Report No. 1509-MAS

The Economy of Mauritius
A Basic Economic Report

Annex II—The Power Sector

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Country Programs Department II
Eastern Africa Region

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MAURITIUS

POWER SECTOR REVIEW

Currency Equivalents

1 US$	=	6.7 Mauritian Rupees (Rs)
1 Mauritian Rupee	=	100 Mauritian Cents (M¢)
1 Pound Sterling	=	Rs 11.4
1 Mauritian Rupee	=	US$0.149

Weights and Measures

1 Meter	=	3.28 Feet
1 Kilometer (km)	=	0.0621 Miles
1 Square Kilometer (km^2)	=	0.386 Square Miles
1 Kilovolt (kV)	=	1,000 Volts
1 Kilowatt (kW)	=	1,000 Watts
1 Kilowatt-hour (kWh)	=	1,000 Watt-Hours
1 Megawatt (MW)	=	1,000 Kilowatts
1 Gigawatt-hour (GWh)	=	1 Million Kilowatt-Hours

Abbreviations and Acronyms

ADB	=	African Development Bank
BADEA	=	Arab Bank for Economic Development of Africa
CCCE	=	Caisse Centrale de Cooperation Economique (France)
CDC	=	Commonwealth Development Corporation
CEB	=	Central Electricity Board
CWA	=	Central Water Authority
EIB	=	European Investment Bank
EPDC	=	Electric Power Development Consultants (U.K. Consultant)
FNCB	=	First National City Bank (USA)
GRNW	=	Grand River Northwest
GRSE	=	Grand River Southeast
MPFE	=	Ministry of Power, Fuel and Energy
ODM	=	Overseas Development Ministry (U.K.)
PCR	=	Preece, Cardew and Rider (U.K. Consultant)

CEB's Fiscal Year

January 1 - December 31

MAURITIUS

POWER SECTOR REVIEW

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I. INTRODUCTION

1.01 Diversification of the economy has been an important Government objective since independence in 1968. Mauritius has been particularly successful in attracting labor-intensive industries and developing the tourism industry. It is therefore not surprising that consumption of electricity has risen at a high rate over the past seven years.

1.02 Rapid growth of electricity consumption is likely to continue while Mauritius implements the Second National Development Plan. To fulfill the Plan's objectives, the electricity industry must undertake a large investment program. If electricity is to be made available at a price which consumers can afford, this program must be carefully selected according to economic criteria. Furthermore, while the Central Electricity Board is generally well run, it must continue to seek improvements in its operations. An important objective of the following report is to assist CEB in this task.

1.03 From the Bank's perspective, the objective of the report is essentially to develop sufficient sector knowledge to permit orderly preparation of the Second Power Project now scheduled for FY1979. The First Power lending operation of the Bank in Mauritius was in 1963 for generation and transmission facilities (Loan 355-MAS). Most of the objectives of that lending operation were achieved, except on the financial side. The report draws the attention to these.

1.04 The report is based on the findings of a mission, consisting of Messrs. Tuncay and Heitner, which visited Mauritius in April 1976, and of a short updating visit in January 1977.

II. SUMMARY AND CONCLUSIONS

2.01 Except for limited hydroelectric resources, for which there is competition with other users such as irrigation and bagasse, a by-product of sugarcane processing, Mauritius has no indigenous sources of energy. Diesel generation based on imported fuel accounts for about 70% of total electricity generation, and its share is expected to increase in the future.

2.02 Domestic use accounts for 40% of total electricity consumption. Practically the whole population lives in areas supplied by electricity and about 80% actually has access to electricity. This is essentially due to the high commitment of the Government and the Central Electricity Board (CEB) for rural electrification. Commercial and industrial use account together for about 46% of total consumption and their share is rising. The balance of 14% is for irrigation and miscellaneous services.

2.03 The Central Electricity Board is a generally well managed utility. Its main weaknesses lie in generation planning, and financial performance. Some areas of its operations also require strengthening.

2.04 A summary of recommendations appears at Chapter VIII. The main ones are that: (i) CEB should improve its planning activities (Power Market Surveys, Financial Planning, etc.); (ii) the Government should undertake, on behalf of all water users, a study to determine how the water resources of the island should be allocated to various users on the basis of cost and benefits; (iii) incentives should be found to increase production of electricity from bagasse from existing and possibly new plants; (iv) appropriate remedial measures be taken to restore financial health to CEB; and (v) declining block tariffs, with their promotional characters, be abolished in favor of tariff structures which reflect the long-term marginal cost of supply.

III. THE ENERGY SECTOR

Energy Resources

3.01 Mauritius has no known fossil fuel resources. The main indigenous sources of commercial energy are: (i) hydroelectric power, on the Grand River Southeast (GRSE) and Grand River Northwest (GRNW); and (ii) bagasse, a by-product of sugar processing, which is burnt in generating plants located on sugar estates.

3.02 Although the annual rainfall on the island is one of the highest in the world, the number of suitable hydroelectric sites is limited by the following factors: (i) small catchment areas; (ii) juxtaposition of a good storage volume with a good head is not often available; and (iii) there are many, old-established water-rights on the available water resources, mostly for irrigation purposes.

3.03 The largest catchment on the island is that of GRSE. It is oriented toward the prevailing wind so that it obtains the maximum advantage from orographic rainfall, and it is an area where demand for water from other users is noticeably less than elsewhere.

Energy Demand

3.04 The energy crisis has encouraged offshore oil exploration but so far no deposits of any significance have been discovered. Meanwhile, imports of refined oil products - there is no refinery on the island - have increased from 115,000 tons in 1973 to 135,000 tons in 1976, while the cost of these imports increased from about US$15 million to US$25 million. The share of oil products in total imports now approximate 15%. Mauritius also imports coal, albeit in small quantities (about 1200 tons per annum).

3.05 Commercial energy requirements in 1976 aggregated to about 285,000 tons of coal equivalent 1/. Eighty-five percent of these were met by imported oil, 8% by hydroelectric generations and 7% by burnt bagasse.

3.06 The share of electricity in total energy consumption has increased from 28% in 1970 to 32% in 1976. This trend is expected to continue, and reach 34% in 1980.

IV. POWER SUPPLY AND DEMAND

Existing Facilities

4.01 The Central Electricity Board (CEB) is in charge of most electricity generation and all electricity distribution on the island. CEB has about 90 MW of power generating facilities, of which 64 MW are thermal, and the balance hydro. Further, 16 sugar estates own and operate private generating plants based on process steam and bagasse, and two small hydroelectric stations with a combined capacity of 15 MW.

4.02 CEB, has an extensive 66, 22 and 6.6-kV network covering the whole island. At present overhead lines measure about 3,500 km, and underground cables about 100 km, a relatively high density for an island of 1,850 km^2. Annex 1 gives a detailed description of CEB's facilities.

Power Market

4.03 CEB's sales more than doubled between 1965 and 1975, with an average growth rate of 7% per annum. The growth has been particularly rapid since 1970 with an average 11% growth rate per annum. The mix of energy sales is as follows: 40% go for domestic sales, 23% for commercial sales and 20% for industrial sales; the balance goes essentially for irrigation. A discernible trend since 1970 has been the more rapid growth of commercial and industrial sales which increased their combined market share from 38.5% in 1970 to 46% in 1975. Annex 2 shows CEB's annual GWh generation and sales in the 1970-1975 period.

1/ Ton of coal equivalent (TEC)

1 TEC = 7×10^6 Kcal
1 Ton fuel oil = 1.37 TEC
1 GWh = 330 TEC
1 m^3 natural gas = 1.3 TEC

4.04 The number of domestic consumers at end-1975 was approximately 109,000. Currently, 98% of the total population of 860,000 lives in areas with an electricity supply and about 80% of the population actually uses electricity. This remarkable achievement is essentially due to the high priority given to rural electrification by the Government and the CEB. It is anticipated that, by end-1978, the whole population of the island will have access to electricity.

4.05 The specific monthly consumption per connection, while low (about 56 kWh per month), has increased steadily from the 1970 level, when it was 46 kWh per month. The growth in specific consumption does not fully reflect the improvement in the standard of living which has taken place because the bulk of new consumers has been from the lower income groups.

Supply and Demand

4.06 Rapid growth in electricity demand over the last decade was not matched by a corresponding growth in power generation facilities. Maximum demand occurs around December, when firm capacity is low. Of the 26 MW of hydro capacity, only 6 MW are firm in December because this is just prior to the rainy season. Also, by December, the generating plants using bagasse have been closed down. Consequently, CEB relies heavily on its diesel plants. The capacity of such plants was 51 MW in 1975 to meet a maximum demand of 54 MW in the same year. 1/ The shortage of capacity has led to load shedding and somewhat deteriorated the industrial development of Mauritius. In taking future policy decisions, the CEB and Government should fully take into account the dangers of underestimating the importance of infrastructure investment.

V. THE CENTRAL ELECTRICITY BOARD

The Act

5.01 The Central Electricity Board, a statutory body, was established in December 1952, through the acquisition by Government, and consolidation of several private undertakings. Since July 1956, CEB has been the sole public supplier of electricity and has had the full responsibility to operate and develop the integrated electric power system on the island.

5.02 The Board of Directors consists of eleven members, i.e., the Chairman, the General Manager, four representatives of the Government and Parastatals, two representatives of consumer groups, and three representatives from the private sector. The Governor appoints all the non-ex-officio members of the Board by delegation of MPFE.

1/ Two 6.5 MW diesel sets were subsequently commissioned at end-1976, thus alleviating the current shortfall of generating capacity.

5.03 The CEB Ordinance of 1963 gave broad powers to the Board in running the Corporation; the Board in turn can delegate the necessary powers to the General Manager. Although the degree of autonomy of the CEB, as provided for in its Ordinance, was not unreasonable, it causes concern to the Government so that in April 1976, the Act was amended by adding to the Board's membership two representatives of the Government, and the General Manager of the Central Water Authority (CWA). Further, the Minister in charge (now the Minister of Power, Fuel and Energy) can give "general directions" to the Board, with which the Board has to comply.

Organization and Staffing

5.04 The Organization Chart of the CEB is in Annex 3; CEB has seven main departments, four of which deal with Operations and one each for Transmission and Distribution Planning, Accounts and Personnel. The important function of Generation Planning is a direct responsibility of the management and while the two Generation Engineers participate in the generation planning works, they are mostly occupied by the day-to-day operation of the thermal, and hydroelectric plant.

5.05 At end-1975 CEB's staff stood at 1500, with one-third being qualified personnel and the rest manual workers 1/. The size of the staff seems about right when compared with CEB's scope of activities. Like many operating concerns in Mauritius, CEB's management has been preoccupied, over the last two years with an unusual level of labor unrest, caused mainly by a rate of inflation which had outpaced wage increases. CEB's management was able to deal with these problems effectively by creating a Personnel Department, and placing a competent person in charge.

Training

5.06 With assistance from the French Government, Electricite de France (EDF) set up a vocational training school in 1974. An EDF engineer presently runs the school, but it is expected that a Mauritian engineer, after initial training in France, will take over the management of the school during 1977. Instructors are Mauritians who have been trained in France by EDF. This program has been very successful and combines theoretical courses with practical training. At present about 60 apprentices participate in the program. At the upper echelons, CEB sponsors students for courses abroad and at the University of Mauritius. CEB's training program appears satisfactory.

Operations and Maintenance

5.07 Although system control activities need some improvement (particularly in the areas of system frequency and voltage control and reactive load supply), operation and maintenance of power plants and transmission

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1/ Semi-skilled or unskilled workers who work in transmission/distribution construction and in security services as guards.

system are good. Since fuel consumption of the Board represents about 15% of the island's total requirements, big efforts have been made to reduce diesel oil consumption, which is expensive, and increase consumption of inexpensive residual oil in electricity generation. CEB has successfully modified diesel engines burning light oil to burn heavy fuel oil (residual oil) and has reduced fuel expenses substantially.

Insurance

5.08 CEB's plant is not presently insured against fire, flood, explosion or cyclones. Further, no reserve exists (funded or not) against such damages. While the Government has come to CEB's rescue after major natural catastrophies (such as cyclone Gervaise in February 1975, see para. 7.05), CEB ought to undertake a study on the merits of a coverage of generating plant and transmission and distribution assets against major disasters, and to determine whether a commercial insurance is preferable or not to a funded reserve. In any event, the cost of protection against unexpected damages should be borne by CEB (and therefore indirectly by electricity consumers) and not by Government. The present situation, where there is neither a commercial insurance nor a funded reserve, is unsatisfactory.

Accounts and Audit

5.09 CEB's accounts are well maintained and reports are prepared promptly. Performance, as measured by inventory levels and accounts receivable, has been good. On the other hand, the budgeting process and cost control mechanisms could be improved; on the first item above, CEB's budgets have proven systematically optimistic, essentially because of overestimation of high assumption regarding hydroelectric power production and underestimation of costs. As a result, CEB's requests for tariff increases to meet its financial objectives (see para. 7.10) have proved to be too low in several instances.

5.10 CEB's accounts are audited annually by De Chazal du Mee & Co., a local audit firm with links to Coopers and Lybrand. The scope of the audit appears generally satisfactory. CEB's audited accounts are not qualified.

VI. PLANNING AND INVESTMENT

6.01 CEB is in charge of planning for the whole power sector in Mauritius. Except for multipurpose projects with an electrical component, CEB is fully in charge of constructing power facilities. CEB relies for much of its planning on its consultants, Preece, Cardew and Rider (PCR), a U.K. firm; PCR has provided assistance to CEB in various aspects of planning for including financial planning. CEB, however, has not been

always satisfied with the quality of the assistance offered, and ought to develop in the future its own planning capacity, particularly in the areas where the required expertise is not excessively specialized.

6.02 In March 1976, PCR completed a 10-year program for the Development of Generation, Transmission and System Control Facilities. This report was used as a basis for the discussions which the IBRD mission of April 1976 had with CEB and Government officials on the subject of power sector planning in Mauritius.

Power Market Survey

6.03 PCR completed a detailed Power Market Survey in February 1975. Its conclusions were still considered valid by PCR in early 1976 1/, and were therefore used to prepare the Generation and Transmission Development plans. The forecasts of Energy Sales and Maximum Demand over the 1977 - 1983 period appear at Annex 4.

6.04 The methodology used by PCR consists in analyzing the trends for each category of consumers, without any econometric studies, or sensitivity analyses. The main assumptions have been that:

(i) the annual growth rate in domestic sales will gradually decline from 14% in 1975 to 8.5% in 1980;

(ii) the annual growth in commercial sales will gradually decline from 9.1% in 1975 to 7.5% in 1982 (due mainly to saturation); and

(iii) the annual growth in industrial sales will gradually decline from 14.9% in 1975 to 10.7% in 1983 (due mainly to saturation).

Demand forecasts for very large industries, such as the fertilizer factories, were included on the basis of current plans, on an individual basis.

6.05 PCR also anticipated that the morning peak, now 89% of the evening peak, will gradually approach the evening peak. This phenomenon is mostly due to the faster growth rates of the industry and tourism markets, and will have serious repercussions on power system operations and planning.

Generation

6.06 Generation projects, now being implemented, and for which financing has been secured, are as follows: (i) two 6.5 MW diesel sets for the Fort Victoria power station to be commissioned during 1977; and (ii) two 12 MW diesel units to be commissioned during 1978 at the St. Louis power station.

1/ The actual 1976 results and the 1977 budget are broadly in line with the 1975 survey.

6.07 CWA is now implementing a multipurpose irrigation/water supply/ hydroelectric power project at Baptiste Guibies; the project has been affected by long delays, substantial cost overruns and the hydroelectric plant (8 MW) will not provide any firm capacity during the dry season. Commissioning is not expected until 1980 at the earliest. CEB and CWA have so far not reached agreement on sharing and the costs purchase price of electric power from CWA.

6.08 PCR's generation development program of March 1976 has not been prepared on the basis of economic least cost solutions taking into consideration all possible alternatives; it is essentially a fully oil-based development, expected to meet CEB's requirements up to 1986; hydroelectric possibilities, or coal-based units have not been considered. The report recommends: (i) a 12 MV gas turbine (1976); (ii) a 12 diesel set at St. Louis (1978); and (iii) two 12 MW diesel sets at a new power station at Mer Rouge (1979); a further 48 MW would be added to Mer Rouge by 1986.

6.09 PCR's proposal was altered by CEB on the following grounds:

(i) the gas turbine was uneconomic;

(ii) one should assume, for planning purposes, two consecutive years of drought extending from November to January;

(iii) de-rating of the nominal capacity of the St. Louis power station from 14 MW to 8 MW;

(iv) firm capacity of the hydroelectric station set out at 8 MW (vs. 25 MW of installed capacity);

(v) two 6 MW sets at Fort Victoria could be out of service at any one time on account of maintenance and/or mechanical failure (their availability record has proven poor so far); and

(vi) The proposed site for the new thermal plant at Mer Rouge is not suitable at this stage because it would be more economical to extend the existing of St. Louis station, which is located near Port Louis.

6.10 CEB's generation program, as modified, is as follows: in addition to the two 12 MW diesel sets at St. Louis (1977/78) (para. 6.06): (a) one 12 MW diesel set at St. Louis (1979); and (b) the 15 MW Quatre Soeurs Hydroelectric Project (1980). Development beyond 1980 and until 1986 will be through two additional 12 MW sets at St. Louis and the Diamamouve hydroelectric project (upstream of Quatre Soeurs), around 1982. Annex 5 shows the forecast of Maximum Demand and, Installed and Firm Capacity.

6.11 The feasibility study for the Quatre Soeurs Hydroelectric Project (para. 6.10) was prepared by Engineering Power Development Consultants (EPDC), U.K. Consultant, in 1976. The consultant has prepared tender documents

for all the major components of the project, and all bids are expected to be made by September 1977; the intention is, at that time, to review the merits of the project, on the basis of actual tenders, and decide with the Government and the interested lender (BADEA) whether to go ahead or not.

6.12 As was mentioned earlier (para. 3.03), while the island enjoys ample rainfall, there is competition for water use between irrigation, domestic and industrial consumption and hydroelectric power. The problem is complicated further by the existence of water rights dating, in some cases, back to the eighteenth century. In view of the already large investment in hydroelectric plant and the two hydroelectric projects now contemplated (Baptiste/Guibies and Quatre Soeurs), it would be useful to determine how water would be allocated on the basis of economic criteria alone. In the short run, it would then be possible to establish the opportunity costs of allocating water between competing uses on a different basis. Thus, the cost of allocating water in a given way to a particular use is the value at the margin of that water in the most valuable alternative use. In the longer term, pricing policies for water use can be developed which will bring about a greater equality of the marginal value of water in alternative uses, subject to any social or other constraints.

6.13 The following observations can be made on CEB's generation planning procedures:

(i) generation development plans should be based on economic least cost solutions taking into account all possible alternatives;

(ii) the planning figure for firm capacity and average energy of hydroelectric plants should be revised by incorporting the results of recent observations (see also para. 7.10);

(iii) in view of the high oil prices, the CEB should study whether methods (e.g., increasing generating capacity, changing pricing arrange ments, giving CEB an increased control over the day-to-day operation of bagasse-based generating plants) can be found which are mutually beneficial to CEB and sugar producers, to increase production of electricity from bagasse (a contact is expected to be signed soon regarding the operation of a sugar estates' plant during inter-crop season); and

(iv) a small generation planning unit should be created in the CEB (para. 5.04), and should concentrate its activities on the economics of generation on the island, and the identification of sequences of least-cost solutions.

Transmission and Distribution Program

6.14 A long-range construction program for transmission, primary and secondary distribution has been prepared by PCR in the March 1976 report. It covers the future development of the transmission system from 1977 onwards to meet the steadily increasing demand. By 1981/82, the capacity of the transmission system would be sufficient to cope with the anticipated loads into the 1990s. Thus, after 1982, the program is mainly confined to adding transformers and switchgear to the proposed 66/22 kV substations.

6.15 This program was appropriately modified by CEB due mainly to the changes in the generation construction program (para. 6.09). CEB's transmission and distribution program now includes the constructin of about 100 km of 66 kV, 22 kV and lower voltage overhead lines and cables, and about 250 MVA of transformer capacity with related equipment for the proposed substations between 1976 and 1983.

Investments in the Power Sector

6.16 CEB's construction program appears at Annex 6. The total cost of the program, over the 1977-1980 period, has been estimated at Rs 439 million (US$65 million), of which Rs 271 million is for Generation and Rs 131 million for Transmission and Distribution projects.

6.17 CEB's policy has been to secure external financing for Generation projects. Recent projects have been:

Project		Financing Source	Years
Fort Victoria Units	3, 4, 5, 6	O.D.M.	1972 - 75
Fort Victoria Units	7, 8, 9, 10	E.I.B.	1975 - 77
St. Louis - First two	12 MW units	CCCE/FNCB	1976 - 77

CWA has obtained a loan from ADB to finance the Baptiste/Guibies scheme (para. 6.07), and a BADEA loan is expected for the Quatre Soeurs hydroelectric scheme under the conditions described in para. 6.11 above. Transmission and Distribution schemes have usually been financed through borrowings from Government and internal resources.

VII. FINANCIAL CONDITION AND PROSPECTS

Past Performance

7.01 CEB's financial objectives, as stated in the Act, are to maintain tariffs sufficiently high to cover: (i) the cost of production (including depreciation and interest charges); (ii) the amounts needed for the redemption of loans (to the extent that such amounts exceed the provision for depreciation); and (iii) allocations to reserves. 1/ Under a covenant of IBRD loan 355-MAS, CEB is required to earn 8% on its net operating assets, and is bound to consult with IBRD prior to incurring any new long-term debt, if the anticipated debt coverage ratio will be less than 1.5.

1/ The amount was not specified.

7.02 Neither the legislation in Mauritius nor the IBRD loan agreement required CEB to revalue its assets, and so far CEB's management has requested tariff increases predicated on an 8% rate of return on historical costs. Mauritius has experienced, however, considerable inflation between 1970 and 1975 - the General Price Index rose by 78%. Under such circumstances, an 8% rate of return on historical costs means much less in real terms; in March 1976, PCR suggested that, on a replacement cost basis, CEB's assets are understated by 50%, and that a rate of return target of 12% is "not at all excessive".

7.03 At end 1976, CEB undertook a revaluation of assets exercise, by applying the average Cost of Living Index to its assets since 1964. The exercise concluded that CEB's net operating assets were understated by Rs 102 million (US$15.2 million), or 46%. Under such circumstances, an 8% rate of return on the basis of historical costs is equivalent to less than 4% in real terms, or alternatively, an 8% rate of return in real terms would be equivalent to at least 17% on an historical cost basis. Annex 7 shows the methodology used by CEB to revalue its assets.

7.04 CEB's Income Statements during the past three years appear at Annex 8. While in 1973 and 1974, CEB was able to earn about 5% on net operating assets (on the basis of historical costs), it was unable to generate reasonable surpluses to finance its construction program: during those two years, on the average, only 11% of the construction program was self financed. The balance was essentially financed by way of loans and Government grants/soft-loans.

7.05 In 1975, CEB suffered exceptional losses, attributable to cyclone "Gervaise" which hit the island in February. The loss of sales alone has been estimated at 23 GWh, or Rs 7 million (12% of annual sales), to which must be added the cost of rehabilitating the plant. Thus CEB ended 1975 with a net loss of Rs 9.3 million. The Government assisted with a grant of Rs. 2.4 million, an interest free loan of Rs 2.4 million, and rescheduled debt to the extent of Rs 9.6 million (Government has promised to cover entire CFB losses-MR 4.8 million). CEB's construction program in 1975, which was substantially higher than in earlier years (Rs 23.5 million vs Rs 10.1 million and Rs 15.2 million in 1973 and 1974 respectively) was mainly financed by soft-loans and Bank overdrafts (to the extent of Rs 6.7 million or 28% of the construction program). While 1975 cannot be considered as a "normal" year, it highlights the need for CEB to create a reserve against damages caused by cyclones. The reserve should cover the loss of revenues and the rehabilitation of operating plant (see para. 5.09).

7.06 As the Balance Sheets indicate (Annex 9), CEB's year-end financial position deteriorated considerably between 1972 and 1975. The current ratio decreased from 1.5 in 1972 to 0.7 in 1975, while the debt/equity ratio increased from 35:65 to 45:55 in the same period. 1/ CEB's working capital

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1/ The relatively low debt/equity ratio is due to the large amount of grants and soft loans received from Government essentially to finance rural electrification.

went down from Rs. 4.5 million at end 1972 to a negative Rs 10.1 million at end 1975, and was essentially used to meet CEB's current obligations, and to finance construction. As a result, CEB has had increasing liquidity problems during the period under review, and ended 1975 with practically no cash resources and a Bank overdraft of Rs. 12.4 million (US$1.9 million).

7.07 Apart from the cyclone (para. 7.05), the underlying reason for the unsatisfactory performance of the CEB during the 1973-1975 period was that tariff increases in 1974 and 1975 have not been sufficient to cover the rapid increase in operating costs, particularly fuel and labor. For instance, the unit cost of thermal generation more than doubled between 1973 and 1975; 1/ as 1974 and 1975 were dry years, the impact of the increase in fuel prices was even bigger. Labor costs have increased substantially in Mauritius during the past few years; the CEB estimates that the cost of unskilled or semi-skilled (for construction of transmission facilities) about 45% since July 1973, while at the upper echelons the increase has been of the order of 15%. Against this background, tariffs have been increased by about 50% between 1973 and 1975. This increase was clearly insufficient, and tariffs were increased by a further 19% in March 1976.

Financial Prospects

7.08 Financial projections for the period 1977 - 1980, jointly prepared by IBRD and CEB, and their supporting assumptions appear at Annexes 8 - 11. The forecast is based on the tariff introduced in March 1976, and indicates that CEB's financial performance will deteriorate further, unless electricity tariffs are increased. As the target outlined in IBRD Loan 355 MAS is no longer relevant (paras. 7.01 - 7.03), one could select one of the two following financial targets: (i) CEB should finance from internal sources, not less than 30% of its construction program. This would imply that CEB ought to generate during the 3 years 1977 - 1979, a surplus of Rs 103 million (US$15.4 million). This in turn implies extra revenues of the order of Rs 175 million, equivalent to an average 60% tariff increase; or (ii) should earn 8% on its net operating assets on a revalued basis. This implies an average Operating Income of Rs 39.6 million per annum over the next three years, against a Rs 22.1 million deficit in the forecast (after restating depreciation). The increase in average annual revenues should therefore be of Rs 61.7 million, a 60% tariff increase. Thus, both methods indicate that a 60% increase over the existing tariffs is called for.

7.09 CEB increased its tariffs by 30% in June 1977 and intends to increase another 30% in 1978; an immediate 60% tariff increase is considered to be excessive essentially on political grounds. The need for a quick tariff increase is highlighted further by the facts that: (i) the bulk of incremental sales of CEB will have to be met from thermal sources; and (ii) the level of

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1/ CEB is protected through a fuel price escalation charge against an increase in oil prices. However, it is not applicable to the common domestic tariff, which accounts for 40% of total energy sales.

investment in the sector will increase substantially, to the tune of about Rs 110 million per annum, against an average of Rs 14.4 million in the 1970-1975 period. 1/

7.10 While the CEB has aimed in the past to meet the financial covenants embodied in the IBRD Loan (para. 7.01), tariff increases have usually failed to meet the expected targets essentially because of optimistic forecasts of: (i) costs; and (ii) hydroelectric generation. While inflation has been unusually high in Mauritius in recent years (para. 7.02), more realistic assumptions will be needed in the preparation of budgets and financial forecasts. As far as hydroelectric generation is concerned, it has been recommended elsewhere (para. 6.12) that these figures be updated to reflect past experience.

7.11 Under a covenant of Loan 355-MAS, the Bank is to be contacted if CEB is to incur new debt, while its debt coverage ratio has been below 1.5. The Bank has been lenient in authorizing, on the basis of assurances, a borrowing from EIB. The financial performance of CEB in 1976 hardly improved, while prospects for 1977 are slightly better. A less flexible attitude on the Bank's side is called for in the future.

Tariff Structure

7.12 CEB's existing tariffs appear at Annex 12. The domestic tariff, which accounts for 40% of energy sales, is characterized by a declining block energy charge: the first block of 10 kWh is priced at M¢ 80-86 per unit (US¢ 12-13), while all consumption beyond 60 kWh is priced at M¢ 23 per unit (US¢ 3.5). The result is a sharp reduction in the charge per unit, as consumption rises, and thus the tariff is highly promotional. Indeed, the last block (at M¢ 36) hardly covers the price of fuel. CEB's promotional policy works not only through the tariff, but also by encouraging the sale of electrical appliances by keeping their prices low.

7.13 As no additional sources of hydroelectric power or steam units using bagasse are likely to be commissioned before 1980, all the additional demand will have to be met from thermal sources (para. 7.09). In the long-run, since the potential for hydroelectric power is very limited in Mauritius, thermal electricity will represent an increasing proportion of total consumption. Under such circumstances it would be inappropriate to maintain promotional electricity tariffs in Mauritius. A flat domestic tariff, or even increasing blocks, might well represent a structure better geared to the social and economic objectives of the Government. The ultimate structure of the appropriate tariff requires CEB to undertake further study.

1/ This also underlines the fact that in the 1970-75 period, the construction program was insufficient in relation to CEB's future requirements (see also para. 4.06).

7.14 Concerning the commercial, industrial, and irrigation tariffs consideration ought to be given to the introduction of time-of-day tariffs, as well as seasonal tariffs based on long-term marginal costs of supply. 1/ Such tariffs ought to increase load factors of the CEB which is now relatively low (about 50%); they should also reflect the fact that the pattern of supply varies seasonally, and that investments for capacity are essentially needed when the sugar estates are not producing power, and when the availability of hydroelectric power is low.

VIII. RECOMMENDATIONS

8.01 The recommendations listed in this chapter have been discussed in more detail in the body of the report. These are key factors for the efficient operation of the utility, and the successful development of the sector.

CEB's Operations

8.02 It is essential, particularly for industrial consumers, to improve the reliability of supply (para. 4.06). The existing system control center needs improvement in the areas of instrumentation, as well as active and reactive load dispatching and switching techniques. A special training program, on modern load dispatching techniques should be arranged.

8.03 CEB ought to study on merits of insurance coverage of generating plant against major disasters, and to determine whether a commercial insurance is preferable to funded reserve (para. 5.09). In any case, Government should not bear these costs in the future.

8.04 Strict cost control systems should be implemented (para. 5.10).

Planning

8.05 CEB should undertake itself some of the planning now done by consultants which is not very specialized in nature (e.g. Financial Planning, Power Market Surveys) (para. 6.01).

8.06 A Generation Planning Unit should be created within CEB (para. 5.04).

8.07 The following improvements in Generation Planning procedures are called for (para. 6.13):

(i) generation development plans should be based on economic least cost solutions taking into account all possible alternatives;

1/ A time-of-day tariff option now exists for domestic consumers, but few have chosen it as the financial incentive was not sufficient. It also applied to the irrigation tariff, but such sales represent a small proportion of the power market (about 7%).

(ii) the planning figure for firm capacity and average energy of hydroelectric plants should be revised by incorporating the results of recent observation;

(iii) the Government should undertake, on behalf of all water users, a study to determine how the water resources of the island should be allocated to various users including hydro on the basis of economic costs and benefits; and

(iv) in view of the high oil prices, the CEB should study whether methods, (e.g. increasing generating capacity, changing pricing arrangements, giving CEB an increased control over the day-to-day operation of bagasse based generating plants), can be found which are mutually beneficial to CEB and sugar producers, to increase production of electricity from bagasse.

Finance

8.08 CEB should earn 8% on its net operating assets, on a revalued basis (paras. 7.02 - 7.04); or generate from internal funds not less than 30% of its construction program (para. 7.08). Both methods call for a 60% increase over the tariffs implemented in March 1976.

Tariffs

8.09 Declining block tariffs are promotional and should be replaced with tariffs which reflect the long-range incremental costs of supply to various consumer groups (paras. 7.13 - 7.14).

April 4, 1977

MAURITIUS

POWER SECTOR REVIEW

Existing Facilities

1. Generation

1.01 Power is generated by diesel, hydroelectric and thermal (steam) plant, the diesel units being entirely owned by CEB. Two hydroelectric plants and seven steam plants are owned by various sugar estates who sell surplus power to CEB. These sale agreements are reviewed from time to time.

a. Diesel Generation

1.02 Diesel generation is confined to two stations, both close to Port Louis, the capital, Fort Victoria and St. Louis. At end 1976 the total installed capacity was 62.5 MW of which 14.4 MW was at St. Louis and 48 MW at Fort Victoria. Set sizes and manufacturers are as follows:

Sizes of Diesel Plant

Set #	Ft. Victoria	MW	St. Louis	MW
1	Fiat	5.5	Mirless	1.6
2	Fiat	5.5	"	1.6
3	Mirless	6.0	"	1.8
4	"	6.0	"	1.8
5	"	6.0	"	1.9
6	"	6.0	"	1.9
7	"	6.5	"	1.9
8	"	6.5	"	1.9
	TOTAL	48.0	TOTAL	14.4

1.03 All engines burn heavy fuel (1,000 seconds) except St. Louis Nos. 1 and 2 sets. Generation is at 11 kV at Fort Victoria and 6.6 kV at St. Louis. The two stations are interconnected by four 66-kV cables, two of which have recently been uprated from 22 kV to operate at their nominal voltage.

b. Hydroelectric Power

1.04 Hydro potential of the GRSE and GRNW are being used both for irrigation and electric power. The installed hydroelectric capacity at the end of 1976 was 25.74 MW. The size of the sets are as follows:

Size of CEB's Hydroelectric Plant

	Unit Size in MW
Tamarind Falls:	
Nos. 1 and 2	0.5
3 and 4	2.0
5	3.0
Magenta: No. 1	0.94
Reduit: Nos. 1 and 2	0.15
3	0.30
Eau Bleue: Nos. 1 and 2	2.0
Cascade Cecile: No. 1	1.0
La Ferme: No. 1	1.2
Ferney: Nos. 1 and 2	5.0

1.05 Only the Tamarind and Eau Bleue schemes have significant reservoirs capable of supplying power towards the system daily peak demand. The rest of the hydro stations have little firm supply capability, though they do permit economies of diesel fuel. The operation of the existing hydroelectric sets is not, perhaps, as flexible as might be anticipated, since almost all are run-of-the-river stations with minimum storage capacities. The only plant with substantial storage, Tamarind Falls, is required to operate primarily to fit the needs of irrigation.

c. Thermal Generation (steam)

1.06 A number of sugar estates process sugarcane and use considerable quantities of steam in the process. The steam is produced in boilers burning bagasse (the residue from processed sugarcane) and part of the steam is used to generate electric power. Some of the power is sold to CEB at favorable prices (average selling price is about M¢ 8 (US¢ 1.2) per kWh). Although there is a good working relationship between CEB and the estate owners, control of the sugar estates generation does not lie with CEB. Furthermore, should the bagasse ever be used in considerable quantities as a raw material for other products, such as paper and animal food, the amount of power exported from the sugar estates will fall. The generation of electricity at the estates is dependent upon the sugar harvest, so that power is exported only between July and December.

2. Transmission/Distribution System

2.01 For many years, 22 kV was the main transmission system voltage but with the increase in demand in recent years, the 22-kV network is being overlayed with a 66-kV system. Eventually, 66-kV will become the main transmission voltage with the 22-kV networks split and used as radial feeders. The distribution feeders system consists of a 6.6-kV network in the urban and industrial areas but in the rural area distribution is at 22-kV.

a. 66-kV Transmission System

2.02 At present, the only 66-kV feeders in operation are those interconnecting the Fort Victoria and St. Louis power stations and the double circuit overhead line between St. Louis and Wooton Substation. However, it is intended that the overhead lines between St. Louis and Nicolay Road (double circuit), and between Wooton substation and the Ferney hydroelectric station (single circuit), will be uprated from 22-kV to 66-kV, for which they were originally designed. This will provide a main transmission tie between the west and south-west of the island. It is intended to construct a similar link to the north of the island by interconnecting Nicolay Road with F.U.E.L. (a sugar estate), via Belle Vue. All the 66-kV substations are outdoor single bus using 1,500 MVA minimum oil circuit breakers. The system is solidly grounded and the sub-stations continuously manned.

b. 22 kV System

2.03 At present the 22 kV system is the main transmission system throughout the island; it is also used for distribution in rural areas. The back bone of the network is the 22-kV feeders which form a ring around the island; this is strengthened at present by a tie between Wooton and Ferney, currently operated at 22 kV, although insulated for 66 kV.

2.04 Most of the 22 kV feeders have "T" branch connections supplying rural loads; pole mounted automatic reclosing circuit breakers are used on many of these to improve service. The majority of the 22-kV overhead lines are supported on pre-stressed concrete poles manufactured by CEB.

2.05 In general all the 22 kV substations are outdoor using minimum oil circuit breakers rated at 440 MVA. Minor substations and "T" connections are protected by pole mounted fuses. The system is solidly grounded although increasing generating plant may require the use of resistance grounding, especially in the vicinity of St. Louis.

c. 6.6 kV Distribution System

2.06 The 6.6-kV distribution system consists almost entirely of overhead lines using pre-stressed concrete poles made by CEB. The 6.6 kV substations are predominantly of indoor construction using metal clad bulk oil switchgear.

d. System Relay Protection

2.07 Extensive use has been made in the past of inverse definite minimum time over-current and ground fault protection on the feeders throughout the island. However, the overlapping loop connections of the system have led to selectivity difficulties which are being solved by the limited application of distance relays on the important circuits. Under frequency relays have also been applied to some circuits in an effort to maintain important feeders in the event of loss of generating capacity.

3. System Operation

3.01 The 66 kV, 22 kV and 6.6 kV networks are monitored from a "system control center" located at Curepipe utilizing VHF radio network which extends over the whole island. All 66 kV, major 22 kV substations and generating stations are continuously manned and operated by instructions from the control center at Curepipe.

3.02 Voltage control and stability problems are experienced particularly when the hydroelectric or sugar estate generation is in operation. Some hydro machine inertias have been increased by originally designed fly-wheels in an attempt to eliminate these problems. Additionally a 3 MVAR capacitor bank has been installed at St. Louis to improve the system performance. Transient faults on the island are largely due to blown foliage which is rendered conducting by the prevailing damp condition during particular seasons.

MAURITIUS

POWER SECTOR REVIEW

Statistical Data on CEB's Power System

Calendar Year	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
System Capacity											
Hydro Capacity MW	15.74	15.74	15.74	15.74	15.74	25.74	25.74	25.74	25.74	25.74	25.74
Thermal Capacity MW	28.40	28.40	28.40	28.40	28.40	28.40	28.40	28.40	32.81	38.71	50.51
Total CEB	44.14	44.14	44.14	44.14	44.14	44.14	54.14	54.14	58.55	64.45	76.25
Sugar Estates Plants MW	14.20	14.20	15.20	17.20	19.35	19.35	19.65	19.65	15.05	15.05	15.05
Total Country	58.34	58.34	59.34	61.34	63.49	63.49	73.79	73.79	73.60	79.50	91.30
Maximum Demand MW	26.7	29.2	29.9	31.0	31.7	33.1	33.8	39.0	42.9	46.4	53.7
Staff											
Number of Staff Employed	1,318	1,301	1,285	1,242	1,251	1,260	1,283	1,323	1,355	1,485	1,490
Network											
Length of Overhead Lines km	1,650	2,150	2,300	2,381	2,477	2,576	2,677	2,839	3,030	3,191	3,300
Length of Cables km	30	40	48	40	41	69	73	84	92	97	103
Distribution Transformer Capacity MVA	51.1	56.3	59.3	62.2	63.9	66.5	70.0	76.0	89.6	99.7	110.0
Transmission Transformer Capacity MVA	93.7	94.2	95.7	98.7	101.6	116.9	120.2	125.2	205.3	206.7	210.0
Total Transformer Capacity MVA	144.8	150.0	155.0	160.9	165.5	183.4	190.2	201.2	294.9	306.2	320.0

MAURITIUS

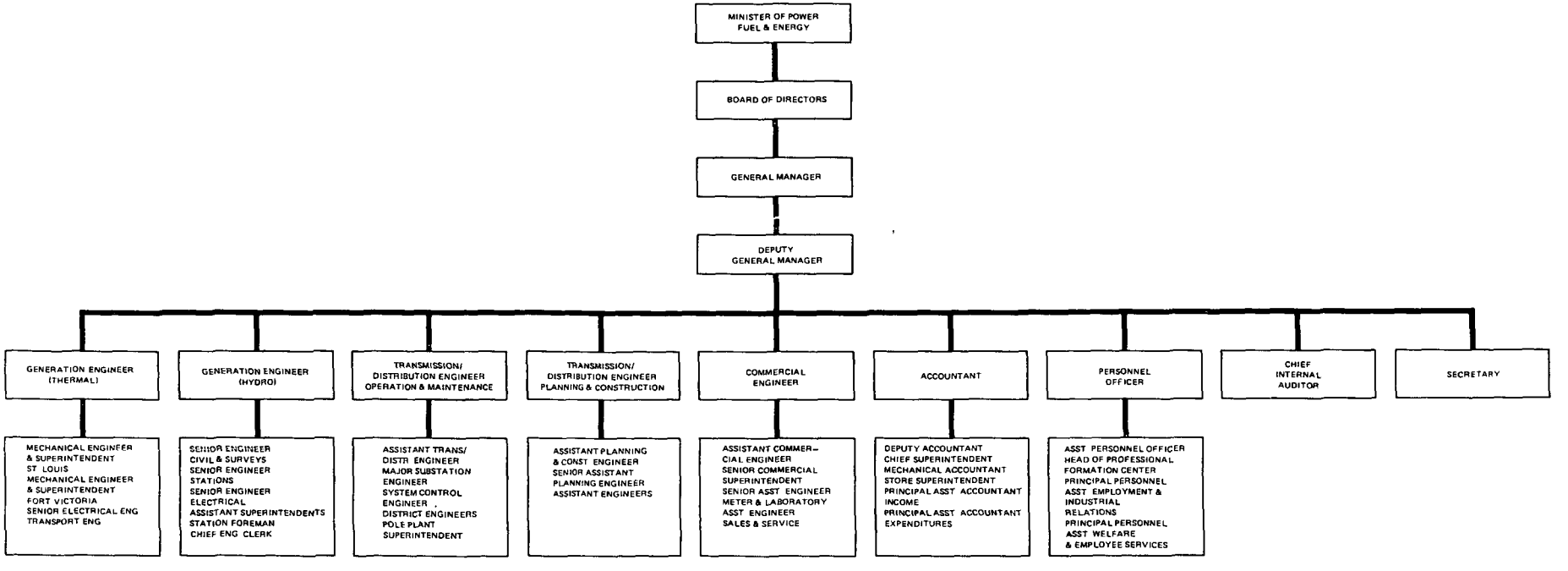
POWER SECTOR REVIEW

Generation and Sales
(GWh)

Generation	1970	1971	1972	1973	1974	1975 1/
Hydro	50.9	50.3	68.1	73.6	40.2	56.2
Thermal	62.8	73.3	72.8	89.1	144.3	151.2
Total CEB	113.7	123.6	140.9	162.7	184.5	207.4
Purchases	22.3	24.7	23.4	24.2	24.1	16.7
Total Generation	136.0	148.3	164.3	186.9	208.6	224.1
Station Losses	2.1	2.6	2.6	2.8	2.9	4.7
Total Sent-out	133.9	145.7	161.7	184.1	204.7	220.1
Network Losses	24.7	25.2	26.5	30.8	35.6	35.6
Total Sales	109.2	120.5	135.2	153.3	173.1	184.5
Sales						
Domestic	45.8	49.4	55.1	61.2	70.0	74.2
Commercial	23.3	26.1	31.6	36.3	40.0	39.8
Industrial	18.8	20.8	24.6	28.5	35.1	44.5
Irrigation	5.5	8.6	7.7	11.4	13.7	13.1
Other	15.8	15.6	16.2	15.9	14.3	12.9
Total	109.2	102.5	135.2	153.3	173.1	184.5
Number of Consumers						
Domestic	82,762	85,948	91,092	97,497	103,905	109,358
Commercial	9,520	9,736	10,044	10,356	10,592	10,692
Industrial (general)	1,458	1,516	1,688	1,899	2,074	2,222
Industrial (iffigation)	46	52	59	71	85	103
Others	124	133	138	146	92	107
Total Consumers	93,910	97,385	103,021	109,969	116,748	122,482
Tariff						
Average Revenue M¢ per kWh	21.64	21.14	20.99	20.77	28.82	31.18
Average Revenue US¢ per kWh	3.33	3.25	2.23	3.19	4.43	4.77

1/ The loss of sales attributed to cyclone Gervaise (February 1975) has been estimated by CEB at 23 GWh.

MAURITIUS
POWER TRANSMISSION PROJECT
CENTRAL ELECTRICITY BOARD
ORGANIZATIONAL STRUCTURE



World Bank – 18013

ANNEX 3

MAURITIUS

POWER SECTOR REVIEW

Projected Sales & Maximum Demand

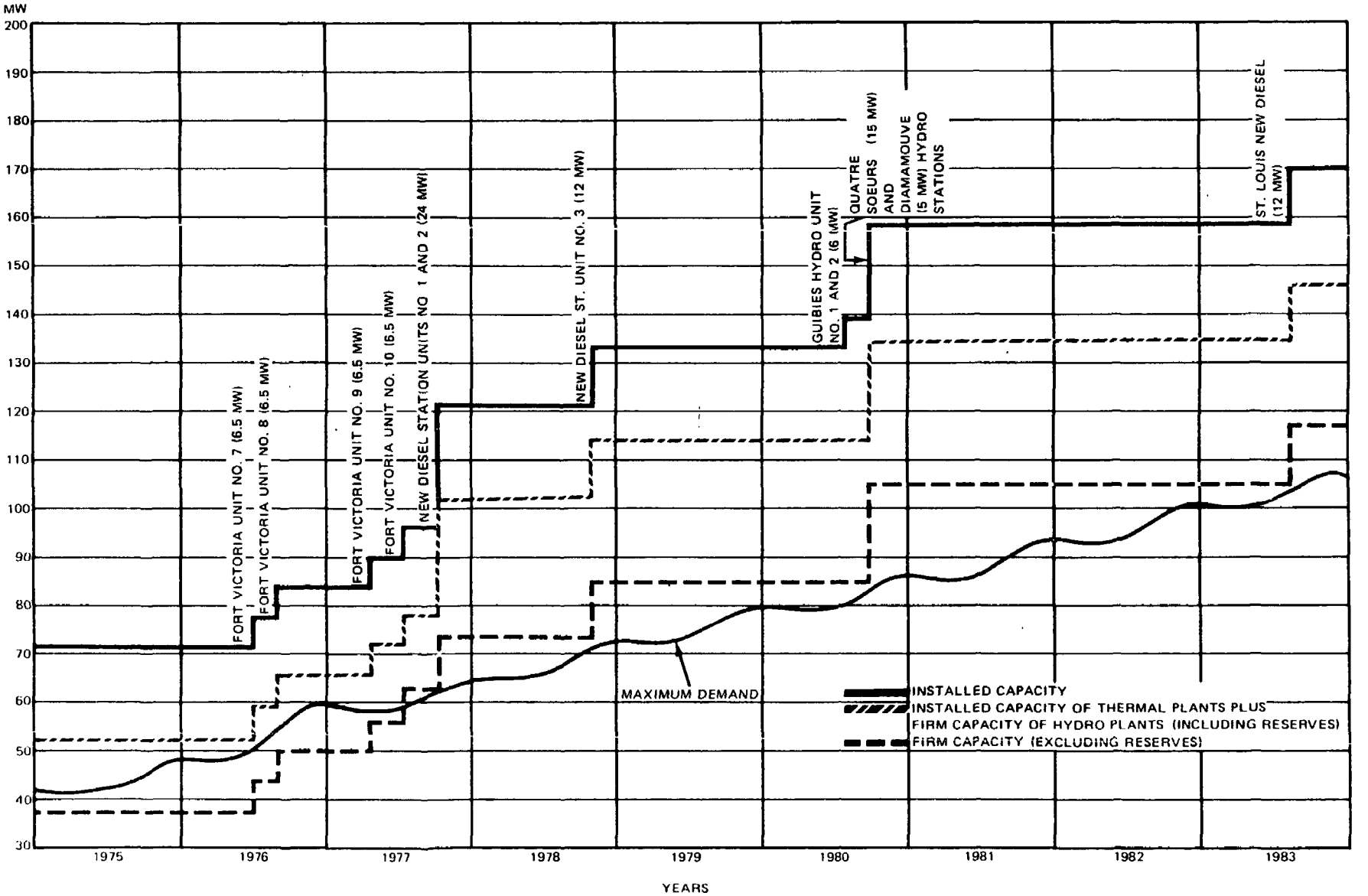
Years	GWh Domestic	Commercial	Industrial General	Industrial Irrigation	HMS 1/ Mauritius	Others	Total	Yearly Growth (%)	Energy Generated GWh	Maximum Demand MW	Load Factor (%)
1977	99.2	52.1	75.0	16.0	7.9	1.0	251.2	11.0	300	66	52
1978	109.1	56.4	84.9	20.5	7.0	1.0	278.9	10.7	332	73	52
1979	119.2	60.9	95.5	25.0	7.0	1.0	308.7	8.6	367	80	52
1980	129.5	65.6	106.8	25.0	7.0	1.2	335.1	8.4	398	87	52
1981	140.7	70.5	119.0	25.0	7.0	1.2	363.4	8.3	430	94	52
1982	152.6	75.8	132.1	25.0	7.0	1.3	393.8	8.1	465	101	52
1983	165.6	81.5	145.2	25.0	7.0	1.4	425.7	8.1	500	109	52

1/ Communications Base.

May 1976

ANNEX 4

MAURITIUS
POWER SECTOR REVIEW
CEB INTERCONNECTED SYSTEM
INSTALLED AND FIRM CAPACITY AND
MAXIMUM DEMAND



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ANNEX 5

MAURITIUS

CENTRAL ELECTRICITY BOARD

CONSTRUCTION PROGRAM
(Rs Millions)

	1976	1977	1978	1979	1980
GENERATION THERMAL					
F. Victoria Sets 7 & 8 Civil Works	-	-	-	-	-
" " " M & E	4.2	-	-	-	-
" " 9 & 10 Civil Works	1.2	-	-	-	-
" " " M & E	9.3	9.3	-	-	-
New Station (At.St.Louis) Civil Works	2.0	3.4	2.8	-	-
" " " " 12 MW Sets No.1 and 2	-	56.6	-	-	-
" " " " 12 MW Sets No. 3	-	-	30.4	-	-
Other Works	0.9	4.0	1.0	0.8	0.7
O/Heads	0.3	0.3	0.4	0.4	0.4
Sub Total	17.9	73.6	34.6	1.2	1.1
GENERATION HYDRO					
Quatre Soeurs & Diamamouve	6.3	20.9	45.9	50.5	37.0
Minor Works	1.0	1.1	1.2	1.3	1.5
O/Heads	0.3	0.3	0.4	0.4	0.4
Sub Total	7.6	22.3	47.5	52.2	38.9
TRANSMISSION					
Lines	6.9	4.7	1.7	1.0	11.0
Substations	2.3	3.3	11.3	1.3	8.8
Sub Total	9.2	8.0	13.0	2.3	19.8
DISTRIBUTION					
Primary	6.2	10.0	10.7	11.0	16.0
Secondary	4.0	6.0	7.3	7.8	9.1
Overhead Charges	1.9	2.1	2.3	2.5	2.8
Sub Total	12.1	18.1	20.3	21.3	27.9
Commercial	3.7	4.1	4.9	5.6	6.3
Non-operational Buildings, Furniture & Equipment	.3	.7	1.0	1.4	2.0
Vehicles	1.3	1.1	1.1	.9	.7
Rodrigues Branch	1.8	.2	.1	.1	.1
System Control	-	6.2	.4	-	-
GRAND TOTAL	53.9	134.3	122.9	85.0	96.8

April 20, 1976

MAURITIUS

CENTRAL ELECTRICITY BOARD

Revaluation of Assets
(Rs Thousands)

	AT HISTORICAL COSTS			Average		AT 1975 PRICES		
	Gross Assets	Depreciation	Net Assets	Cost of Living Index	Conversion Factor	Gross Assets	Depreciation	Net Assets
Fixed Assets as of December 31, 1964	94,605	18,014	76,591	100.3	2.10	198,670	37,830	160,840
Additions during 1965	8,859	4,099	4,760	102.1	2.06	18,250	8,444	9,806
1966	5,922	4,249	1,673	104.7	2.01	11,903	8,541	3,362
1967	5,286	4,721	565	106.6	1.98	10,467	9,348	1,119
1968	3,310	4,889	(1,579)	114.1	1.85	6,124	9,044	(2,920)
1969	2,407	5,059	(2,652)	116.7	1.81	4,356	9,156	(4,800)
1970	2,660	5,175	(2,515)	118.5	1.78	4,734	9,211	(4,477)
1971	20,689	5,532	15,157	118.9	1.77	36,620	9,792	26,828
1972	6,926	5,984	942	125.3	1.68	11,637	10,053	1,584
1973	11,475	6,416	5,059	142.2	1.48	16,982	9,495	7,487
1974	14,811	7,090	7,721	183.6	1.15	17,033	8,154	8,879
1975	20,632	7,924	12,708	210.7	1.00	20,632	7,924	12,708
Total	197,582	79,152	118,430			357,408	136,992	220,416

Source: CEB

September 1976

ANNEX 7

MAURITIUS

CENTRAL ELECTRICITY BOARD

Actual and Forecast Income Statements
(Rs '000)

Year Ending December 31	Actual 1973	Actual 1974	Actual 1975	Estimate 1976	Forecast 1977	Forecast 1978	Forecast 1979	Forecast 1980
Sales (MWh)								
Domestic	61,178	69,987	74,250	89,400	96,000	107,000	119,000	129,000
Commercial	36,294	39,970	39,836	47,900	51,000	58,000	61,000	66,000
Industrial	28,510	35,093	44,472	61,690	71,000	82,000	94,000	106,000
Irrigation	11,352	13,747	13,062	17,700	17,000	19,000	24,000	23,000
Others	15,936	14,301	12,899	7,310	10,000	8,000	6,000	6,000
Total MWh	153,270	173,098	184,519	224,000	245,000	274,000	304,000	330,000
Average Revenue per Unit (cents)								
Domestic	25	29	29	35	36.5	36.5	36.5	36.5
Commercial	21	32	36	42	43.5	43.5	43.5	43.5
Industrial	18	30	33	35	36.8	36.8	36.8	36.8
Irrigation	11	19	22	24	24.5	24.5	24.5	24.5
Others	18	27	29	35	36.0	36.0	36.0	36.0
Average Revenue per Unit	21	29	31	36	37.2	37.2	37.2	37.2
Sales Revenues (Rs '000)								
Domestic	15,048	20,139	21,690	31,290	35,040	39,055	43,435	47,085
Commercial	7,626	12,870	14,490	20,118	22,185	25,230	26,535	28,710
Industrial	5,040	10,383	14,477	21,592	26,128	30,176	34,592	39,008
Irrigation	1,260	2,653	2,864	4,008	4,165	4,655	5,880	5,635
Others	2,866	3,848	3,687	2,992	3,600	2,880	2,160	2,160
Total Sales	31,840	49,893	57,208	80,000	91,118	101,996	112,602	122,598
Cyclone Grant			2,400					
Other Operating Income	700	759	780	800	848	895	925	955
Total Revenues	32,540	50,652	60,388	80,800	91,966	102,891	113,527	123,553
Operating Expenses								
Generation	10,179	23,776	30,890	41,700	51,925	66,302	83,640	102,437
Purchases	909	908	1,135	1,900	1,920	1,920	1,920	1,920
Transmission & Distr.	3,729	4,830	5,155	6,400	7,168	8,028	8,992	10,071
Administrative Expen.	6,509	8,531	17,029	12,900	14,448	16,182	18,124	20,298
Depreciation	6,646	7,363	8,190	9,200	11,885	18,131	20,590	22,538
Total Oper. Exp.	27,972	45,408	62,399	72,100	87,346	110,563	133,266	157,264
Operating Income	4,568	5,244	(2,011)	8,700	4,620	(7,672)	(19,739)	(33,711)
Non-Operating Income								
Interest Charges	6,139	6,806	8,354	10,000	17,655	28,302	38,106	48,705
Less: Interest Capitalized	320	200	354	300	3,100	8,036	11,892	15,392
Interest Charged In the Year	5,819	6,606	8,000	9,700	14,555	20,266	26,214	33,313
Net Income	(244)	(449)	(9,257)	(300)	(9,165)	(27,091)	(45,021)	(65,999)
Ave. Net Assets in Operation	96,246	102,688	113,660	139,405	186,787	273,229	337,919	363,555
Rate of Return	4.7%	5.1%	(1.8%)	6.2%	2.5%	(2.8%)	(5.8%)	(9.3%)

April 20, 1976

MAURITIUS

CENTRAL ELECTRICITY BOARD

Actual and Forecast Balance Sheets
(Rs '000)

December 31	Actual 1972	1973	1974	1975	Estimate 1976	Forecast 1977	1978	1979	1980
ASSETS									
Fixed Assets									
Plant in Service	151,429	163,154	178,321	200,651	247,201	316,501	450,101	484,601	544,401
Less: Accumulated Depreciation	57,722	64,368	71,731	79,921	89,121	101,006	119,137	139,727	162,265
Net Plant in Service	93,707	98,786	106,590	120,730	158,080	215,495	330,964	344,874	382,136
Work in Progress	11,854	10,268	10,330	11,450	18,800	83,800	73,100	123,600	160,600
Total Fixed Assets	105,561	109,054	116,920	132,180	176,880	299,295	404,064	468,474	542,736
Loans	1,737	1,637	1,562	1,397	1,232	1,067	902	737	572
Current Assets									
Cash	5	23	7	14	800	880	968	1,065	1,171
Accounts Receivable	5,821	7,432	9,877	11,442	16,000	18,393	20,578	22,705	24,711
Materials and Supplies	7,945	7,581	13,411	15,669	17,549	19,655	22,014	24,655	27,614
Other Current Assets	274	-	-	-	-	-	-	-	-
Total Current Assets	14,045	15,036	23,295	27,125	34,349	38,928	43,560	48,425	53,496
TOTAL ASSETS	121,343	125,727	141,777	160,702	212,461	339,290	448,526	517,636	596,804
EQUITY AND LIABILITIES									
Equity									
Government Grants/Soft Loans	50,338	49,405	48,274	47,671	48,911	47,830	46,683	45,147	43,621
Retained Earnings/Reserves	20,313	20,069	19,620	10,363	10,063	898	(26,193)	(71,214)	(137,213)
Contributions	-	1,286	2,466	2,466	5,234	6,442	7,607	8,852	10,181
Total Equity	70,651	70,760	70,360	60,500	64,208	55,170	28,097	(17,215)	(83,411)
Soft Loans									
Government									
Cyclone	3,540	3,127	2,714	470	4,288	3,875	3,462	2,809	2,156
Consolidation	-	-	-	9,600	9,600	9,600	9,504	9,408	9,312
Total Soft Loans	3,540	3,127	2,714	10,070	13,888	13,475	12,966	12,217	11,468
Long-Term Debt									
New Borrowings	-	-	-	-	39,000	175,100	311,200	427,300	578,400
IBRD	23,881	22,248	20,519	18,696	16,777	14,763	12,606	10,354	7,959
Government	2,250	3,731	3,809	4,159	4,943	5,710	7,069	7,860	9,075
ODA	4,592	4,868	11,844	15,098	15,952	15,257	14,512	13,712	12,855
EIB	-	-	-	-	13,400	13,400	12,842	11,725	10,608
Others	6,844	6,080	9,106	10,699	8,244	7,030	6,306	5,626	4,894
Total Long-Term Debt	37,567	36,927	45,278	48,652	98,316	231,260	364,535	476,577	623,791
Current Liabilities									
Accounts Payable	7,009	9,359	17,571	24,722	35,882	39,218	42,761	45,890	44,789
Bank Overdrafts	2,410	5,386	5,687	12,360	-	-	-	-	-
Others	166	168	167	167	167	167	167	167	167
Total Current Liabilities	9,585	14,913	23,425	37,249	36,049	39,385	42,928	46,057	44,956
TOTAL EQUITY & LIABILITIES	121,343	125,727	141,777	160,702	212,461	339,290	448,526	517,636	596,804

April 20, 1976

MAURITIUS

CENTRAL ELECTRICITY BOARD

Actual and Forecast Sources and Applications of Funds
(Rs '000)

Years Ending December 31	Actual 1973	Actual 1974	Actual 1975	Estimate 1976	Forecast 1977	Forecast 1978	Forecast 1979	Forecast 1980	Four Years Summary 1977 - 1980
Internal Sources of Funds									
Operating Income	4,568	5,244	(2,011)	8,700	4,620	(7,672)	(19,739)	(33,711)	(56,502)
Depreciation	6,646	7,363	8,190	9,200	11,885	18,131	20,590	22,538	73,144
	11,214	12,607	6,179	17,900	16,505	10,459	851	(11,173)	16,642
Deductions									
Increase in Working Capital other than Cash	(1,379)	64	(3,328)	(4,722)	1,163	1,001	1,639	6,066	9,869
Interest Charged to Operations	5,819	6,606	8,000	9,700	14,555	20,266	26,214	33,313	94,348
Principal Payments	4,924	5,143	5,118	8,191	11,546	12,167	13,423	13,989	51,125
Loans Repayments	(100)	(75)	(165)	(165)	(165)	(165)	(165)	(165)	(660)
	9,264	11,738	9,625	13,004	27,099	33,269	41,111	53,203	154,682
Balance of Funds Available for Investment	1,950	869	(3,446)	4,896	(10,594)	(22,810)	(40,260)	(64,376)	(138,040)
Construction Program	10,139	15,229	23,450	53,900	134,300	122,900	85,000	96,800	439,000
Balance to be Financed	8,189	14,360	26,896	49,004	144,894	145,710	125,260	161,176	577,040
Financed by:									
Contributions	1,286	1,180	-	2,768	1,208	1,165	1,245	1,329	4,947
Govt. Grants/Rural Elec.	736	602	1,150	3,000	900	900	600	700	3,100
Special Cyclone Soft Loan	-	-	9,600	-	-	-	-	-	-
Long-Term Borrowings:									
Government	1,590	248	350	1,120	1,150	1,850	1,400	2,000	6,400
Cyclone Soft Loan	-	-	2,400	-	-	-	-	-	-
ODA	276	6,976	3,254	1,502	-	-	-	-	-
EIB	-	-	-	13,400	-	-	-	-	-
Other	336	4,124	2,722	660	946	1,036	1,180	1,228	4,390
Non-Operating Income	1,007	913	754	700	770	847	932	1,025	3,574
Bank Overdrafts	2,976	301	6,673	(12,360)	-	-	-	-	-
New Loans	-	-	-	39,000	140,000	140,000	120,000	155,000	555,000
TOTAL	8,207	14,344	26,903	49,790	144,974	145,798	125,357	161,282	577,411
Cash Increase/Decrease	18	(16)	7	786	80	88	97	106	371

April 20, 1976

MAURITIUS

POWER SECTOR MEMORANDUM

Assumptions to the Financial Projections

1. Income Statement

1.01 The GWh sales forecast is based on the 1975 PCR report. Average revenue per unit for each category of consumers were based on the new tariff of March 1976. The forecast does not assume a tariff increase until 1980.

1.02 The cost of generation was based on the following plant/load forecast 1/ (GWh):

Source	1976	1977	1978	1979	1980
Hydro	73	73	73	73	73
Thermal	172	196	229	264	295
Purchases	24	24	24	24	24
Total	269	293	326	361	392

The cost of thermal generation is expected to average Rs 0.23 per unit in 1976 (including fuel and labor), and was assumed to increase by 10% per annum thereafter. The cost of hydroelectric production was taken at Rs 2.125 million in 1976 (CEB budget) and was assumed to increase by 10% per annum thereafter. The cost of purchases was assumed to remain Rs 0.08 per unit throughout the forecast period, since the CEB has long-term contracts with the sugar estates.

1.03 The 1976 figures for Transmission and Distribution, and Administrative Expenses were obtained from the budget; both items were assumed to increase by 12% per annum thereafter.

1.04 The CEB depreciates its assets along the following lines:

Thermal Assets:	20 years
Hydroelectric Assets:	50 years
Transmission/Distribution Assets:	50 years
Other Assets:	10 - 15 years

The depreciation schedule appears at page 4 of this Annex.

1.05 A detaile schedule of interests repayment on the existing loans was prepared by the CEB. New borrowings were assumed to be at 8%, and amortized over 10 years.

1/ System losses are assumed to represent 16 - 17% of generation and purchases.

Balance Sheets

2.01 CEB's construction program appears at Annex 6. Gross assets and accumulated depreciation are stated at historical costs.

2.02 CEB's cash requirements were estimated at two weeks of total payroll.

2.03 Accounts receivable were estimated to remain equivalent to 47 days of sales, plus a provision for CEB's loans to its own staff.

2.04 Materials and supplies were assumed to increase by 12% per annum.

2.05 Government Grants/soft loans are made essential for rural electrification. These loans carry an interest rate of 2% during the first five years, and 4% for the subsequent thirty-five years. Principal repayment amount to 1% per annum of the original loan during forty years, so that these loans contain a substantial grant element.

2.06 Both for Cyclones Carol (1960) and Gervaise (1975), the CEB has obtained from the Government interest-free loans as well as grants. The Gervaise grant/loan amounts to Rs 4.8 million (US$0.7 million), and the loan is repayable over 10 years including a 3-year grace period.

2.07 The CEB has obtained "industrial loans" from the Government; these at present carry a 7% interest rate, and are repayable over 10 years. These are geared to finance financially viable projects.

2.08 The IBRD loan (Loan 355-MAU) was made in 1963 to finance the first two 6-MW units at Fort Victoria and transmission lines. It carried an interest rate of 5-1/4%, and will be fully repaid in 1983. The outstanding amount of the loan is shown on CEB's books at the historical exchange rates, and at present exchange rates, is understated by approximately 50% (this is because of the devaluation of the Rs in terms of the currencies of disbursement). The exchange loss is carried annually in the P&L Account.

2.09 The CEB obtained two loans from ODM in 1972 and 1974, totalling £Stg. 1.25 million carrying interest rates of 7-1/4% and 8-1/2% respectively, to finance four 6-MW units at Fort Victoria. The Government is carrying the foreign exchange risk on these loans.

2.10 In 1975, and 1976 CEB obtained two loans from EIB at 9-7/8% to finance four 6-MW sets at Fort Victoria. The two loans amount to Units of Accounts 4.00 million, and are repayable over 15 years, including a 3-year grace period. In 1976, CEB borrowed also US$3.3 million from CCCE, and US$2.2 million from FNCB for two 12-MW diesel units for the St. Louis Power Station; the respective terms of these loans are 6% over 12 years, and 7.2% over 5 years.

2.11 The CEB has obtained various other loans from local pension funds and Bank carrying interest rates of 7 - 9% as well as consumer advances, which are usually interest free except for those of the sugar estates (8%).

MAURITIUS

CENTRAL ELECTRICITY BOARD

DEPRECIATION SCHEDULE

(Rs million)

PARTICULARS		1977	1978	1979	1980
Assets in operation as at 31.12.76		10.472	10,735	10,735	10,735
Additions in 1977					
Generation Thermal	73.6	.425	3.680	3.680	3.680
Hydro	22.3	.014	.028	.028	.028
Transmission & Distribution	26.1	.522	1.044	1.044	1.044
Commercial	4.1	.135	.270	.270	.270
System Control	6.2	.310	.620	.620	.620
Non Operational	0.7	.007	.014	.014	.014
Rodrigues	0.2				
Vehicles	1.1				
	134.3				
Additions in 1978					
Generation Thermal	34.6		.865	1.730	1.730
" Hydro	47.5		.016	.032	.032
Transmission & Distribution	33.3		.666	1.332	1.332
Commercial	4.9		.163	.326	.326
System Control	.4		.020	.040	.040
Non Operational	1.0		.010	.020	.020
Rodrigues	.1		-	-	-
Vehicles	1.1		-	-	-
	122.9				
Additions in 1979					
Generation Thermal	1.2			.030	.060
" Hydro	52.2			.017	.034
Transmission & Distribution	23.6			.472	.944
Commercial	5.6			.186	.372
Non Operational	1.4			.014	.028
Vehicles	0.9			-	-
Rodrigues	0.1			-	-
	85.0				
Additions in 1980					
Generation Thermal	1.1				.027
" Hydro	38.9				.019
Transmission & Distribution	47.7				.954
Commercial	6.3				.209
Non Operational	2.0				.020
Vehicles	0.7				-
Rodrigues	0.1				-
	96.8	11.885	18.131	20.590	22.538

April 20, 1976

MAURITIUS

CENTRAL ELECTRICITY BOARD

March 1976 Tariffs

Domestic Block Type Tariff

Tariffs 110, 120, 130, 140

Initial 10 kilowatt hour units per month to be at the rate of	80	cents per unit
Next 20 kilowatt " " " " " "	38	" " "
Next 30 kilowatt " " " " " "	31	" " "
All additional units	23	" " "

Monthly Minimum Charges shall be:

For a total connected load:

of 300 watts or less	Tariff 110	Rs 4.00
of 301 to 3,000 watts incl.	Tariff 120	12.50
of 3,001 to 10,000 " "	Tariff 130	19.00
in excess of 10,000 watts	Tariff 140	30.00

Tariff 150 (Domestic Day Block Type and Night Tariffs)

Day Tariff: Between 07.00 hours and 21.00 hours

Initial 10 kilowatt hour units per month to be at the rate of	86	cents per unit
Next 20 kilowatt " " " "	46	" " "
Next 30 kilowatt " " " "	31	" " "
All additional units	23	" " "

Night Tariff: Between 21.00 hours and 07.00 hours

All kilowatt hour units to be at the flat rate of 21 cents per unit.

MONTHLY MINIMUM CHARGE

The Monthly Minimum Charge shall be Rs 25.00

Fuel Cost Adjustment Clause

The Night kWh rate of 21 cents in Tariff 150 would be subject to a Fuel Cost Adjustment Clause as set out below:

> "For every 5.0 cents variation in the price paid by the Board for its heavy oil fuel above or below Rs 2.86 per Imperial Gallon, the rate in respect of the above tariff shall be varied by an amount of 0.3933 cents x R, where R is the ratio of kWh generated by the Board's Thermal Stations to the total kWh generated and purchased by the Board in the calendar month preceding that in which the account is submitted".

SCHEDULE I

COMMERCIAL CONSUMERS

Tariff 210 - Flat Rate Tariff

Tariff available to Commercial Consumers

Running Charge	... ...	51 cents per kWh
Minimum Charge	... ...	Rs 8.00 per month per kilowatt or fraction thereof of the total connected load subject to a minimum of Rs. 8.00 per month.

Tariff 211 - Maximum Demand Tariff

Tariff available to Commercial Consumers whose total connected load exceeds 15 kW:

Demand Charge	... ...	Rs 22.00 per KVA of Maximum Demand subject to a minimum of 15 KVA, together with a
Running Charge	... ...	28 cents per kWh
Minimum Charge	... ...	A sum equal to the highest demand charge paid in any one of the preceding six months of account.

INDUSTRIAL CONSUMERS

Tariff 310 - Flat Rate Tariff

Tariff available to all Industrial Consumers

Running Charge	... ...	48.5 cents per kWh
Minimum Charge	... ...	Rs 10.50 per month per kilowatt or fraction thereof of the total connected load, subject to a minimum of Rs 10.50 per month.

Tariff 311 - Maximum Demand Tariff

Tariff available to industrial consumers whose total connected load exceeds 15 kW:

Demand Charge	...	...	...	Rs 18.50 per KVA of Maximum Demand, subject to a minimum of 15 KVA, together with a
Running Charge	...	...	...	26 cents per kWh
Minimum Charge	...	...	...	A sum equal to the highest demand charge paid in any one of the preceding six months of account.

SCHEDULE II

BULK CONSUMERS

Tariff 410

Demand Charge	...	...	...	Rs 22.00 per KVA of Maximum Demand, together with a
Running Charge	...	...	...	28 cents per kWh
Minimum Charge	...	...	...	A sum equal to the highest demand charge paid in any one of the preceding six months of account or Rupees 310 whichever is the greater.

SCHEDULE III

Tariff 411 - Industrial Consumers on a restricted hour supply

Running Charge	...	...	...	46 cents per kWh

INDUSTRIAL CONSUMERS BLOCK TARIFF

Tariff 412

Tariff applicable to sugar factories which require standby supply for starting the factory and for emergency supply, during the crop season.

Initial 20,000 kWh per month at	45 cents per kWh
Next 20,000 " " " "	35 cents " "
All additional units per month at	30 " " "

Minimum Charge - For a month or fraction thereof.

For up to and including 500 KVA standby	Rs 450
For 501 to 1000 KVA standby	Rs 750
For 1001 to 1500 KVA standby	Rs 1,150
For 1501 to 2500 KVA standby	Rs 1,500

The KVA for minimum monthly charge will be based on the installed capacity of the import transformers. The supply above 2,500 KVA would be subject to a separate agreement with the Board.

Period of Agreement

The period covered by this tariff is from 1st June to 31st December of each year.

SCHEDULE IV

TARIFF APPLICABLE TO TOWN AND CITY COUNCILS AND VILLAGE COUNCILS FOR STREET LIGHTING PURPOSE

Tariff 510

Unmetered Flat Charge	35.5 cents per kWh, based on the number of hours of use and the total wattage of the lamps installed.
Minimum Charge (Applicable after a cyclone or drought)	Based on the wattage of lamps connected, or 25% of the amount paid during the month preceding the cyclone or drought, whichever, is the highest.

SCHEDULE V

PUMPING FOR OVERHEAD - IRRIGATION

Tariff 511

For electricity supply available 21-1/2 hours per day.
Not available for 2-1/2 hours during the evening peak.
First 50 kWh per month per kilowatt installed at 37 cents/kWh
Next 50 kWh per month per kilowatt installed at 25 cents/kWh
All additional kWh at 23 cents per kWh.

Maximum Average Price per kWh

The Maximum average price per kWh payable by consumers on this tariff in any one month of account shall not in any case exceed 28.5 cents provided pumping under full load exceeds 200 hours/month.

Cost of kWh on Peak Hours (evening)

Any kWh consumed during peak hours will be recorded separately and will be charged for at a flat rate of 62 cents per kWh.

Period of Agreement

All consumers on Tariff 511 will by contract remain on this Tariff for a period of not less than one year.

Peak Hours

The peak hours applicable for this tariff are as follows:

Winter Period	-	1st April to 30th September 5:30 p.m. to 8.00 p.m.
Summer Period	-	1st October to 31st March 6.00 p.m. to 8.30 p.m.

FLAT TARIFF 512 FOR PUMPING FOR ANY PURPOSE

Tariff 512	:	For electricity supply available 21-1/2 hours per day. Not available for 2-1/2 hours during the evening peak.
Running Charge	:	29 cents per unit.

Cost of kWh on Peak Hours (evening)

Any kWh consumed during peak hours will be recorded separately and will be charged for at a Flat Rate of 62 cents per kWh.

Period of Agreement

All consumers on Tariff 512 will by contract remain on this Tariff for a period of not less than one year.

Minimum Charge: Not applicable.

Peak Hours

The peak hours applicable for this tariff are as follows:

Winter Period	-	1st April to 30th September 5:30 p.m. to 8.00 p.m.
Summer Period	-	1st October to 31st March 6.00 p.m. to 8.30 p.m.

SCHEDULE VI

Tariff 610

Tariff applicable to Temporary supply (unmetered consumption) for:

(i) Decorative Lighting
(ii) Illuminations of Streets
(iii) Power for Public Address System
(iv) Other similar purposes

1. (a) Cost : 62 cents per unit
   (b) The consumption shall be calculated as follows:
   Connected load in kW x number of hours per day
   x number of days.

2. Connection and disconnection fees (including labor and transport) Rs. 20.- for each service.

3. In cases where requests for temporary supply are received from applicants whose premises are not connected to the network, it will be for the applicant to provide the material.

4. All charges calculated in accordance with paragraphs 1 and 2 shall be paid in advance.

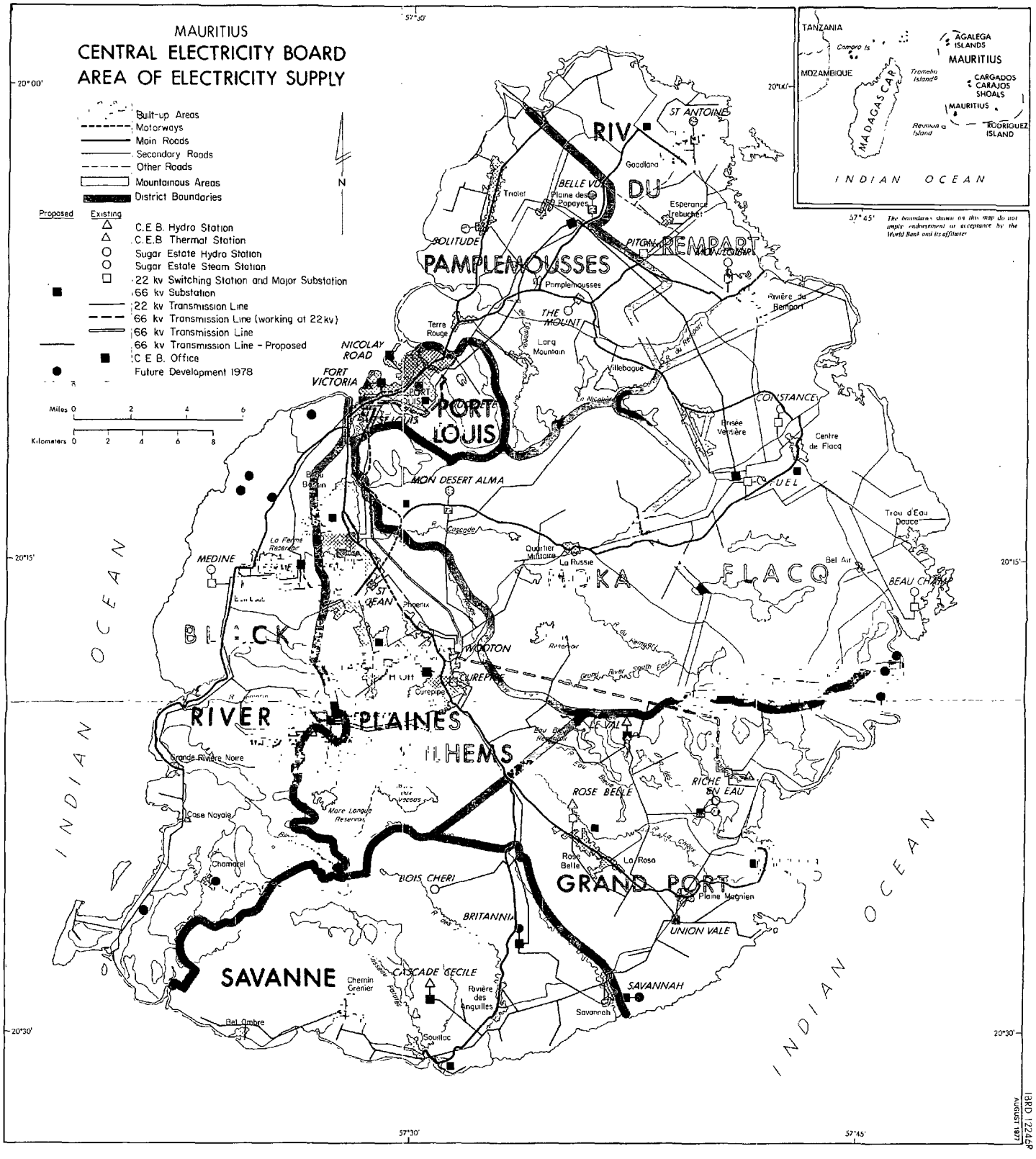
SCHEDULE VII

Full Cost Adjustment Clause

The kWh rates in the above tariffs would be subject to a Fuel Cost Adjustment Clause as set out below:

"For every 5.0 cents variation in the price paid by the Board for its heavy oil fuel above or below Rs 2.86 per Imperial Gallon, the rates in respect of the tariffs below shall be varied by an amount of 0.3933 cents x R, where R is the ratio of kWh generated by the Board's Thermal Stations to the total kWh generated and purchased by the Board in the calendar month preceding that in which the account is submitted".

Tariff 211	The kWh rate of 28 cts/kWh
Tariff 311	The kWh rate of 26 cts/kWh
Tariff 412	The kWh rate of the 3rd Block of 30 cts/kWh
Tariff 511	The kWh rate of the 2nd Block of 25 cts/kWh and the kWh rate of the 3rd Block of 23 cts/kWh.


MAURITIUS
CENTRAL ELECTRICITY BOARD
AREA OF ELECTRICITY SUPPLY
Built-up Areas
Motorways
Main Roads
Secondary Roads
Other Roads
Mountainous Areas
District Boundaries
Proposed
Existing
C.E.B. Hydro Station
C.E.B Thermal Station
Sugar Estate Hydro Station
Sugar Estate Steam Station
22 kv Switching Station and Major Substation
66 kv Substation
22 kv Transmission Line
66 kv Transmission Line (working at 22kv)
66 kv Transmission Line
66 kv Transmission Line - Proposed
C E B. Office
Future Development 1978
Miles 0 2 4 6
Kilometers 0 2 4 6 8
N
TANZANIA
Comoro Is
MOZAMBIQUE
MADAGASCAR
AGALEGA ISLANDS
MAURITIUS
Tromelin Island
CARGADOS CARAJOS SHOALS
MAURITIUS
Reunion Island
RODRIGUEZ ISLAND
INDIAN OCEAN
The boundaries shown on this map do not imply endorsement or acceptance by the World Bank and its affiliates
57°30'
57°45'
20°00'
20°15'
20°30'
RIV
DU
REMPART
ST ANTOINES
Goodland
Esperance Trebuchet
BELLE VUE
Plaine des Papayes
Triolet
BOLITUDE
PITON
MOUNT PLAISANT
PAMPLEMOUSSES
Pamplemousses
THE MOUNT
Larg Mountain
Terre Rouge
NICOLAY ROAD
FORT VICTORIA
PORT LOUIS
Villebague
Rivière du Rempart
CONSTANCE
Brisée Verdière
Centre de Flacq
FLACQ
Trou d'Eau Douce
Bel Air
BEAU CHAMP
MON DESERT ALMA
Quartier Militaire
La Russie
MEDINE
La Ferme Reservoir
ST JEAN
Phoenix
WOODTON
Curepipe
BLACK
RIVER
PLAINES
WILHEMS
Grande Rivière Noire
Case Noyale
Mare Longue Reservoir
Chamarel
BLOIS CHERI
BRITANNIA
ROSE BELLE
RICHE EN EAU
Rose Belle
La Rosa
GRAND PORT
Plaine Magnien
UNION VALE
SAVANNE
Chemin Grenier
CASCADE CECILE
Rivière des Anguilles
SAVANNAH
Savannah
Souillac
Bel Ombre
INDIAN OCEAN
IBRD 12246R
AUGUST 1977