = y/1,000,000$

$y = 268,075$ tons of coal per year

With oil at $21 per barrel and coal at $36 per ton, the expenditures on the former would amount to $27.8 million per year, and on the latter to $9.7 million per year, for an annual savings of $18.1 million once the construction period has been completed. [redacted] 25X1

B. Construction of a new coal-fired unit (66 MW) and its associated receiving and handling facilities:

Applying Rule 1: $66/1,000 = x/26,500$

$x = 1,749$ bdoe or 638,385 barrels per year

Applying Rule 2: $1,749/13,541 = y/1,000,000$

$y = 129,163$ tons of coal per year

With oil at $21 per barrel and coal at $36 per ton, the expenditures on the former would amount to $13.4 million per year, and on the latter to $4.6 million per year, for an annual savings of $8.8 million once the construction period has been completed. [redacted] 25X1

[redacted] 25X1