◆ Chapter 8 Tech-Economic Assessment of Important Issue in Energy Sectro ◆

Chapter 8 Tech-Economic Assessment of Important Issues in Energy Sector

8.1 Comparison of Electricity Generation System

Figure 8.1.1 shows the comparison of generation costs among 4 types of power generation (Diesel, GT, CCGT and Coal) as compiled by ESMAP, by Kennedy & Donkin, and by JICA study team. It is noted, that the data by the JICA team was compiled with the data of Southeast Asian and other developing countries taken into account.

The ESMAP data are hard to use for comparison as they only have one point per item. The Kennedy & Donkin data are, however, seen to show almost the same trend as that of the JICA study team data.

On the basis of these generation cost figures, the power generation costs for various types of power generation are shown in Tables 8.1.1 through 8.1.4, with the utilization rate taken as the variables. It is noted, that these data are compiled for 1995(just fuel price are based on Dec.21,1996. refer to Table 8.1.5), and the fuels for the GTs and the CCGTs are compared for both kerosene and gasoil.
Figure 8.1.2-3 show screening curves for these types of power generation.

From these diagrams, it is seen that GTs are appropriate for the peak demand response, and CCGTs are appropriate for the intermediate load, with diesels being appropriate for the base load.
The reasons are as follows,

(1) When CCGTs are employed, GTs will be installed on the power system in advance for peak demand. These GTs will be usable later with only the additional installation of Sts. This provides a greater certainty of securing power supply sources.
(2) For the above reason also, facility delivery time and construction time would be shortened when CCGTs are employed.
(3) When the maintenance work is compared, CCGTs are more convenient than diesels.

From now on, in planning the power development schemes for the next 30 years, the JICA study team will employ CCGTs for supply to the intermediate load and for the base load up to 2020 and Coal-Fired thermal for the base load after 2021.

Table 8.1.1 COMPARISON OF GENERATION COST OF GT

Item	Unit	Financial						Ecconomic					
Plant Type		GT	GT	GT	GT	GT	GT	GT	GT	GT	GT	GT	GT
Fuel		kerosene	kerosene	kerosene	Gasoil	Gasoil	Gasoil	kerosene	kerosene	kerosene	Gasoil	Gasoil	Gasoil
Unit Capacity	MW	30	50	75	30	50	75	30	50	75	30	50	75
Number of Unit		1	1	1	1	1	1	1	1	1	1	1	1
Annual Plant Factor	%	90	90	90	90	90	90	90	90	90	90	90	90
Annual Energy	GWh	237	394	591	237	394	591	237	394	591	237	394	591
Service Life	Years	20	20	20	20	20	20	20	20	20	20	20	20
Scheduled Outage Ratio	%	12	12	12	12	12	12	12	12	12	12	12	12
Forced Outage Ratio	%	4	4	4	4	4	4	4	4	4	4	4	4
Construction Cost	US$/kW	520	480	450	520	480	450	520	480	450	520	480	450
Discount Rate	%	12	12	12	12	12	12	12	12	12	12	12	12
Capital Recovery		0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142
Capital Cost	US$/kW	73.84	68.16	63.90	73.84	68.16	63.90	73.84	68.16	63.90	73.84	68.16	63.90
O/M Annual Fixed Cost	US$/kW	5.30	3.84	3.15	5.30	3.84	3.15	5.30	3.84	3.15	5.30	3.84	3.15
Fixed Cost Total	US$/kW	79.14	72.00	67.05	79.14	72.00	67.05	79.14	72.00	67.05	79.14	72.00	67.05
	US$/kWh	0.010	0.009	0.009	0.010	0.009	0.009	0.010	0.009	0.009	0.010	0.009	0.009
Fuel Caloric Rate	kcal/kg	10,366	10,366	10,366	10,366	10,366	10,366	10,366	10,366	10,366	10,366	10,366	10,366
Fuel Heat Rate	kcal/kWh	2,914	2,818	2,532	2,914	2,818	2,532	2,914	2,818	2,532	2,914	2,818	2,532
Fuel Price	US$/kg	0.3211	0.3211	0.3211	0.4357	0.4357	0.4357	0.254	0.254	0.254	0.2659	0.2659	0.2659
Unit Fuel Cost	US$/kWh	0.090	0.087	0.078	0.122	0.118	0.106	0.071	0.069	0.062	0.075	0.072	0.065
Variable O/M Cost	US$/kWh	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Variable Cost Total	US$/kWh	0.092	0.089	0.080	0.124	0.120	0.108	0.073	0.071	0.064	0.076	0.074	0.066
Total Cost	US$/kWh	0.102	0.098	0.088	0.134	0.129	0.116	0.083	0.080	0.072	0.086	0.083	0.075
Operating Hours													
1000	US$/kWh	0.1711	0.1609	0.1470	0.2033	0.1921	0.1750	0.1522	0.1427	0.1306	0.1555	0.1459	0.1335
3000	US$/kWh	0.1183	0.1129	0.1023	0.1505	0.1441	0.1303	0.0994	0.0947	0.0859	0.1028	0.0979	0.0888
5000	US$/kWh	0.1077	0.1033	0.0933	0.1400	0.1345	0.1213	0.0889	0.0851	0.0769	0.0922	0.0883	0.0799
7000	US$/kWh	0.1032	0.0992	0.0895	0.1354	0.1303	0.1175	0.0844	0.0809	0.0731	0.0877	0.0842	0.0760
8000	US$/kWh	0.1018	0.0979	0.0883	0.1340	0.1291	0.1163	0.0829	0.0797	0.0719	0.0863	0.0829	0.0748
8760	US$/kWh	0.1009	0.0971	0.0876	0.1332	0.1283	0.1156	0.0821	0.0789	0.0712	0.0854	0.0821	0.0741

Table 8.1.2 COMPARISON OF GENERATION COST OF CCGT

Item	Unit	Financial						Ecconomic					
Plant Type		CCGT	CCGT	CCGT	CCGT	CCGT	CCGT	CCGT	CCGT	CCGT	CCGT	CCGT	CCGT
Fuel		kerosene	kerosene	kerosene	Gasoil	Gasoil	Gasoil	kerosene	kerosene	kerosene	Gasoil	Gasoil	Gasoil
Unit Capacity	MW	100	150	225	100	150	225	100	150	225	100	150	225
Number of Unit		2+1	2+1	2+1	2+1	2+1	2+1	2+1	2÷1	2+1	2+1	2+1	2+1
Annual Plant Factor	%	80	80	80	80	80	80	80	80	80	80	80	80
Annual Energy	GWh	701	1,051	1,577	701	1,051	1,577	701	1,051	1,577	701	1,051	1,577
Service Life	Years	20	20	20	20	20	20	20	20	20	20	20	20
Scheduled Outage Ratio	%	15	15	15	15	15	15	15	15	15	15	15	15
Forced Outage Ratio	%	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Construction Cost	US$/kW	770	670	570	770	670	570	770	670	570	770	670	570
Discount Rate	%	12	12	12	12	12	12	12	12	12	12	12	12
Capital Recovery		0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Capital Cost	US$/kW	115.50	100.50	85.50	115.50	100.50	85.50	115.50	100.50	85.50	115.50	100.50	85.50
O/M Annual Fixed Cost	US$/kW	7.64	6.64	5.59	7.64	6.64	5.59	7.64	6.64	5.59	7.64	6.64	5.59
Fixed Cost Total	US$/kW	123.14	107.14	91.09	123.14	107.14	91.09	123.14	107.14	91.09	123.14	107.14	91.09
	US$/kWh	0.018	0.015	0.013	0.018	0.015	0.013	0.018	0.015	0.013	0.018	0.015	0.013
Fuel Caloric Rate	kcal/kg	10,366	10,366	10,366	10,366	10,366	10,366	10,366	10,366	10,366	10,366	10,366	10,366
Fuel Heat Rate	kcal/kWh	1,861	1,763	1,706	1,861	1,763	1,706	1,861	1,763	1,706	1,861	1,763	1,706
Fuel Price	US$/kg	0.3211	0.3211	0.3211	0.4357	0.4357	0.4357	0.254	0.254	0.254	0.2659	0.2659	0.2659
Unit Fuel Cost	US$/kWh	0.058	0.055	0.053	0.078	0.074	0.072	0.046	0.043	0.042	0.048	0.045	0.044
Variable O/M Cost	US$/kWh	0.004	0.003	0.003	0.004	0.003	0.003	0.004	0.003	0.003	0.004	0.003	0.003
Variable Cost Total	US$/kWh	0.061	0.058	0.056	0.082	0.078	0.075	0.049	0.047	0.045	0.051	0.049	0.047
Total Cost	US$/kWh	0.079	0.073	0.069	0.099	0.093	0.088	0.067	0.062	0.058	0.069	0.064	0.060
Operating Hours													
1000	US$/kWh	0.1844	0.1652	0.1472	0.2050	0.1847	0.1661	0.1724	0.1538	0.1362	0.1745	0.1558	0.1381
3000	US$/kWh	0.1024	0.0938	0.0865	0.1229	0.1133	0.1053	0.0903	0.0824	0.0754	0.0924	0.0844	0.0774
5000	US$/kWh	0.0859	0.0795	0.0743	0.1065	0.0990	0.0932	0.0739	0.0681	0.0633	0.0760	0.0701	0.0652
7000	US$/kWh	0.0789	0.0734	0.0691	0.0995	0.0929	0.0880	0.0669	0.0620	0.0581	0.0690	0.0640	0.0600
8000	US$/kWh	0.0767	0.0715	0.0675	0.0973	0.0910	0.0864	0.0647	0.0601	0.0564	0.0668	0.0621	0.0584
8760	US$/kWh	0.0754	0.0703	0.0665	0.0959	0.0898	0.0854	0.0633	0.0589	0.0555	0.0655	0.0609	0.0574

Table 8.1.3 COMPARISON OF GENERATION COST OF DIESEL

Item	Unit	Financial			Ecconomic		
Plant Type		Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
Fuel		HFO	HFO	HFO	HFO	HFO	HFO
Unit Capacity	MW	30	40	50	30	40	50
Number of Unit		1	1	1	1	1	1
Annual Plant Factor	%	77	77	77	77	77	77
Annual Energy	GWh	202	270	337	202	270	337
Service Life	Years	25	25	25	25	25	25
Scheduled Outage Ratio	%	12	12	12	12	12	12
Forced Outage Ratio	%	5	5	5	5	5	5
Construction Cost	US$/kW	1,530	1,480	1,450	1,530	1,480	1,450
Discount Rate	%	12	12	12	12	12	12
Capital Recovery		0.143	0.143	0.143	0.143	0.143	0.143
Capital Cost	US$/kW	218.79	211.64	207.35	218.79	211.64	207.35
O/M Annual Fixed Cost	US$/kW	20.54	17.55	15.34	20.54	17.55	15.34
Fixed Cost Total	US$/kW	239.33	229.19	222.69	239.33	229.19	222.69
	US$/kWh	0.035	0.034	0.033	0.035	0.034	0.033
Fuel Caloric Rate	kcal/kg	9,673	9,673	9,673	9,673	9,673	9,673
Fuel Heat Rate	kcal/kWh	1,841	1,841	1,841	1,841	1,841	1,841
Fuel Price	US$/kg	0.1529	0.1529	0.1529	0.121	0.121	0.121
Unit Fuel Cost	US$/kWh	0.029	0.029	0.029	0.023	0.023	0.023
Variable O/M Cost	US$/kWh	0.003	0.003	0.002	0.003	0.003	0.002
Variable Cost Total	US$/kWh	0.032	0.032	0.031	0.026	0.026	0.025
Total Cost	US$/kWh	0.067	0.066	0.064	0.061	0.060	0.058
Operating Hours							
1000	US$/kWh	0.2713	0.2608	0.2538	0.2653	0.2547	0.2477
3000	US$/kWh	0.1118	0.1080	0.1053	0.1057	0.1019	0.0993
5000	US$/kWh	0.0799	0.0774	0.0756	0.0738	0.0714	0.0696
7000	US$/kWh	0.0662	0.0643	0.0629	0.0601	0.0583	0.0568
8000	US$/kWh	0.0619	0.0602	0.0589	0.0558	0.0542	0.0529
8760	US$/kWh	0.0593	0.0578	0.0565	0.0532	0.0517	0.0505

Table 8.1.4 COMPARISON OF GENERATION COST OF COAL

Item		Unit	Financial			Ecconomic		
Plant Type			Coal	Coal	Coal	Coal	Coal	Coal
Fuel			Coal	Coal	Coal	Coal	Coal	Coal
Unit Capacity		MW	100	200	300	100	200	300
Number of Unit			1	2	3	1	2	3
Annual Plant Factor		%	71	71	71	71	71	71
Annual Energy		GWh	622	1,244	1,866	622	1,244	1,866
Service Life		Years	25	25	25	25	25	25
Scheduled Outage Ratio		%	12	12	12	12	12	12
Forced Outage Ratio		%	6	6	6	6	6	6
Construction Cost		US$/kW	1,390	1,270	1,190	1,390	1,270	1,190
Discount Rate		%	12	12	12	12	12	12
Capital Recovery			0.09	0.09	0.09	0.09	0.09	0.09
Capital Cost		US$/kW	125.10	114.30	107.10	125.10	114.30	107.10
O/M Annual Fixed Cost		US$/kW	26.9	18.27	12.41	26.9	18.27	12.41
Fixed Cost Total		US$/kW	152	132.57	119.51	152	132.57	119.51
		US$/kWh	0.024	0.021	0.019	0.024	0.021	0.019
Fuel Caloric Rate		kcal/kg	6,160	6,160	6,160	6,160	6,160	6,160
Fuel Heat Rate		kcal/kWh	2,799	2,799	2,799	2,799	2,799	2,799
Fuel Price		US$/kg	0.0775	0.0775	0.0775	0.0574	0.0574	0.0574
Unit Fuel Cost		US$/kWh	0.035	0.035	0.035	0.026	0.026	0.026
Variable O/M Cost		US$/kWh	0.001	0.001	0.001	0.001	0.001	0.001
Variable Cost Total		US$/kWh	0.037	0.037	0.037	0.028	0.027	0.027
Total Cost		US$/kWh	0.061	0.058	0.056	0.052	0.049	0.047
Operating Hours								
	1000	US$/kWh	0.1887	0.1692	0.1561	0.1795	0.1601	0.1469
	3000	US$/kWh	0.0873	0.0808	0.0764	0.0782	0.0717	0.0673
	5000	US$/kWh	0.0671	0.0631	0.0605	0.0579	0.0540	0.0513
	7000	US$/kWh	0.0584	0.0556	0.0536	0.0492	0.0464	0.0445
	8000	US$/kWh	0.0557	0.0532	0.0515	0.0465	0.0441	0.0424
	8760	US$/kWh	0.0540	0.0518	0.0502	0.0449	0.0426	0.0411

Table 8.1.5 CEB`S PERCHASING PRICES AS OF 21, DEC., 1996

HFO	Economic	2.3470 Rs/l	2.4317 Rs/kg	0.1210 $/kg
	Financial	2.9700 Rs/l	3.0722 Rs/kg	0.1529 $/kg
Kerosene	Economic	4.003 Rs/l	5.1050 Rs/kg	0.2540 $/kg
	Financial	5.077 Rs/l	6.4539 Rs/kg	0.3211 $/kg
Coal	Economic	1.1530 Rs/kg		0.0574 $/kg
	Financial	1.5566 Rs/kg		0.0775 $/kg
Gasoil	Economic	4.2067 Rs/l	5.3442 Rs/kg	0.2659 $/kg
	Financial	6.8742 Rs/l	8.7570 Rs/kg	0.4357 $/kg

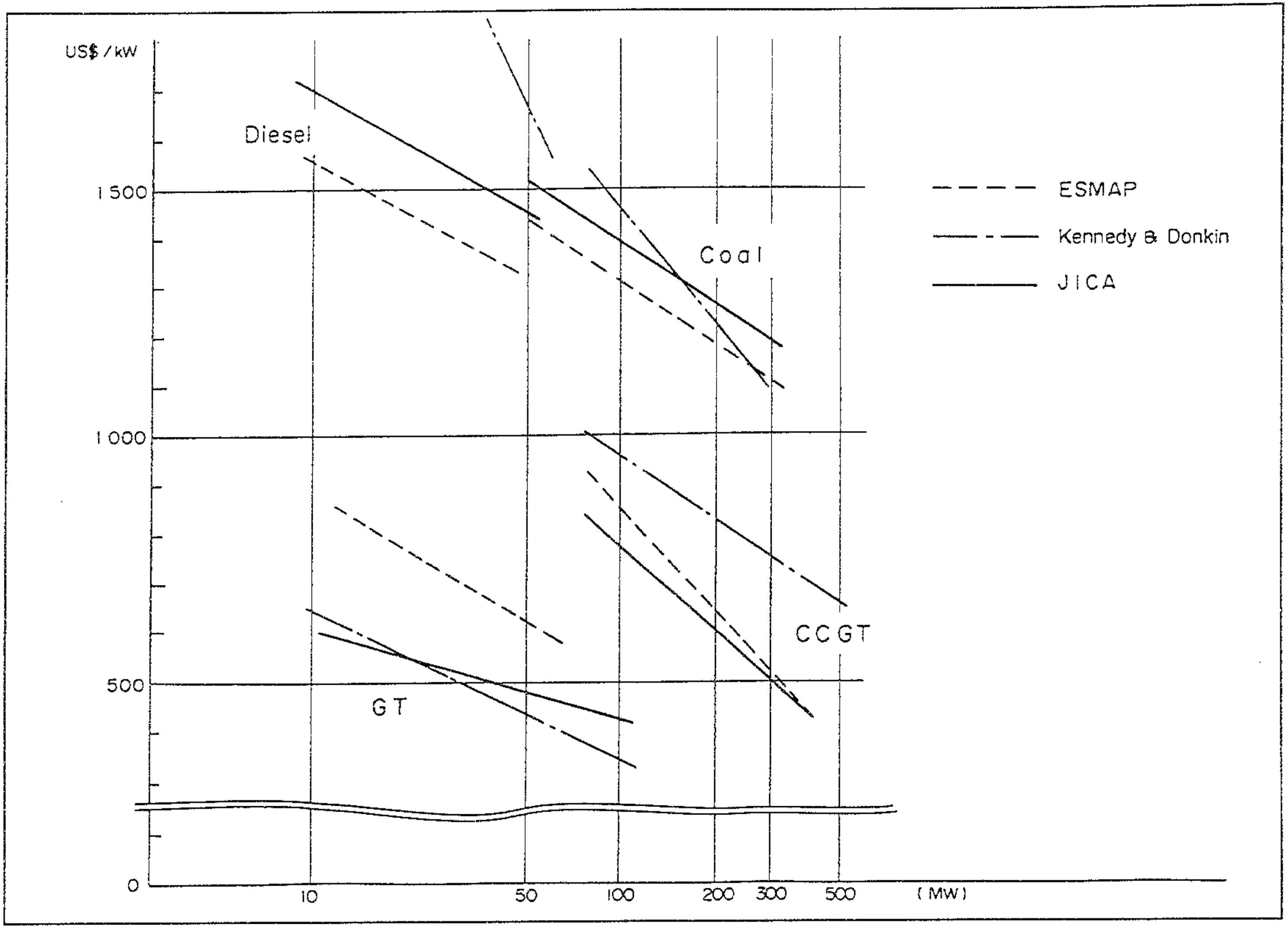


Figure 8.1.1 COMPARISON OF CONSTRUCTION COST

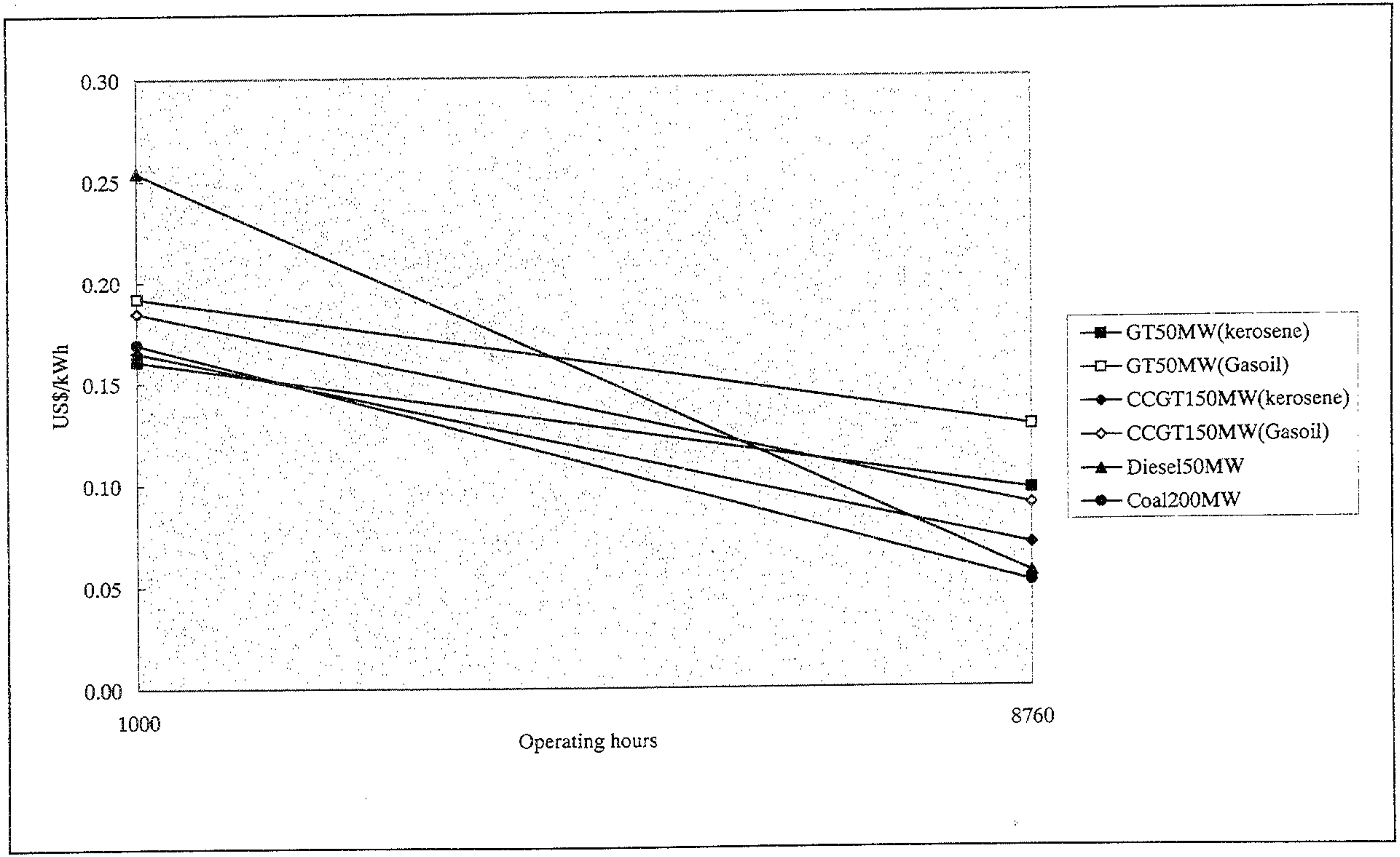


Figure 8.1.2 COMPARISON OF GENERATION COST (FINANCIAL)

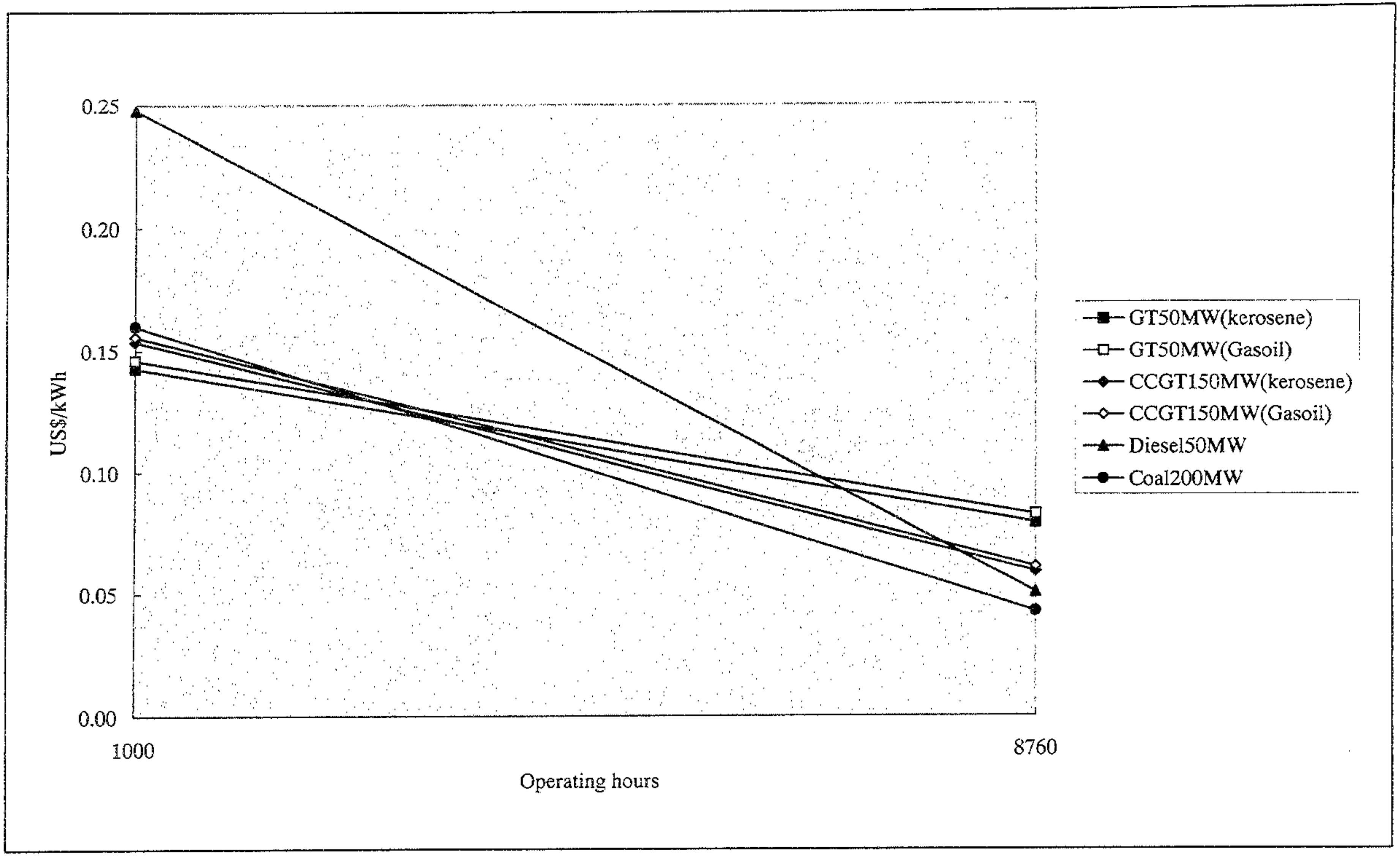


Figure 8.1.3 COMPARISON OF GENERATION COST (ECONOMIC)

8.2 Inland Transportation System for Improving Energy Efficiency

8.2.1 General

Development of national economy and improvement of living standard caused rapid increase of personnel car and commercial vehicles. Motor way from Port Louis to Curepipe , which pass through most populated area, is congested heavily these days. This heavy traffic congestion causes trouble on efficient business activity and realize fuel efficiency drop and environmental pollution problem by exhaust gas. Traffic congestion will become worth due to motorization and increasing such imported cargo as primary energy, materials for construction and industries, and food. To improve such traffic condition and maintain smooth and efficient inland transportation of cargo from the port, the government plans to build Port Louis by-pass road and passenger mass transfer system along the main motor way. Sift of considerable number of passengers from personnel car and public bus to new transport system is expected to improve overall energy efficiency including that for power generation. In addition, benefit of primary energy sift from gasoline and diesel oil to coal for electric power generation. This energy diversion to coal contributes in lowering petroleum products dependency and higher energy conversion efficiency may compensate CO_2 emission. Furthermore, application of latest clean coal technology is expected to reduce emission of SO_x , NO_x and CO_2.

All of CEB power plants have been located in Port Louis area and most of their fuel is supplied by pipeline from port. According to demand growth, power generator is required to locate in east side of the island for improving power transmission reliability and efficiency. One of major concern on this power plant is supply system of coal which is main primary energy used for the plant. Considering required quantity, inland transportation is not a realistic solution. Fortunately, there is good point to build coal power plant alongside sea where is inside lagoon required special care on environment. As prospected from the fact that port with dolphin had been located in this area, power plant with coal receiving jetty can be built at less cost because canal from outside and an anchorage with sufficient drought for ocean ship is expected available.

On the other hand, establishment of safe and efficient transportation system becomes one of major concern against increasing demand of petroleum products. According to the demand forecast in 2025, jet fuel consumption will grow up to 273000 Kl which requires 9000 trips of 30 Kl lorry-truck annually or 30 trucks daily to the air port. For other petroleum products than jet fuel and use of power generation, about 10000 lorry trucks are required to transport to the east area in which consumption is assumed 20% of total. Lorry truck loading terminal is generally operated during daytime from view point of safety, and will be croweded at their begining of operation for 1st loading. Lorry trucks repeat their transportation trip and wake peak load at loading terminal a few times a day. As for jet fuel in Mauritius, around 30 trips of 30 kl capacity Lorry are required to transport jet fuel to the airport every day in 2025. Time for a round trip is calculated 3 hrs as a summation of 1 hr for loading including waiting time etc., 1 hr for driving to the airport, an half hour for unloading and 1 hr for return. In case they trip 3 times a day and the loading terminal has capacity to manage all of them in one hour, 3 times of intensive load of 10 trucks an hour are realized every day. Other petroleum products are expected similar behavior and lorry trucks for delivery forms a peak a few times a day. According to demand forcast, 170 trips a day of lorry truck are required to distribute petroleum products except jet fuel in 2027. In case peak load is assumed as low as 25% of total trucks an hour, 40 lorry trucks an hour will go through from the port area to publicroad. As for the main road through major cities in the direction of the airport, as many as around 30 lorry trucks an hour are expected. These inflammable transport lorry trucks, same to heavy cargo trucks and bus, drive at low speed, accordingly they may restrict smooth traffic and promote congestion in key motor road from Port Louis through air port. To prevent accident caused by traffic congestion and to reduce transport problems, it is recommended to establish petroleum distribution terminal adjacent to the above mentioned coal power plant in Mahebourg.

To minimize transport problem caused by rapid increase of vehicles and movement of person, the government plans to develop a policy of close localization of living to work place and is planning to build passenger mass transport system between Port Louis and Curepipe along with most busy motor way in this country. Realization of this new mass transport system with expected diversion of peoples from passenger car and public bus attains considerable improvement of transport efficiency. Besides direct effect, indirect energy saving due to improvement of traffic condition to smooth driving may achieve better engine efficiency or reduced fuel consumption. These improvement in transport efficiency contribute on reduction of import petroleum dependency. According to experience in Japan, a few years after opening new load to reduce congestion, transport fuel consumption reduction due to improved traffic condition was compensated by increasing driving cars and their distance. To achieve the target, the government is required to promote peoples diversion to new transport system by applying economical fare and providing convenient system in use.

As a conclusion of the result of the study given int he Para. 8.2, both ideas for building new mass transportation system and new energy center in the east side of the Island are recommended from various factors for efficient and secure energy supply point of view.

8.2.2 Transport System for Petroleum Products and Coal

Improvement of road network in the area of the port is under construction according to requirement for expansion and modernization to cope with future growth of handling volume and development of free port related functions. However, MMA is concerned about construction of junction to general road for smooth traffic without restriction. Because we can imagine easily how big numbers of transportation vehicles is necessary to distribute the goods imported according to the forecast applied for the port expansion. Among total cargo to be transported outside the port, petroleum products except CEB use amounts about 20% in 2015, its reduction is expected to cause considerable benefit on improvement of road traffics.

The motor way to the air port is busiest road in this country, however many heavy trucks especially lorry trucks loaded hazardous material are obliged to drive in lower speed compared to cars. This may cause reduction of road capacity, increase possibility of road congestion, worsening engine efficiency and increase fuel consumption. In this connection, engine efficiency of car is generally designed to get highest value around 80 km/hr, and efficiency goes down with slowing down speed due to congestion and results worsening environmental pollution.

With improving living standard, diversification of energy to electric power is progressing.

To cope with electric power demand, power plant is required in east side of the island to supply electric power efficiently and in higher reliability. This power plant is planned to use coal taking account of contribution in energy security in addition to economic point. Coal utilizing plant is to be located in an area where coal can be unloaded directly from ocean ship, due to enjoy its economical benefit without costly inland transportation. According to survey result, the site of old port located in Mahebourg is recommended. Chart shows that canal with sufficient draft continues to an anchorage inside of lagoon and a port with jetty exclusive use for energy unloading is expected to be built in cheaper investment. Area for power plant will be provided by reclaim and coal is received through jetty from ocean ship directly. Considering the area located inside lagoon, pollution prevention measures shall be taken in coal unloading and storage facilities being closed. Opening of new port for international trade needs big investment and is very difficult to proceed plan for the moment according to MMA. However, there is a possibility in case of limited object to unloading of energy sources and realization of this plan is expected inevitable for economic and safe energy supply. Opening 2nd international port has been discussed in the authority, however this project shall be proceeded considering time schedule for construction of the power plant.

According to oil company, a study was made about transportation of jet fuel to air port by sea through new port in same location of the above, however that plan was not economically feasible due to high investment cost at that time. Now investment can be reduced by utilizing jetty for power plant mentioned above for putting a few lines for unloading petroleum products including jet fuel and oil terminal adjacent area to the plant. In this plan, petroleum products will be unloaded from ocean tanker and energy saving against present system is equivalent to energy consumption corresponding to difference of distance of inland transportation. Difference is 40 km for jet fuel and 30 km for others and corresponding energy saving is estimated based on the following conditions.

- 100% of jet fuel, 20% of other petroleum products, except bunker and power generation use, of demand in 2025 are distributed from new terminal
- length of journey to air port is 10 km and average 20 km to other consumers
- size of lorry truck is 30 kl (10 ton for LPG)
- lorry truck energy consumption : 700 kcal/ton-km,(2000 kcal/truck-km for

return way)

product	transport quantity (ton/y)	No. of trucks required to transport	energy saved (TOE)
jet fuel	217,784	9,105	683
gasoline	65,000	2,912	154
diesel	50,000	1,970	117
fuel oil	90,000	3,150	208
LPG	25,000	2,500	68

TOTAL : No. of trips by truck per annual : 19,637

Energy Conserved : 1,230 TOE/year

The following is estimation of energy requirement for transportation of equivalent diesel oil to be used for gas turbine which substitutes three of 100MW coal power plant as mentioned above.

Energy conversion efficiency : 0.31 ton / Mwh
Electric power generated : 300 Mwh x 8000 hrs
Fuel consumption : 744,000 ton / year
Lorry trucks to transport : 31,105 trips /year
Required transport energy : 2,915 TOE / year

Total transport energy conserved by building energy center composed of power plant and petroleum products terminal in Mahebourg area is accordingly
4,145 TOE / year.

Besides, such subsidiary benefit as below are realized;

- reduction of transport fuel by improvement of traffic condition of most busy motor way
- reduction of road maintenance cost due to decrease heavy cargo truck
- lowering accidental risk by reduction of inflammable material transport

8.2.3 New Mass Transport System Between Port Louis and Curepipe

Motor way between Port Louis and Curepipe is critical condition and serious congestion is observed at the rush hour. Congestion and environmental pollution are concerned growing worse due to increasing vehicles. To prevent more critical condition, the government is planning to improve existing road and to construct new road. In addition to improvement of road net work, new mass-transport system is being studied to construct along the key motor way as substitution of transportation from personal car and public bus. Detail of new transport system is not available, however electricity is expected for driving power sources because of higher overall energy efficiency including power generation.

According to "Transport Energy in Africa", bus passengers in week day was 740,000 /day in 1991 and one third of them traveled the line between Port Louis and Curepipe. And also, he estimated that 67% of peoples who move this section will utilize bus.
Furthermore, he assumed number of passengers of new transport system in 2010 as 133000 persons in a day (one way) , and total distance of journey will be 1,452,000 person-km. This means average journey distance is 5.5km on each way.

Referring the above information, following bases are established for our study.
In 1993, population of 5 cities along this system amounted 44% of total population and around 50% after excluding population for agriculture and so on. According to the forecast, population engaged in 2nd and 3rd industries in 2010 and 2025 are 614,000 and 761,000 persons respectively. 50% of them live in this area and further 50% (corresponding to 25% of total) is assumed to utilize this new transport system then number of passengers are counted as 150,000 persons in 2010 and 180,000 in 2025. In assumption of percentage becoming passengers , government policy of close location of work place by living and possible travel direction outside of line are taken in to account. Daily average journey distance of 5.5 km looks short compared to total length of this system, about 30 km and 15km is assumed for study base.
Under this condition, total daily distance of journey is calculated 4,500,000 km in 2010 and 5,400,000 km in 2025.
Next assumption is number of person converting to the system from personnel car. According to the forecast, number of car and dual purpose car are 160,000 in 2010 and

450,000 in 2025. 50% of those cars are owned by people living in an area of subject 5 cities, 80% of those cars are assumed to go to the office then corresponding number of car are counted as 6,400 in 2010 year and 180,000 in 2025. Ratio converting to new transport system from car is assumed 50% in 2010 and 30% in 2025 considering that rate of car owner will become considerably high in 2025. Average number of person in a car is also assumed 1.5 and 1.0 in respectively. Daily average length of journey is 40 km, then;

	2010	2025
distance of journey by car(km-man/day)	1,920,000	2,160,000
transport by new system(km-man/day)	4,500,000	5,400,000
conversion from bus (km-man/day)	2,600,000	3,240,000

This new mass-transport system is aimed at absorbing as much peoples as possible from car and bus and reducing road congestion by decreasing driving car. To attain this target, essential requirement are economical fare, convenience, and political support by government to enforce conversion from car.

Energy to be conserved by introduction of the new transport system is calculated as following.

Energy efficiency of car, public bus and train is 600, 180 and 100 kcal/man-km respectively. No detail information is available, however transport driven by electric power such as monorail and special type trolley bus in exclusive road is expected to be applied efficiency figure of train accordingly. Transport system driven by electric motor has better energy efficiency compared to gasoline or diesel engine, because energy conversion efficiency in power generation and electric motor is high.

	2010	2025
Conserved energy by car (TOE/year)	28,800	32,400
Conserved energy by bus (TOE/year)	6,240	7,780
Total Energy Conserved (TOE/year)	**35,040**	**40,180**

Although above figures are calculated with many assumptions, new transport system is clearly expected to contribute in reduction of petroleum products consumption considerably in addition to reduction caused by improved driving condition. This reduction of petroleum products consumption contribute in lowering import dependency and in improvement of national energy security.

8.3 Energy Conservation and the Development of Related Technology

8.3.1 Introduction
(The Understanding of Energy Conservation in Current World)

The experience of the oil crises took place two times during 1970's, up set the believing of the countries, who were dependent upon very much on the imported petroleum product for long time. Almost 30 years after second world war, the people relating to energy supply thought the stable supply of very low cost petroleum product is the matter of fact lasting forever.

However, after 10 years high oil price period had over by the surplus of crude supply in the international market caused by long lasted recession of world economy, the remarkable reduction of oil use in many OECD and the increase of supply of crude oil production by non-OPEC countries.

The energy conservation activities seen in many oil scarce developing countries during the high oil price period gradually slowed down.

On the countraly, many industrially developed countries as OECD member countries continued serious effort for energy conservation in their countries. The reduction of oil consumption for long period has been considered as the very important effort to ease the problem of shortage of supply of fossil fuel infuture, which is considered as the resources having limitation in its resources in long term, and also the necessary effort to maintain stable demand supply balance in the international oil market.

In these years, the recovery of economic development world wide, in particular many Asian countries is indicating rapid growth of the demand of oil product internationally, and the short of supply in near future is envisaged.

In addition, the global concern on the climate change by increasing of green house gas in the atmospheric environment is now limelighting the energy conservation activities, which can achieve the reduction of energy consumption, petroleum and coal use, by improving the energy use efficiency and the development of use of renewable energy.

This current interpretation of energy conservation is clearly described in the following statement in the IEA report "WORLD ENERGY OUTLOOK 1995".

The Global concern on environmental conservation, in particular the concern on the increase of Green House Effect Gas in the global atmospheric environment, is directing the world economy to the line of high energy efficiency even though it may require additional cost.

The major targets of current energy conservation are described as follows: (World Bank: Energy Conservation Policy Paper)

* Continuous development of indigenous energy to increase the extent of self-sufficiency of energy supply.
* Promote diversification of importing and indigenous energy sources without jeopardize the cost and stability of energy supply.
* Pursue the development of new energy resources and renewable energy resources.
* Promote thoughtful energy conservation and energy use efficiency improvement.
* Promote the participation of the private sector to the development and investing of the energy sector.
* Promote the application of environment friendly energy system.
* Develop energy related energy information system required for energy related planning and decision making.

When we consider the present international concerns on energy conservation, the present energy conservation activities of Mauritius is required a fundamental reviewing.

8.3.2 Energy Conservation Activities in Mauritius

(1) General

The energy conservation has a few important impact to Mauritius. At first, the dependence on the imported petroleum product and coal as the main source of energy will be reduced by the development of energy conservation, which include the development of indigenous energy sources such as bagasse. In this way the security of energy supply of the country under the up set condition of oil supply from abroad will be improved and the damage to economy of the country by the excessive increase of oil price will be reduced.

In addition, the nation wide participation to energy conservation activities will improve technology level of the country through the introduction of modern high efficiency technology, and it will contribute the strengthening of international competitively of the industrie of the country.

Further, the international co-operation to mitigate the potential climate change problem by the increase of green house effect gas in the global atmospheric environment will be accomplished by mean of the reduction of the fossil fuel use by the energy conservation.

The mitigation of the climate change, which is considered to result the rise of sea level, is very important for Mauritius to protect the resource of coast area tourism.
At present, the smallness of total amount of energy use and the lack of the energy intensive industries, which normally act the positive promoter of energy conservation, results inactive energy conservation in Mauritius.

As it is described in the preceding paragraph, the energy conservation is the important task of international society for global environment protection and the counter-measure for prevention of shortage of crude oil supply the energy conservation activities in Mauritius should be improved urgently.

(2) Existing energy conservation activities in Mauritius.

1) Bagasse Energy Development Project (BEDP)

The importance of efficient use of bagasse, which is a by-product of sugar production in the country, as the major indigenous energy source of the country is considered as the way to reduce the production cost of sugar for improving cost competitively of sugar in the international market is well recognized in the country, and the government of Mauritius obtaining the co-operation of sugar industry positively promoting use of bagasse energy for power generation in these years. (Ref: Chapter 5)

The capacity of bagasse power will exceed 20% of total generation capacity by AD 2000.

2) Energy Conservation in Electrical Sector.

At present, CEB is intending to replace old diesel engine power generators, which were built in 1970's and its energy efficiency is inferior to modern machine, by the latest design machines with power generation efficiency 45 ~ 46%. The introduction of high efficiency machine will reduce fuel consumption by 30~40%, but the financial justification of this improvement is difficult under present low oil price unless low cost fund is available.

As the renewable energy development, the development of wind power generation are continuing, but further technology improvement seems required to realize the commercial operation in large scale. (Ref: Para 4.5)

The reduction of energy loss by the transmission system has improved significantly in these years by replacement of old 33KV transmission system by 66KV system.

3) Energy Conservation in Industrial Sector

The current development of energy conservation in industrial sectors of Mauritius is not clear because of lack of reliable information. The JICA study team with assistance of the MEW counter team conducted "enquête" to collect information from major factory, but only 10% of the inquiry sent was responded. According to that limited amount of information, following estimation were made but accuracy is not high.

* The improvement of power efficiency, to above 90%, of almost all the factory were completed. The tax exemption of import of necessary equipment and the merit of tariff reduction by power efficiency improvement encouraged the improvement.
* The application of modern high efficiency lighting fixture is used by many industrial facility. The use of high frequency fluorescent seems more than 60% of the lighting.
* However, the application of high energy efficiency technology such as flow

control by mean of the control of pump/blower speed by thyrister seems very limited. A report of University of Mauritius in relation to the energy efficiency improvement on steam boiler also indicating the majority of plants are still working on improvement of insulation and prevention of steam leak, and the energy saving, which require significant investment such as combustion air pre-heater, are not implemented by the most of plant. The response to JICA team inquiries also indicated the similar status as described in the report of U. M. on present energy conservation in most of industries.

4) Domestic Energy Use

The use of solar energy water heater is pretty well developed in the country. The present estimate of total number in use is 18,000. (The total household in Mauritius is 240,000) The increase of use is slowed down because of maintenance problem and the high initial cost for the low income house hold.

8.3.3 Impact of Technology Improvement to the Energy Use

(1) Automobile Fuel

The 1994 report of the I.E.A., Energy in Developing Countries, describes the results of a study on the changes in energy demand in the last 20 years in various countries in Asia, Africa and Latin America. It contains observations that are useful in considering the future of energy demands in Mauritius.

This study shows several very common changes which took place in many countries, many of which are precisely applicable to Mauritius. For example it says in its summary, in the past 20 years many countries covered by this study have experienced increases in energy demand underpinned by increases in population, development of the economy and increases in per capita income.

The strengthening of the economy, supported by an increase in industrial activities, together with the acceleration in urbanization and the rapid adoption of the automobile in society has resulted in rapid increases in energy demand in the country.

It has been observed in many countries that the rate of increase in energy consumption exceeds the rate of increase in GDP with a resultant massive increase in energy consumption. However, a few east Asian countries, which have advanced economies, nevertheless showed very low energy consumption increases; this was accomplished by means of increasing the importance of the service sector in their economies.

The rate of energy demand increase in Mauritius (as TOE), during the past 10 years shows an 8.6%/year average increase versus a 6.1% annual growth in GDP (constant price). The increase in the use of fuels for transportation (gasoline/diesel) increased as much as 9.0% at the same time. The total energy consumed by the transportation sector accounts for some 30% of total energy consumption. In the following, future demand for transportation fuels are assessed from the point of view of technological improvements.

1) Energy (fuel) efficiency of automobile

Automobile fuel consumption is determined by many complex factors, and therefore it is difficult for any assessment to show an entirely clear picture, but generally speaking the following factors, a) design of the car (energy efficiency of the new car just after manufacture), b) allowances for the age of the car, c) level of maintenance, and finally, d) traffic conditions, are considered as the major factors affecting the energy efficiency of an automobile.

a) Some 80% of automobiles used in Mauritius are believed to be made in Japan and rest are from Europe, Malyasia, S.Korea. Most automobile manufacturers in the world (including the Japanese) desire to sell their cars to the U.S. market. Accordingly, newly manufactured cars must meet the American CAFE (Corporate Average Fuel Economy) regulations. Therefore, cars manufactured after the 1980s will achieve 13 km/liter of gasoline consumption rate (Japanese made) and 11 km/liter (USA made) when they are maintained well.

Improvement in fuel economy after the latter part of the 1980s lagged, due to the fact that the priority in new car design shifted from fuel consumption to exhaust emissions control and a greater emphasis on passenger safety.

Consider, for example, that the Japanese national target for energy efficiency is set so as to reduce fuel consumption (and exhaust emissions) by 10% (based on 1988 performance) by the year 2000 and 15% (based on the same criteria) by 2010 (Passenger Car). Similarly the target for trucks is set at 5% (based on 1988 performance) by 2010 for trucks and buses. These current worldwide tendencies indicate that significant improvements in energy efficiency for new cars in the near future are not likely.

Accordingly, cars currently in use in Mauritius, most of which were manufactured after the mid 1980s, are considered to have similar energy efficiencies to cars manufactured in the 1990s. Therefore, significant improvement in the energy efficiency of cars in Mauritius cannot be expected in the near future by the replacement of old cars with newer models.

b) Obsoletion by aging

The average age of automobiles in Mauritius is estimated at 6 years, which means that 50% of cars are six years old or less, and 50% were manufactured more than six years ago.

Until now, reliable information indicating changes in automobile energy efficiency in Mauritius as a result of aging has not been available, but data collected by IEA in Indonesia, Thailand and Korea indicates that current cars on the road achieve an average 10 km/liter. This is some 10-30% lower than newly manufactured cars. Therefore, we can conclude that differences in energy efficiency between newly manufactured cars and current used cars are not very significant.

As a drastic shortening of the average age of automobiles in Mauritius is not likely, any improvement of energy efficiency due to this will not be significant.

c) Maintenance levels

This factor is closely related to the deterioration in efficiency due to aging. Generally speaking, arrangements for adequate supplies of spare parts and qualified maintenance technicians are available for automobile maintenance, and therefore should be performed well and energy efficiency maintained at a satisfactory level even despite the age of the automobile.

Reliable data for assessment of maintenance levels in Mauritius has not been available up until now, but interviews with a bus company and a car rental company did not reveal any maintenance problems.

Further, when we travel by road in countries noted for having maintenance problems, such as India, Pakistan and Bangladesh, we can very often see broken-down trucks and buses deserted by the roadside due to mechanical failures. In Mauritius, such occurrences are almost nil. Therefore, it can be considered that automobile maintenance is conducted fairly well in the country, and so significant improvement in energy usage through improvements in maintenance cannot be expected in the near future.

d) Traffic conditions

One of the serious social problems in the country is traffic congestion between Port Louis and the residential areas located south east of Port Louis such as Curepipe/Rose Hill. This problem has occurred due to rapid increases in the movement of both personnel and goods between the area, where people have traditionally resided due to better weather (200-400 meter above sea level) and fewer problems with tropical diseases. The Port Louis area is where newly-developed, export-oriented industries, with their increased flow of goods to and from the port, as well as financial institutions and Government offices are located.

In addition, increases in per-capita income accelerated the shift from public transit (buses) to private automobiles making the problem worse. The Government of Mauritius is trying to solve the problem by improving the road system, introducing an efficient public transportation system, and decentralizing facilities presently there. However, any fundamental solution to traffic congestion normally requires both a long time and a huge investment. Improvements in automobile energy efficiency by eliminating this problem will not take place in the near future .

To summarize the above assessment, any possible improvements in energy efficiency with respect to transportation fuels will only be accomplished by replacing older auto designs with newly manufactured ones year by year. It is expected that the fuel efficiency of passenger cars will be improved by 10% between 1995 and 2010; trucks and buses from Japan and the EC by 3%, from India by 6% (altogether about 4.5%) during the same time period.

Since gasoline and diesel consumption will be almost equal in the coming years, annual savings in transportation fuel due to technology improvements will amount to 0.73%/year from 1995-2005 and 0.48% from 2005 to 2010.

(2) Energy for Industrial Use

Introduction

Member countries of the OECD achieved remarkable energy conservation under the close cooperation that arose between the Government and the private sector after the oil crises in the 1970s, which proved to be a bitter experience, particularly in economic disruption caused by skyrocketing prices, and supply disruptions by the OPEC countries.

This energy conservation effort brought down the energy intensity (or energy consumption to generate one unit of GDP) for the OECD as shown in the Figure 8.3.2. Most of the countries had reduced their energy intensities about 20% from 1980 by the mid 1990s.

Energy conservation was achieved by two major methods: one was the shifting of energy intensive industries such as steel, aluminum smelting etc. from OECD countries to other countries where economical energy resources are abundant. The other way was the positive introduction of new technology which helped to reduce the energy consumption required to produce one unit of product.

The latter method, which could decrease the total global consumption of energy, is now considered as not only a task for the OCED, but indeed, a global task necessary if increases in the amount of greenhouse gases such as CO_2 and N_2O, which can cause global future warming, are to be reduced in the atmospheric environment.

OECD and IEA countries are expecting a reduction in energy intensity of OECD countries of 1.0%, of ex-USSR countries of 1.2% and other countries of 1.1% during the period from 1990-2010.

The change of energy intensity of Mauritius in these years is indicated in the following table:

Table 8.3.1 TRANSITION OF ENERGY INTENSITY

	1985	1988	1991	1994	1995
Energy Consumption (TOE/Y)	292,853	457,555	574,473	643,010	670
GDP Mrs Constant	27,183	35,176	40,678	47,113	47,600
GDP 1985 US$	1,760	2,278	2,634	3,051	3,082
Energy Intensity TOE/10^3US$	0.166	0.200	0.218	0.210	0.217

The tendency for Mauritius is similar to the non-OECD countries, where the development of industry is intense. In Mauritius, energy intensive industries have never existed and the increase in energy intensity only took place as a consequence of the development of the textile industry--in particular dyeing and refining.

Almost alone among those industries in the country which consume a great deal of energy, can be found the textile industry, representing almost 50% of national GDP. Therefore, the possibilities for energy conservation in the country can be estimated from the potential for energy conservation in the textile industry.

Data on the energy use of the Mauritius textile industry does not exist; data on the Japanese textile (dyeing, refining) industry, which is considered to have the most advanced technology in the world is used instead, as follows:

Table 8.3.2 ENERGY CONSUMPTION PER 1000m^2 TEXTILES

(Kl)

	1973	1978	1983	1988	1993 (Estimate)
Fuel Oil	0.216	0.194	0.131	0.132	0.133
KWH (F.O. equiv.) Kl	0.038	0.045	0.046	0.050	0.055
Total	0.254	0.239	0.177	0.183	0.189

Source: MITI

The above data indicate that as of the mid 1980s, very intensive energy conservation achieved savings of as much as 3% annually. However, the rate of reduction of energy consumption in the Japanese textile industry has very much slowed recently because of the market demand for high quality and a wide variety of products.

It is also been observed that significant price reductions for petroleum in the 1980s resulted in relatively low incentives to invest in energy conservation. In order to estimate how such modern energy conservation technology can be introduced to the textile industry of Mauritius, the present technology used in the industry must be identified. Unfortunately, there is currently no information in the country on this.

The JICA team and its MEW counterpart tried to survey major industries to collect information on the energy consumption of miscellaneous industries in the country, but the response was very poor.

Therefore, here we must depend on information collected by the Mauritius Research Council in relation to the general technology level of the country's industries in order to estimate the present technology level of Mauritius industries. This information indicates that people are aware of the existence of better technology in the world than they are currently using, and the objectives of their investments made in the past five years were assessed. (See Table 8.3.3.)

The results show that 65% of textile industry personnel are aware of the existence of better technology in the world, and that currently almost no investment is devoted to cost reductions, including energy savings. It is clear that the current efforts of the industrialists of Mauritius are aimed at capacity expansion, product quality improvement, replacement of obsolete equipment and labor cost reductions. Therefore, the introduction of advanced technology, which is directly tied with energy conservation, has not been prevalent. Technology of the early 1980s, when many plants were built in Mauritius, is still being used in most industries today.

Table 8.3.3 TECHNOLOGY LEVEL ASSESSMENT

Industrial Sector	Awareness of Better Technology	Investment for Cost Reduction (Excluding Labor Cost Reduction)
Agriculture, Agro Industry (Include brewery distiller)	90	0
Bread	50	0
Metal Forming	61	0
Plastic Forming	55	0
Printing	55	0
Stationarics	73	some
Sugar	100	0
Textile	65	0
Transportation	70	33

When we consider that the Mauritius textile industry is now focusing on high quality, sophisticated products and that positive investment in energy conservation is unlikely, the possibility of active energy conservation such as that which took place in OECD countries (Annual reduction was 1.0%-1.5%) cannot expected in Mauritius. However, some industrialists are positive toward energy conservation, and most plant and equipment are being gradually replaced by new ones as old equipment becomes obsolete. Therefore, a reduction in energy consumption in the range of 0.5% annually can be expected from now until the year 2010.

(3) Energy Consumption in Domestic/Commercial Sectors

Generally speaking the energy consumption in these sector is estimated by the number of equipment to be used in every houses and shops, the duration of use of these equipment and the energy consumption rate during the time of use. The influence of technology improvement to the energy consumption of non-electrical energy in these sectors of Mauritius can not be assessed because of the lack of data and information for the assessment, and the impact is very limited because of the total amount is small. Therefore, the electrical energy consumption in these sector will be assessed.

A study of IEA on the world wide electricity consumption trend in the domestic/ commercial sectors are indicating the possible energy saving in these sectors by technology improvement as shown in the table below.

Items	Achievable Saving(%)	Constrain (Market/Regulation)	2010 Non-realization
Domestic Air Conditioner	10 - 50	Small/Large	Variety
Domestic Water Heater	Undeterminable	Small/Large	variety
Domestic Refrigerator	30 - 50	Very large	10 - 30
Lighting (House)	50% over	Very large	30 - 50
Commercial Air Conditioner	Undeterminable	Small/Large	Variety
Lighting (Commercial)	10 - 30	Small/Large	Variety
Electrical Motor (Commercial)	10 - 30	Minimum/Small	0 - 10

The total electricity consumption by the household in 1995 in Mauritius was 292 Gwh (33.7MW Average). This amount is almost equal to commercial use, and reaches to 33% of total consumption. The consumption of commercial use is the third largest demand following to the domestic and industries. The total consumption of domestic and commercial use consistute 56% of total electricity consumption.

This means, the consumption of energy for electricity of domestic and commercial use reaches 20% of total energy consumption of the country as the electricity generation consumes 33% of total energy consumption.

The impact of energy saving in these sector has large contribution to the national energy balance.

The data collected by University of Mauritius in 1995 in relation to the use of electrical equipment in the house-hold are shown on the Table 8.3.4. The data did not included the number of electrical lamps in a houses. The other statistic of the housing (MEPD) shows the average number of rooms in a house as four, but this does not mean these lamps are lit all the time. The data of Japanese house-hold during 1970's, the life style of that time is similar to present Mauritius, is indicating about 15-20% of total electricity consumption, about 2,000 x 103 cal/yearhousehold, of a house-hold was used for lighting. This means about 130W of power is consumed for 10 hours in every houses in average. When we consider the current lighting mode in Mauritius should be similar to this, the distribution of power consumption to each items in average house-hold is estimated as 27% for lighting, 24% for refrigerator, 11% for water heater and 10% for iron and rice cooker etc. are rest.

Out of above domestic electrical equipment, it is considered that the possibility of improvement of energy efficiency is existing for lighting, television and refrigerator. The energy efficiency of these three items have improved significantly in the last twenty years, but the tendency of improvement of energy efficiency has slow down since the middle of 1980's because of the change of attitude of customer and low cost of electricity. The statistics of Mauritius on the distribution of the refrigerator to each house-holds indicate the majority of refrigerators in use in the country were imported after the middle of 1980's. Therefore, most of the refrigerators in the country already incorporated the energy efficient design, and the improvement of efficiency by spreading modern type refrigerators are not possible in the near future. This observation is applicable to the energy efficiency of TV and Air Conditioners (Ref. Figure 8.3.1). Therefore, the largest potential of energy saving in domestic consumption will be the lighting. It is expected that the replacement of the old type fluorescent bulb and candescent bulb by new type fluorescent bulb (inverter, high-frequency) is still progressing in many house-holds. When all the lights in house-hold are replaced by new design one, about 20-30% of reduction of energy consumption is possible. This can contribute about 5% of saving of domestic electricity consumption. Assuming this replacement will takes 15 years, the annual reduction will be about 0.33% from now to AD2010.

The commercial sector improvement is not hopeful because most of the commercial facility such as supermarkets, restaurants, hotels already applied modern high efficient type lighting. There is the possibility of energy saving in commercial sector by the application of cogeneration of electricity and heat, but the implementation of this type of energy saving require a positive leadership of the government in the similar way of the propagation of solar heat utilization in the country. The current electricity tariff and petroleum fuel way not high enough to encourage the private parties to promote investment for high level energy saving project. As the one of "DEMAND SIDE MANAGEMENT" activities, the cogeneration of electricity and heat for a large office buildings, a commercial center and a large housing complex will have good potential of energy saving, but the estimation of impact of such technology improvement to energy consumption is not possible at this time.

Table 8.3.4 1995 DATA

Device	Energy Consump. A=C*F kWh/day/UHH	Energy Consump. B=A*D/1000 MWh/day	Rating C kW	Number of User Household D	[%]	Potential Load E=C*D/1000 MW	Usage Factor F hr/day/UHH
Hot plate / cooker rings	3.00	49.7	2	16582	7	33.2	1.5
Instant. water heater	2.40	91.0	3	37902	16	113.7	0.8
Storage water heater	9.00	19.2	3	2132	1	6.4	3.0
Television set	0.25	54.5	0.05	217934	92	10.9	5.0
Electric kettle	0.33	18.2	2	54484	23	109.0	0.2
Washing machine	0.34	13.5	0.3	40270	17	12.1	1.1
Refrigerator	1.20	193.3	0.05	161082	68	8.1	24.0
Freezer	2.40	11.4	0.1	4738	2	0.5	24.0
Electric iron	0.60	135.0	0.75	225041	95	168.8	0.8
Air- conditioner#	2.43	2.3	0.8	948	0.40	0.8	N.A.
Rice cooker	0.62	64.6	1	104229	44	104.2	0.6
Lighting#	0.76	178.2	N.A.	234516	99	N.A.	N.A.

UHH = User Household

Data source :

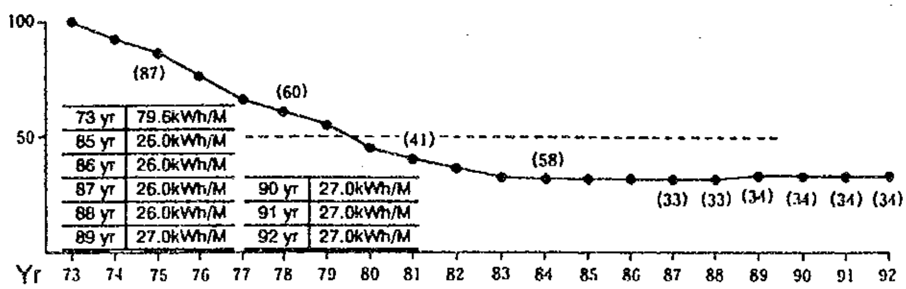
	A	Survey result
	B	Comptuted
	C	Survey result
	D	Survey result
	E	Computed
	F	Survey result
	#	Survey result

Total Number of households = 236,885

From : Beeharry, R.P., Mohee R., and Baguant, J.1995. Domestic Energy Consumption and Related Environmental Impacts.
Interim and Draft Final Reports for the ADB.
University of Mauritius

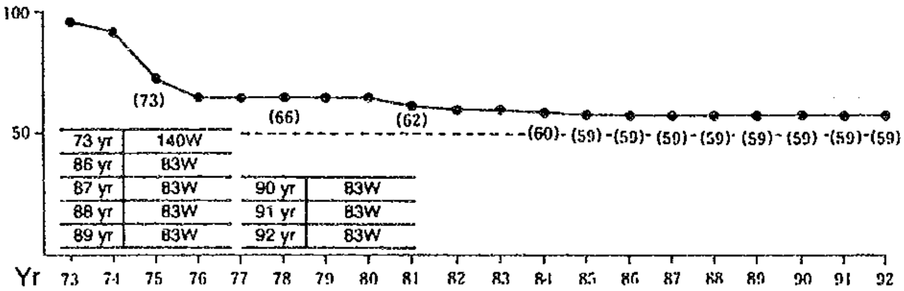
(1) Refrigerator with Freezer

Monthly power consumption of refrigerator with freezer (Capacity: 170L, 2door type) (1973=100)



(2) Color TV

Power consumption of 19". 20" TV (1973=100)



(3) Air conditioner

Power consumption of separate type air conditioner cooling capacity 1,600kcal/h (1973=100)

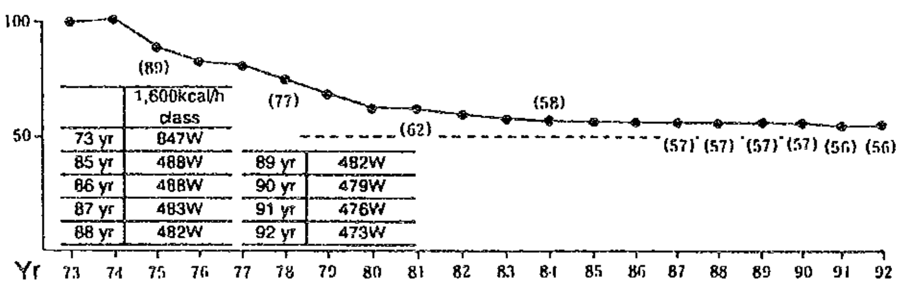
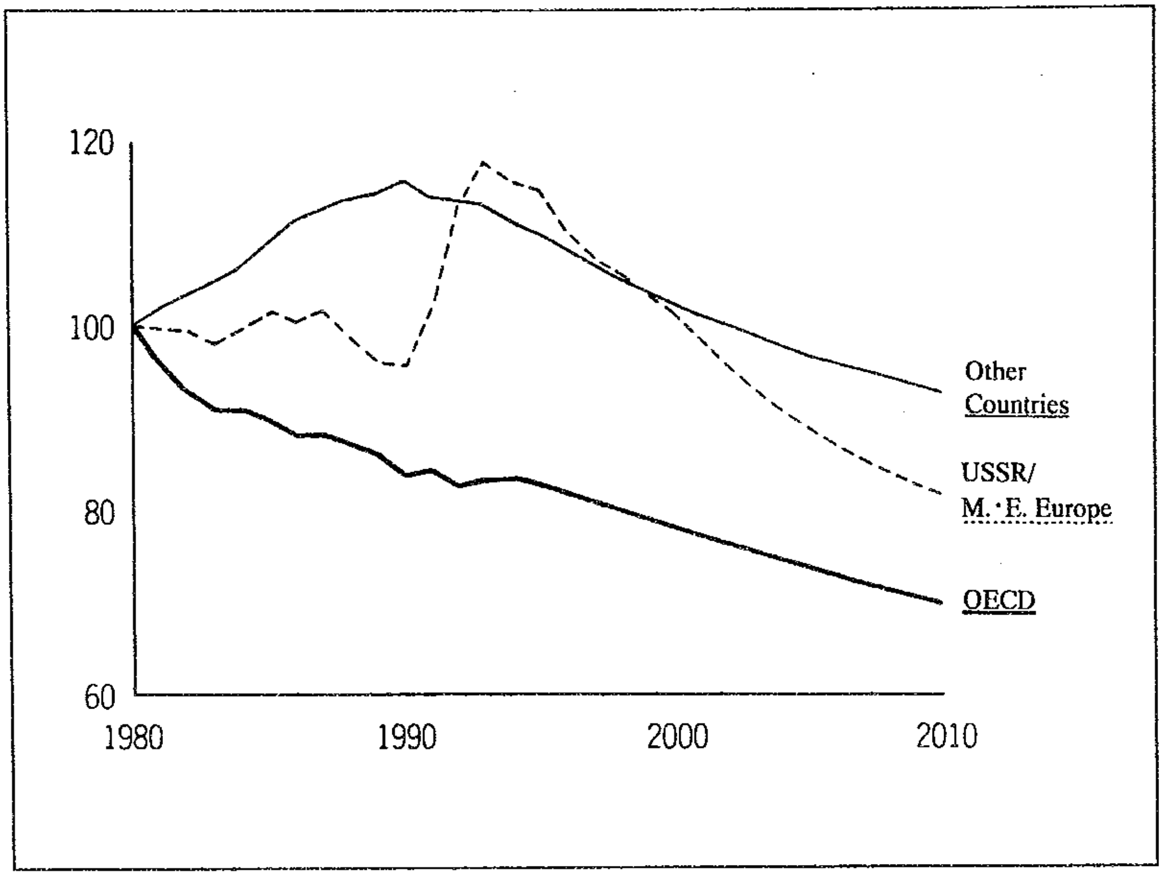


Figure 8.3.1 PROGRESS OF ENERGY SAVING IN HOUSEHOLD ELECTRICAL APPLIANCES



Source: IEA

Figure 8.3.2 ENERGY INTENSITY (1880=100)

8.3.4 The Bottle-neck of Energy Conservation Activities in Mauritius and Its Solution.

(1) The lack of national consensus on the importance of energy conservation as the element of national energy policy

Just after the oil crisis, durning the time high oil price were prevail, the energy conservation was considered as crucial problem to the economy of the country, which deeply depend on the imported oil product as its energy source, and the sustaining of the development of the country. Unfortunately, after the low oil price prevailed in the international market, the energy conservation is not considered as the high priority task in the country

.

However, as it described in preceding paragraph, the importance of energy conservation for the Mauritius must be recognized by the people of every government agencies and private sectors. In particularly, the positive impact of energy conservation to the global and national environmental issues must be reconsidered. It is very desirable that the national energy policy, which will be promoted by MLGPU, will include the strategy for activating the energy conservation.

The strategy must include two measures mentioned in the followings.

(2) Set-up of a core organization for the energy conservation

The current activities in relation to energy conservation are proceeded independently by MLGPU, University of Mauritius and some private sector enterprises. There is no consistent co-ordination as the national program. It is recommended that the MLGPU should set up a core organization for long term national energy conservation program, we may name the organization as "the energy conservation center" with the participation of private sectors. This center will function as the spear-head of the national program of energy conservation/environment management to activate energy conservation in the broad scenes.

This center should be the center point of collecting data & information of the country and

of abroad relating to the energy conservation continuously, and the collected useful information should be distributed to the concerned party as required from this center.
It is also desirable to have a few experts in the organization, who will be able to assist the parties required the technical assistance for development of energy conservation in their entity.

It is informed that recently MLGPU has set up an Advisory Committee on Renewable Energy comprising representatives of the public and private sectors. It is expected that the committee will be developed to the national "Energy Conservation Center" in future.

(3) The comprehensive and continuous collection of energy related information from all the public and private sectors.

At present, there is no systematic information collecting system in relation to energy conservation is existing in the country.

Even the above mentioned energy center is set up the activity will not be fruitful unless the Government guidance, which make possible the constant data collection from the public and private sectors entity by the center, is made. In many countries in the world, the ministry in charge of energy administration set up regulation which make possible the continuous collection of national energy related information, and in many country the Government provides the incentive for sumission of reliable data from related parties. Take for an example when the submitted information indicates excellent performance in respect of energy conservation, Government send prize to such party or the low cost fund will be provided for the project implementation of the party which is positively co-operating to provide the data & information useful to promote the energy conservation of the country.

8.3.5 Suggestion on Practical Plan for Energy Conservation

(1) Promotion of Cogeneration of Electricity and Heat

The one of important current international movement in the improvement of energy use efficiency is the cogeneration of electricity and heat, but presently the people of Mauritius is not interested in this subject. However, most of people do not aware the fact, that is one of very active projects in the country in relation to energy conservation is BEDP project and one of important element of this project is the cogeneration of electricity and steam for sugar processing.

At present, many countries in the world interested in the implementation of cogeneration as the practical energy conservation scheme. The application of co-generation for electricity and heat supply to a large building, a large housing complex and a large industrial estate, which are require continuous supply of the electricity and heat such as steam, hot water, hot air, are being implemented as the viable project. Most of case, the power generation by diesel/engine/ gasturbine and waste heat recovery of the engine exhaust for generation of steam/hot water even refrigiration are combined.

The experience of the implementation of the power-heat co-generation projects in Japan are indicated in the Appendix 4-B.

It is expected that the power generation by diesel engine/gas turbine together with steam generation is adopted by the large hotels, the large residential complexes and the shopping centers the evening peak load of electricity demand to CEB grid can be controlled significantly.

The promotion of such co-generation schemes should be considered as a important role of CEB as one way of "the Demand Side Management" in the country. The difficulties involved in such co-generation project are high initial investment and the required technology sources. CEB is the party in Mauritius possessing such capabilities.

It is awared that the waste heat of diesel engines of CEB are partly recovered to generate steam required in the power plants. It is observed that the CEB power plants located close to industrial facilities has good potential to apply co-generation, but there is no such plan for near future.

When we consider the increase of energy cost in future, the application of co-generation in to the power generation system of Mauritius should be considered seriously.

(The IEA reported that by AD2010 the thermal power plant of industrially developed countries will realize co-generation which meets 6～10% of energy being use for power generation)

(2) Diversification of Energy Resources

The diversification of energy resources of Mauritius is the one of important task of energy conservation of the country. Detail of this subject is described in para 4.3.

(3) Development of Non-traditional Energy

The development of renewable energy is also another important subjects of energy conservation. The detail of proposal on this aspect is described in para 4.5.

(4) Further development of "Solar Water Heater" use, and reduction of electricity use for Water Heater"

It is observed that the development of use of Solar Water Heater in Mauritius is not so fast as it is expected as the attractive way of renewable energy use.

The problems of causing the staggering the acceleration of the use of "Solar Water Heater" in Mauritius are reported as follows:-

1) High initial cost of the equipment
2) Problem of maintenance (High cost and lack of adequate service)
3) Low cost of electrical water heater

The importance of reduction of electricity consumption of water heater is very important to the country not only for converting imported energy to indigenous renewable energy but also the possibility of reduction of peak electricity demand during evening peak.

However, it should be noted that even "the Solar Heater" equipped of the hot water reservoir is developed, the electricity demand during evening peak may not be reduced unless the electricity heater is not used during the time of no-sunshine days.

It is considered that the Solar Water Heater system, which equipped of LPG Water Heater as back-up, is made available to consumers on "Lease Basis" the problem of propagation may be minimized.

When we consider the technical-financial capability of the CEB after de-regulation, such project will be very viable as the new business opportunity of CEB.

The high cost of LPG comparing with Petroleum Fuel/Coal will be off set by high energy efficiency of hot water system than electricity generation, and the reduction of CEB facility cost for very short peak demand supply.

◆ *Chapter 9 Optimum Investment Plan* ◆

Chapter 9 Optimum Investment Plan

9.1 Selecting Optimum Investment Plan

(1) Purpose

The purpose of this chapter is to select through econometric comparative evaluation the investment plan that is the most advantageous in terms of finance and economy from among the power supply investment plans which have been proposed from the technical perspective to meet the projected total power demand.

(2) Evaluation and selection methods

Comparative evaluation models shall be used to select the plan that is the most advantageous in terms of finance and economy from among the proposed power supply plans to meet power demand in the future. Since the power demand to be met (direct benefit) in the future is the same in any of the cases under consideration, the minimum cost method shall be used in comparative evaluation of the proposed plans.

(3) Outline of evaluation models

For the purpose of financial and economic evaluation of the proposed investment plans, evaluation models built for the present project shall be used. The outline of the models prepared using MS/EXCEL is given below.

(1) Financial cost evaluation model

* Input the disbursement amount for each year, including the escalation, to the investment schedule sheet that covers the entire investment period starting from the base year.
* Input all the operating costs (variable and fixed) over the entire period of evaluation, starting from the base year, to prepare a summary table of operating costs, including the escalation.
* Obtain the present values of those costs using a program for calculating present

values by a certain discount rate.

* Prepare a comparison table of the alternative cases (for selecting the optimum case).
* Work out a method of sensitivity analysis for confirming the variation of evaluation results due to changes of major cost items or evaluation conditions.

(2) Economic cost evaluation model

* Build an automatic calculation model which excludes the transfer costs included in all cost items and makes necessary adjustments of the individual cost items to convert the financial costs into economic costs.
* The calculation models for the investment schedule and cost summary table shall be the same as the ones for the financial evaluation model.

9.2 Power Supply Plan

(1) Power development plan

We prepared the power development plan up to 2025. This plan is intended for use in the formulation of a long-term investment plan, and is not intended to be as an electric power master plan. For this reason, the plans by ESMAP and Kennedy & Donkin are formulated on the basis of Loss of Load Probability (LOLP), but, in this case,this method need not be adopted due to an only small number of populations (total number of power sources).

The JICA study team, therefore, paid attention to the supply reserve capacity and formulated a plan aiming at keeping the reserve capacity between minimum 10% and 20% (including 5% of spinning reserve) as a more realistic approach taking examples of other similar developing countries with a relatively small insular power system into consideration.

Based on the forecast of **Chapter 7**, the power demand forecast is estimated as Table 9.2.1. The capacity of the existing facilities is shown in Table 9.2.2. No maintenance work is scheduled for the maximum consumption month of December. The forced-outage rates are shown in Table 9.2.2. The retirement plan of power plants was formulated on the basis of the site survey and through discussion with the CEB. Due to their extensive deterioration, and especially with Fort victoria (Mirrlees), of the constant outage of one or two units because of failure, it was decided to decommission Fort Victoria and St. Louis according to the schedule shown in Table 9.2.3.

From the above condition and an assumption of the utilization of the coal which is abundant and is able to be provided stably in the future, for Base Case and High Case of demand forecast, following three scenarios are assumed.

Scenario 1

From 2021 to 2025, Coal-fired plant with 100 MW will be started to operate each year.

Scenario 2

In 2013 and 2014, Coal-fired plant with 100 MW will be started to operate and from 2023 to 2025, Coal-fired plant with 100 MW will be started to operate each year.

Scenario 3

From 2002 to 2006, Diesel with 50 MW will be stated to operate and from 2021 to 2025, Coal-fired plant with 100 MW will be started to operate each year

As a result, 6 cases of power development plans are shown as Table 9.2.4 through Table 9.2.9.

(a) Short-term Plan (from 1996 to 2000)

Tables 9.2.10 through Table 9.2.14, the power development plans for the 5 years between 1996 and 2000. The power demands for the respective months were estimated on the basis of load curves obtained on the basis of the assumed demand for the respective years. Due to the current work progress, operation of Fort George Unit #3 is scheduled to start December 1996. Operation start of Unit #4 is scheduled for January 1999 due to trouble free progress in the civil works.

With the bagasse project, the operation schedule of starting Beau Champ in 1997 and starting Belle Vue in 2000 was adopted. With the existing power generation stations, the operation schedule of operating the bagasse station between July and November, except for the F.U.E.L. operation was adopted. No maintenance work will be conducted in December, the month of peak power generation. The maintenance intervals adopted are; 6 weeks/year for Fort George, 4 months/year for St. Louis, 2 months/year for Fort Victoria (old), 1 month in the first year, 2 months in the second year and so on for Fort Victoria (new), and 1 month/year for Nicolay.

As there are several months with shortage of electricity in 1998 according to Table 9.2.12., an additional 34MW GT should be considered urgently.

(b) Medium and Long term Plan (from 2001 to 2025)

After 2001, Fort George Unit #5 will start operation in 2001, followed by the development of 50 - 75 MW GT and 150 - 225 MW CCGT in combination in the course of time.

As the power system is expected to increase to 1,100 - 1,600 MW by 2020 to 2025, the installation of 100 MW power supply units becomes feasible, and the JICA study team recommends the introduction of coal-fired thermal plants to reduce generation cost.

As construction sites, Fort-William near to the capital and Grand-Port located on the south-east of the inland are recommended. But, F/S is necessary as soon as possible for realization of these CCGT and Coal-fired thermal Plant.
As for generation costs, Chap.8.1 is referred.

(2) Transmission Line and Substation Plan

JICA`s study team has reviewed the past reports, ESMAP and Rust Kennedy & Dunkin`s , regarding the transmission lines, distribution lines and substations.
Kennedy & Donkin`s report has accurately covered the present situation and the technical issues including necessary analyses in detail up to 2015.

After 2015, 132kV transmission lines, substations should be added to the CEB`s network according to the commissioning of 225MW CCGT and 200 or 300MW Coal-fired thermal plants.
Distribution system also has to be reinforced year by year accordingly.

Recommendations or expansion planning are summarized as follows,

1) Short-term(1996-2000)
The result of the analysis carried out for the short-term indicate that the 66kV voltage can be maintained in the period to the year 2000.
In evaluating the costs, it has been assumed that all of the future transmission lines will be constructed in accordance with 132kV design standards, to facilitate upgrading to the higher voltage in the longer term.

From a technical point of view, given that the short-term generation plan indicates that Fort-George should continue to be extended, and that energy needs to be transmitted to the Curepipe area.

Scenario 1 will be recommended for the transmission development in the short-term after economic evaluation of three alternative scenarios.
Breakdown of scenario 1 is shown in Table 9.2.15 and the drawing in figure 9.2.2.

The distributed forecast of evening peak loads, 1995-1999 is shown in Table 9.2.16.

2) Medium & long-term(2001-2015)

The result of the long-term transmission planning analysis suggest that the 132kV voltage should be introduced for the part of the system during the medium-term between years 2005 and 2008, with the precise timing depending on the load forecast scenario assumed. Under the base load forecast, the first upgrade to 132kV operation on the system would be required in 2007.

This scenario turns out to be the optimum from the transmission viewpoint, with generation at Fort-William initially connected to the 66kV network. In the period between 2005 and 2008 part of the network is uplifted to 132kV voltage level.

Further consideration was given in this scenario to earlier introduction of high voltage to the system.

Table 9.2.17 and Figure 9.2.3-5 represent the overhead line and substation developments recommended by the years 2005, 2010 and 2015 as they are proposed to be erected.

All the major overhead lines recommended should be installed to a 132kV design voltage level, although they should be initially operated at 66kV. It is shown that the first step of the upgrade should include the Fort-William, Rose Hill and Wooton substations, with associated overhead lines. Next step should be taken within the following two years, to upgrade the Nicolay II substation, L`Avenir and Amoury including the step-up and step-down transformers.

The Fort-George and Nicolay sites already have an established concept based on the 66kV voltage level. It is suggested that this concept should be retained for supplying the northern parts of Port-Louis city, the industrial zone around Fort-George, Arsenal and larger area of Belle Vue.

Besides Nicolay II, St. Louis substation should be another key substation in 66kV system with enough generation to ultimately supply the rest of Port-Louis city and area between, and including St. Louis and Chaumiere.

Table 9.2.18 shows bulk supply point transformers, and Table 9.2.19-20 shows distributed forecast of evening peak loads.

Table 9.2.1 ELECTRICITY PEAK DEMAND FORECAST

Unit : MW

Years	Base case	High case	Low case
1995	200	200	200
1996	222	222	222
1997	241	242	241
1998	257	257	256
1999	271	272	271
2000	288	289	287
2001	315	323	313
2002	344	358	339
2003	372	395	364
2004	402	435	390
2005	428	474	413
2006	455	515	435
2007	485	563	460
2008	516	615	485
2009	549	672	512
2010	584	735	539
2011	601	755	565
2012	655	772	612
2013	711	842	660
2014	770	916	709
2015	831	993	760
2016	895	1,076	813
2017	963	1,163	868
2018	1,035	1,256	925
2019	1,110	1,356	985
2020	1,191	1,462	1,048
2021	1,276	1,576	1,114
2022	1,367	1,698	1,184
2023	1,465	1,829	1,257
2024	1,569	1,970	1,334
2025	1,680	2,122	1,415

Note: refer to Chapter 7

Table 9.2.2 CONDITION OF POWER GENERATION FACILITIES

Plant Name & Type	Unit Capacity	Available Units	Effective Capacity	Forced Outage
	MW		MW	p.u.
St. Louis	10	6	60	0.25
Fort Victoria (New)	9	2	18	0.15
Fort Victoria (Old)	4	7	28	0.25
Nicolay	23	1	23	0.04
	23	1	23	0.04
	34	1	34	0.04
Fort George 1&2	24	2	48	0.05
Fort George 3,4&5	29	3	87	0.05
Hydro	10		10	0.01
Bagasse cum coal	—	--	—	0.15
GT (new)				0.03
CCGT (new)				0.03
Coal (new)				0.03

1. Service Life — Diesel : 25 years
   GT : 20 years
   CCGT : 20 years
   Coal : 25 years
2. Forced Outage — St. Louis : fixed
   Fort Victoria : fixed
   others : 1% increses by 5 years

Table 9.2.3 RETIREMENT PROGRAM

Year	Plant Name	Retired Capacity (MW)	
		Unit	Total
1995			
1996			
1997			
1998			
1999	St. Louis 3	10	10
2000	Fort Victoria 6	4	28
	Fort Victoria 5	4	
	St. Louis 1& 2	20	
2001	Fort Victoria 4	4	18
	Fort Victoria 7	4	
		10	
2002	Fort Victoria 8	4	8
	Fort Victoria 9	4	
2003	Fort Victoria 10	4	14
	St. Louis 4	10	
2004	St. Louis 5	10	10
2005	St. Louis 6	10	10
2006	Fort Victoria MAN 1	9	9
2007	Fort Victoria MAN 2	9	9

Table 9.2.4 POWER DEVELOPMENT PLAN (BASE CASE-1)

as of end Dec.

Year	Peak Demand Forecast (MW) (a)	Added Capacity (MW)	Added Units	Retired or Transferred Capacity (MW)	Retired or Transferred Units	Total Capacity (MW) (b)	Biggest Unit (MW) (c)	Available Capacity (MW) (d)=(b)-(c)	Margin (e)=(d)-(a) (MW)	Margin (e)=(d)-(a) (%)
1996	222	29	FG3(29)			285	34.0	251.0	29.0	13.1
1997	241	15	Beau Champ(15), Bagasse Replace(3.5)*			300	34.0	266.0	25.0	10.4
1998	257	34	Bagasse Replace(9)* #GT(34)			334	34.0	300.0	43.0	16.7
1999	271	29	FG4	10	St.L.(10)	353	34.0	319.0	48.0	17.7
2000	288	40	Belle Vue	28	2F.V.(4, 4), 2St.L.(10,10)	365	34.0	331.0	43.0	14.9
2001	315	29	FG5	8	2F.V.(4, 4)	386	34.0	352.0	37.0	11.7
2002	344	50	GT*	8	2F.V.(4, 4)	428	50.0	378.0	34.0	9.9
2003	372	50	GT*	14	F.V.(4), St.L.(10)	464	50.0	414.0	42.0	11.3
2004	402	150	CCGT	110	St.L.(10),2GT(50, 50)*	504	50.0	454.0	52.0	12.9
2005	428	50	GT*	10	St.L.(10)	544	50.0	494.0	66.0	15.4
2006	455	50	GT*	9	F.V.(9)	585	50.0	535.0	80.0	17.6
2007	485	150	CCGT	109	F.V.(9),2GT(50, 50)*	626	50.0	576.0	91.0	18.8
2008	516	50	GT*	23	Nicolay(23)	653	50.0	603.0	87.0	16.9
2009	549	50	GT*			703	50.0	653.0	104.0	18.9
2010	584	150	CCGT	100	2GT(50, 50)*	753	50.0	703.0	119.0	20.4
2011	601	50	GT*	23	Nicolay(23)	780	50.0	730.0	129.0	21.5
2012	655	50	GT*			830	50.0	780.0	125.0	19.1
2013	711	150	CCGT	100	2GT(50, 50)*	880	50.0	830.0	119.0	16.7
2014	770	75	GT*			955	75.0	880.0	110.0	14.3
2015	831	75	GT*	34	Nicolay(34)	996	75.0	921.0	90.0	10.8
2016	895	225	CCGT	150	2GT(75, 75)*	1,071	75.0	996.0	101.0	11.3
2017	963	200	2GT(75, 75)*,GT(50)	24	FG1(24)	1,247	75.0	1,172.0	209.0	21.7
2018	1,035	225	CCGT	174	FG2(24), 2GT(75, 75)*	1,298	75.0	1,223.0	188.0	18.2
2019	1,110	150	2GT(75, 75)*	34	GT(34)	1,414	75.0	1,339.0	229.0	20.6
2020	1,191	225	CCGT	150	2GT(75, 75)*	1,489	75.0	1,414.0	223.0	18.7
2021	1,276	100	Coal(2*100)			1,589	100.0	1,489.0	213.0	16.7
2022	1,367	150	GT(50),Coal(100)*	29	FG3(29)	1,710	100.0	1,610.0	243.0	17.8
2023	1,465	100	Coal(3*100)			1,810	100.0	1,710.0	245.0	16.7
2024	1,569	150	GT(50),Coal(100)*			1,960	100.0	1,860.0	291.0	18.5
2025	1,680	100	Coal*			2,060	100.0	1,960.0	280.0	16.7

Table 9.2.5 POWER DEVELOPMENT PLAN (BASE CASE-2)

as of end Dec.

Year	Peak Demand Forecast (MW) (a)	Added Capacity (MW)	Added Units	Retired or Transferred Capacity (MW)	Retired or Transferred Units	Total Capacity (MW) (b)	Biggest Unit (MW) (c)	Available Capacity (MW) (d)=(b)-(c)	Margin (e)=(d)-(a) (MW)	Margin (%)
1996	222	29	FG3(29)			285	34.0	251.0	29.0	13.1
1997	241	15	Beau Champ(15), Bagasse Replace(3.5)*			300	34.0	266.0	25.0	10.4
1998	257	34	Bagasse Replace(9)* #GT(34)			334	34.0	300.0	43.0	16.7
1999	271	29	FG4	10	St.L.(10)	353	34.0	319.0	48.0	17.7
2000	288	40	Belle Vue	28	2F.V.(4, 4), 2St.L.(10,10)	365	34.0	331.0	43.0	14.9
2001	315	29	FG5	8	2F.V.(4, 4)	386	34.0	352.0	37.0	11.7
2002	344	50	GT*	8	2F.V.(4, 4)	428	50.0	378.0	34.0	9.9
2003	372	50	GT*	14	F.V.(4), St.L.(10)	464	50.0	414.0	42.0	11.3
2004	402	150	CCGT	110	St.L.(10),2GT(50, 50)*	504	50.0	454.0	52.0	12.9
2005	428	50	GT*	10	St.L.(10)	544	50.0	494.0	66.0	15.4
2006	455	50	GT*	9	F.V.(9)	585	50.0	535.0	80.0	17.6
2007	485	150	CCGT	109	F.V.(9),2GT(50, 50)*	626	50.0	576.0	91.0	18.8
2008	516	50	GT*	23	Nicolay(23)	653	50.0	603.0	87.0	16.9
2009	549	50	GT*			703	50.0	653.0	104.0	18.9
2010	584	150	CCGT	100	2GT(50, 50)*	753	50.0	703.0	119.0	20.4
2011	601	50	GT*	23	Nicolay(23)	780	50.0	730.0	129.0	21.5
2012	655	50	GT*			830	50.0	780.0	125.0	19.1
2013	711	150	CCGT	100	2GT(50, 50)*	880	50.0	830.0	119.0	16.7
2014	770	100	Coal(2*100)			980	100.0	880.0	110.0	14.3
2015	831	100	Coal*	34	Nicolay(34)	1,046	100.0	946.0	115.0	13.8
2016	895	75	GT			1,121	100.0	1,021.0	126.0	14.1
2017	963	125	GT(75)*,GT(50)	24	FG1(24)	1,222	100.0	1,122.0	159.0	16.5
2018	1,035	225	CCGT	174	FG2(24), 2GT(75, 75)*	1,273	100.0	1,173.0	138.0	13.3
2019	1,110	150	2GT(75, 75)*	34	GT(34)	1,389	100.0	1,289.0	179.0	16.1
2020	1,191	225	CCGT	150	2GT(75, 75)*	1,464	100.0	1,364.0	173.0	14.5
2021	1,276	150	2GT(75, 75)*			1,614	100.0	1,514.0	238.0	18.7
2022	1,367	275	GT(50),CCGT(225)	179	FG3(29), 2GT(75, 75)*	1,710	100.0	1,610.0	243.0	17.8
2023	1,465	100	Coal(3*100)			1,810	100.0	1,710.0	245.0	16.7
2024	1,569	150	GT(50),Coal(100)*			1,960	100.0	1,860.0	291.0	18.5
2025	1,680	100	Coal*			2,060	100.0	1,960.0	280.0	16.7

Table 9.2.6 POWER DEVELOPMENT PLAN (BASE CASE-3)

as of end Dec.

Year	Peak Demand Forecast (MW) (a)	Added Capacity (MW)	Added Units	Retired or Transferred Capacity (MW)	Retired or Transferred Units	Total Capacity (MW) (b)	Biggest Unit (MW) (c)	Available Capacity (MW) (d)=(b)-(c)	Margin (e)=(d)-(a) (MW)	Margin (e)=(d)-(a) (%)
1996	222	29	FG3(29)			285	34	251.0	29.0	13.1
1997	241	15	Beau Champ(15), Bagasse Replace(3.5)*			300	34	266.0	25.0	10.4
1998	257	34	Bagasse Replace(9)* #GT(34)			334	34	300.0	43.0	16.7
1999	271	29	FG4	10	St.L.(10)	353	34	319.0	48.0	17.7
2000	288	40	Belle Vue	28	2F.V.(4, 4), 2St.L.(10,10)	365	34	331.0	43.0	14.9
2001	315	29	FG5	8	2F.V.(4, 4)	386	34	352.0	37.0	11.7
2002	344	50	Diesel	8	2F.V.(4, 4)	428	50	378.0	34.0	9.9
2003	372	50	Diesel	14	F.V.(4), St.L.(10)	464	50	414.0	42.0	11.3
2004	402	50	Diesel	10	St.L(10)	504	50	454.0	52.0	12.9
2005	428	50	Diesel	10	St.L.(10)	544	50	494.0	66.0	15.4
2006	455	50	Diesel	9	F.V.(9)	585	50	535.0	80.0	17.6
2007	485	50	Diesel	9	F.V.(9)	626	50	576.0	91.0	18.8
2008	516	50	GT*	23	Nicolay(23)	653	50	603.0	87.0	16.9
2009	549	50	GT*			703	50	653.0	104.0	18.9
2010	584	150	CCGT	100	2GT(50, 50)*	753	50	703.0	119.0	20.4
2011	601	50	GT*	23	Nicolay(23)	780	50	730.0	129.0	21.5
2012	655	50	GT*			830	50	780.0	125.0	19.1
2013	711	150	CCGT	100	2GT(50, 50)*	880	50	830.0	119.0	16.7
2014	770	75	GT*			955	75	880.0	110.0	14.3
2015	831	75	GT*	34	Nicolay(34)	996	75	921.0	90.0	10.8
2016	895	225	CCGT	150	2GT(75, 75)*	1,071	75	996.0	101.0	11.3
2017	963	200	2GT(75, 75)*,GT(50)	24	FG1(24)	1,247	75	1,172.0	209.0	21.7
2018	1,035	225	CCGT	174	FG2(24), 2GT(75, 75)*	1,298	75	1,223.0	188.0	18.2
2019	1,110	150	2GT(75, 75)*	34	GT(34)	1,414	75	1,339.0	229.0	20.6
2020	1,191	225	CCGT	150	2GT(75, 75)*	1,489	75	1,414.0	223.0	18.7
2021	1,276	100	Coal(2*100)			1,589	100	1,489.0	213.0	16.7
2022	1,367	150	GT(50),Coal(100)*	29	FG3(29)	1,710	100	1,610.0	243.0	17.8
2023	1,465	100	Coal(3*100)			1,810	100	1,710.0	245.0	16.7
2024	1,569	150	GT(50),Coal(100)*			1,960	100	1,860.0	291.0	18.5
2025	1,680	100	Coal*			2,060	100	1,960.0	280.0	16.7

Table 9.2.7 POWER DEVELOPMENT PLAN (HIGH CASE-1)

as of end Dec.

Year	Peak Demand Forecast (MW) (a)	Added Capacity (MW)	Added Units	Retired or Transferred Capacity (MW)	Retired or Transferred Units	Total Capacity (MW) (b)	Biggest Unit (MW) (c)	Available Capacity (MW) (d)=(b)-(c)	Margin (e)=(d)-(a) (MW)	Margin (e)=(d)-(a) (%)
1996	222	29	FG3(29)			285	34.0	251.0	29.0	13.1
1997	242	15	Beau Champ(15), Bagasse Replace(3.5)*			300	34.0	266.0	24.0	9.9
1998	257	34	Bagasse Replace(9)* #GT(34)			334	34.0	300.0	43.0	16.7
1999	272	29	FG4	10	St.L.(10)	353	34.0	319.0	47.0	17.3
2000	289	40	Belle Vue	28	2F.V.(4, 4), 2St.L.(10,10)	365	34.0	331.0	42.0	14.5
2001	323	79	FG5(29), GT*(50)	8	2F.V.(4, 4)	436	34.0	402.0	79.0	24.5
2002	358	50	GT*	8	2F.V.(4, 4)	478	50.0	428.0	70.0	19.6
2003	395	150	CCGT	114	F.V.(4), St.L.(10),2GT(50, 50)*	514	50.0	464.0	69.0	17.5
2004	435	50	GT*	10	St.L(10)	554	50.0	504.0	69.0	15.9
2005	474	50	GT*	10	St.L(10)	594	50.0	544.0	70.0	14.8
2006	515	150	CCGT	109	F.V.(9),2GT(50, 50)*	635	50.0	585.0	70.0	13.6
2007	563	50	GT*	9	F.V.(9)	676	50.0	626.0	63.0	11.2
2008	615	50	GT*	23	Nicolay(23)	703	50.0	653.0	38.0	6.2
2009	672	150	CCGT	100	2GT(50, 50)*	753	50.0	703.0	31.0	4.6
2010	735	75	GT*			828	75.0	753.0	18.0	2.4
2011	755	75	GT*	23	Nicolay(23)	880	75.0	805.0	50.0	6.6
2012	772	225	CCGT	150	2GT(75, 75)*	955	75.0	880.0	108.0	14.0
2013	842	75	GT*			1,030	75.0	955.0	113.0	13.4
2014	916	75	GT*			1,105	75.0	1,030.0	114.0	12.4
2015	993	225	CCGT	184	Nicolay(34),2GT(75, 75)*	1,146	75.0	1,071.0	78.0	7.9
2016	1,076	75	GT*			1,221	75.0	1,146.0	70.0	6.5
2017	1,163	125	GT(75)*,GT(50)	24	FG1(24)	1,322	75.0	1,247.0	84.0	7.2
2018	1,256	225	CCGT	174	FG2(24), 2GT(75, 75)*	1,373	75.0	1,298.0	42.0	3.3
2019	1,356	150	2GT(75, 75)*	34	GT(34)	1,489	75.0	1,414.0	58.0	4.3
2020	1,462	225	CCGT	150	2GT(75, 75)*	1,564	75.0	1,489.0	27.0	1.8
2021	1,576	250	Coal(2*100),2GT(75,75)*			1,814	100.0	1,714.0	138.0	8.8
2022	1,698	375	Coal(100)*,CCGT(225),GT(50)	179	FG3(29),2GT(75, 75)*	2,010	100.0	1,910.0	212.0	12.5
2023	1,829	250	Coal(3*100),2GT(75,75)*			2,260	100.0	2,160.0	331.0	18.1
2024	1,970	325	Coal(100)*,CCGT(225)	150	2GT(75, 75)*	2,435	100.0	2,335.0	365.0	18.5
2025	2,122	150	Coal(100)*,GT(50)			2,585	100.0	2,485.0	363.0	17.1

Table 9.2.8 POWER DEVELOPMENT PLAN (HIGH CASE-2)

as of end Dec.

Year	Peak Demand Forecast (MW) (a)	Added		Retired or Transferred		Total Capacity (MW) (b)	Biggest Unit (MW) (c)	Available Capacity (MW) (d)=(b)-(c)	Margin (e)=(d)-(a)	
		Capacity (MW)	Units	Capacity (MW)	Units				(MW)	(%)
1996	222	29	FG3(29)			285	34.0	251.0	29.0	13.1
1997	242	15	Beau Champ(15), Bagasse Replace(3.5)*			300	34.0	266.0	24.0	9.9
1998	257	34	Bagasse Replace(9)* #GT(34)			334	34.0	300.0	43.0	16.7
1999	272	29	FG4	10	St.L.(10)	353	34.0	319.0	47.0	17.3
2000	289	40	Belle Vue	28	2F.V.(4, 4), 2St.L.(10,10)	365	34.0	331.0	42.0	14.5
2001	323	79	FG5(29), GT*(50)	8	2F.V.(4, 4)	436	50.0	386.0	63.0	19.5
2002	358	50	GT*	8	2F.V.(4, 4)	478	50.0	428.0	70.0	19.6
2003	395	150	CCGT	114	F.V.(4), St.L.(10),2GT(50, 50)*	514	50.0	464.0	69.0	17.5
2004	435	50	GT*	10	St.L(10)	554	50.0	504.0	69.0	15.9
2005	474	50	GT*	10	St.L(10)	594	50.0	544.0	70.0	14.8
2006	515	150	CCGT	109	F.V.(9),2GT(50, 50)*	635	50.0	585.0	70.0	13.6
2007	563	50	GT*	9	F.V.(9)	676	50.0	626.0	63.0	11.2
2008	615	50	GT*	23	Nicolay(23)	703	50.0	653.0	38.0	6.2
2009	672	150	CCGT	100	2GT(50, 50)*	753	50.0	703.0	31.0	4.6
2010	735	75	GT*			828	75.0	753.0	18.0	2.4
2011	755	75	GT*	23	Nicolay(23)	880	75.0	805.0	50.0	6.6
2012	772	225	CCGT	150	2GT(75, 75)*	955	75.0	880.0	108.0	14.0
2013	842	100	Coal(2*100)			1,055	100.0	955.0	113.0	13.4
2014	916	100	Coal*			1,155	100.0	1,055.0	139.0	15.2
2015	993	75	GT*	34	Nicolay(34)	1,196	100.0	1,096.0	103.0	10.4
2016	1,076	75	GT*			1,271	100.0	1,171.0	95.0	8.8
2017	1,163	275	CCGT(225)*,GT(50)	174	FG1(24), 2GT(75, 75)*	1,372	100.0	1,272.0	109.0	9.4
2018	1,256	150	2GT(75, 75)*	58	FG2(24), GT(34)	1,464	100.0	1,364.0	108.0	8.6
2019	1,356	225	CCGT	150	2GT(75, 75)*	1,539	100.0	1,439.0	83.0	6.1
2020	1,462	150	2GT(75, 75)*			1,689	100.0	1,589.0	127.0	8.7
2021	1,576	225	CCGT	150	2GT(75, 75)*	1,764	100.0	1,664.0	88.0	5.6
2022	1,698	200	2GT(75, 75)*,GT(50)	29	FG3(29)	1,935	100.0	1,835.0	137.0	8.1
2023	1,829	375	Coal(3*100),CCGT(225),GT(50)	150	2GT(75, 75)*	2,160	100.0	2,060.0	231.0	12.6
2024	1,970	250	Coal(100)*,2GT(75, 75)*			2,410	100.0	2,310.0	340.0	17.3
2025	2,122	325	Coal(100)*,CCGT(225)	150	2GT(75, 75)*	2,585	100.0	2,485.0	363.0	17.1

Table 9.2.9 POWER DEVELOPMENT PLAN (HIGH CASE-3)

as of end Dec.

Year	Peak Demand Forecast (MW) (a)	Added Capacity (MW)	Added Units	Retired or Transferred Capacity (MW)	Retired or Transferred Units	Total Capacity (MW) (b)	Biggest Unit (MW) (c)	Available Capacity (MW) (d)=(b)-(c)	Margin (e)=(d)-(a) (MW)	Margin (e)=(d)-(a) (%)
1996	222	29	FG3(29)			285	34.0	251.0	29.0	13.1
1997	242	15	Beau Champ(15), Bagasse Replace(3.5)*			300	34.0	266.0	24.0	9.9
1998	257	34	Bagasse Replace(9)* #GT(34)			334	34.0	300.0	43.0	16.7
1999	272	29	FG4	10	St.L.(10)	353	34.0	319.0	47.0	17.3
2000	289	40	Belle Vue	28	2F.V.(4, 4), 2St.L.(10,10)	365	34.0	331.0	42.0	14.5
2001	323	79	FG5(29), Diesel(50)	8	2F.V.(4, 4)	436	50.0	386.0	63.0	19.5
2002	358	50	Diesel	8	2F.V.(4, 4)	478	50.0	428.0	70.0	19.6
2003	395	50	Diesel	14	F.V.(4), St.L.(10)	514	50.0	464.0	69.0	17.5
2004	435	50	Diesel	10	St.L(10)	554	50.0	504.0	69.0	15.9
2005	474	50	Diesel	10	St.L.(10)	594	50.0	544.0	70.0	14.8
2006	515	50	Diesel	9	F.V.(9)	635	50.0	585.0	70.0	13.6
2007	563	50	GT*	9	F.V.(9)	676	50.0	626.0	63.0	11.2
2008	615	50	GT*	23	Nicolay(23)	703	50.0	653.0	38.0	6.2
2009	672	150	CCGT	100	2GT(50, 50)*	753	50.0	703.0	31.0	4.6
2010	735	75	GT*			828	75.0	753.0	18.0	2.4
2011	755	75	GT*	23	Nicolay(23)	880	75.0	805.0	50.0	6.6
2012	772	225	CCGT	150	2GT(75, 75)*	955	75.0	880.0	108.0	14.0
2013	842	75	GT*			1,030	75.0	955.0	113.0	13.4
2014	916	75	GT*			1,105	75.0	1,030.0	114.0	12.4
2015	993	225	CCGT	184	Nicolay(34),2GT(75, 75)*	1,146	75.0	1,071.0	78.0	7.9
2016	1,076	75	GT*			1,221	75.0	1,146.0	70.0	6.5
2017	1,163	125	GT(75)*,GT(50)	24	FG1(24)	1,322	75.0	1,247.0	84.0	7.2
2018	1,256	225	CCGT	174	FG2(24), 2GT(75, 75)*	1,373	75.0	1,298.0	42.0	3.3
2019	1,356	150	2GT(75, 75)*	34	GT(34)	1,489	75.0	1,414.0	58.0	4.3
2020	1,462	225	CCGT	150	2GT(75, 75)*	1,564	75.0	1,489.0	27.0	1.8
2021	1,576	175	Coal(2*100),GT(75)*			1,739	100.0	1,639.0	63.0	4.0
2022	1,698	225	Coal(100)*,GT(75)*,GT(50)	29	FG3(29)	1,935	100.0	1,835.0	137.0	8.1
2023	1,829	325	Coal(3*100),CCGT(225)	150	2GT(75, 75)*	2,110	100.0	2,010.0	181.0	9.9
2024	1,970	175	Coal(100)*,GT(75)*			2,285	100.0	2,185.0	215.0	10.9
2025	2,122	225	Coal(100)*,GT(75)*,GT(50)			2,510	100.0	2,410.0	288.0	13.6

Table 9.2.10 POWER DEMAND AND SUPPLY IN 1996 (BASE CASE,REFERENCE)

Unit : MW

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fort George 1	24	24	24	24	24	24	24			24	24	24
Fort George 2	24			24	24	24	24	24	24	24	24	24
Fort George 3												
St. Louis	50	50	60	50	50	50	50	50	60	50	50	50
Fort Victoria 1	24	24	28	24	24	28	28	24	24	24	24	24
Fort Victoria 2	9	9	9	18	18	18	9	9	9	18	18	18
Nicolay 1	23	23	23	23	23	23	23	23	23	23	23	23
Nicolay 2	23	23	23	23	23	23		23	23	23	23	23
Nicolay 3	34	34		34	34	34	34	34	34	34	34	34
Hydro	10	20	40	40	20	20	15	15	15	10	10	10
FUEL	15	15	15				12	12	12	12	12	12
Medine							4	4	6	6	6	
Riche en Eau							5	5	5	5	5	
Union St. Aubin							1	1	1	1	1	
Mon Tresor Mon Desert							2	2	2	2	2	
Beau Champ							12	12	12	12	12	15
Other Bagasse							1.1	1.1	1.1	1.1	1.1	
Total Supply Capacity (a)	236.0	222.0	222.0	260.0	240.0	244.0	244.1	239.1	251.1	269.1	269.1	257.0
Biggest Unit Capacity (b)	34	34	29	34	34	34	34	34	34	34	34	34
Available Supply Capacity (c)=(a)-(b)	202.0	188.0	193.0	226.0	206.0	210.0	210.1	205.1	217.1	235.1	235.1	223.0
Peak Demand (d)	213.8	217.1	220.3	224.6	221.4	219.3	219.1	220.5	221.1	224.1	231.0	228.4
Spinning Reserve (5%) (e)	10.7	10.9	11.0	11.2	11.1	11.0	11.0	11.0	11.1	29.0	11.6	11.4
Total Demand (f)=(d)+(e)	224.5	228.0	231.3	235.8	232.5	230.3	230.1	231.5	232.2	253.1	242.6	239.8
Margin (g)=(c)-(f)	-22.5	-40.0	-38.3	-9.8	-26.5	-20.3	-20.0	-26.4	-15.1	-18.0	-7.4	-16.8
Margin (%) (g)/(d)	-10.5	-18.4	-17.4	-4.4	-12.0	-9.2	-9.1	-12.0	-6.8	-8.0	-3.2	-7.4

Table 9.2.11 POWER DEMAND AND SUPPLY IN 1997 (BASE CASE)

Unit : MW

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fort George 1	24	24	24	24	24	24	24			24	24	24
Fort George 2	24			24	24	24	24	24	24	24	24	24
Fort George 3	29	29	29	29	29	29	29	29	29	29	29	29
St. Louis	50	50	60	50	50	50	50	50	60	50	50	50
Fort Victoria 1	24	24	28	24	24	28	28	24	24	24	24	24
Fort Victoria 2	9	9	9	18	18	18	9	9	9	18	18	18
Nicolay 1	23	23	23	23	23	23	23	23	23	23	23	23
Nicolay 2	23	23	23	23	23	23		23	23	23	23	23
Nicolay 3	34	34		34	34	34	34	34	34	34	34	34
Hydro	10	20	40	40	20	20	15	15	15	10	10	10
FUEL	15	15	15				12	12	12	12	12	12
Medine							4	4	6	6	6	
Riche en Eau							5	5	5	5	5	
Union St. Aubin							1	1	1	1	1	
Mon Tresor Mon Desert							2	2	2	2	2	
Beau Champ							12	12	12	12	12	15
Other Bagasse							1.1	1.1	1.1	1.1	1.1	
Total Supply Capacity (a)	265.0	251.0	251.0	289.0	269.0	273.0	273.1	268.1	280.1	298.1	298.1	286.0
Biggest Unit Capacity (b)	34	34	29	34	34	34	34	34	34	34	34	34
Available Supply Capacity (c)=(a)-(b)	231.0	217.0	222.0	255.0	235.0	239.0	239.1	234.1	246.1	264.1	264.1	252.0
Peak Demand (d)	213.8	217.1	220.3	224.6	221.4	219.3	219.1	220.5	221.1	224.1	231.0	228.4
Spinning Reserve (5%) (e)	10.7	10.9	11.0	11.2	11.1	11.0	11.0	11.0	11.1	29.0	11.6	11.4
Total Demand (f)=(d)+(e)	224.5	228.0	231.3	235.8	232.5	230.3	230.1	231.5	232.2	253.1	242.6	239.8
Margin (g)=(c)-(f)	6.5	-11.0	-9.3	19.2	2.5	8.7	9.0	2.6	13.9	11.0	21.6	12.2
Margin (%) (g)/(d)	3.0	-5.0	-4.2	8.5	1.1	4.0	4.1	1.2	6.3	4.9	9.3	5.3

Table 9.2.12 POWER DEMAND AND SUPPLY IN 1998 (BASE CASE)

Unit : MW

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fort George 1	24	24	24	24	24	24	24			24	24	24
Fort George 2	24	24	24	24			24	24	24	24	24	24
Fort George 3	29	29			29	29	29	29	29	29	29	29
St. Louis	50	50	50	50	60	50	50	50	50	50	50	50
Fort Victoria 1	28	28	28	28	28	28	24	24	24	24	24	24
Fort Victoria 2	9	9	18	18	18	18	9	18	18	18	18	18
Nicolay 1	23	23	23	23	23	23	23	23	23	23	23	23
Nicolay 2	23	23		23	23	23	23	23	23	23	23	23
Nicolay 3	34	34	34	34	34	34	34	34	34		34	34
Hydro	10	25	45	45	30	30	15	15	15	10	10	10
FUEL	15	15	15			15	18	18	18	18	18	18
Medine							4	4	6	6	6	
Riche en Eau							5	5	5	5	5	
Union St. Aubin							5	5	5	5	5	
Mon Desert Alma							4.5	4.5	4.5	4.5	4.5	
Mon Tresor Mon Desert							2	2	2	2	2	
Mon Loiser							4.5	4.5	4.5	4.5	4.5	
Beau Champ			15	15	15	15	12	12	12	12	12	15
Savannah							5	5	5	5		
Other Bagasse							1.1	1.1	1.1	1.1	1.1	
Total Supply Capacity (a)	269.0	284.0	276.0	284.0	284.0	289.0	316.1	301.1	303.1	288.1	317.1	292.0
Biggest Unit Capacity (b)	34	34	34	34	34	34	34	34	34	29	34	34
Available Supply Capacity (c)=(a)-(b)	235.0	250.0	242.0	250.0	250.0	255.0	282.1	267.1	269.1	259.1	283.1	258.0
Peak Demand (d)	230.9	234.4	237.9	242.6	239.1	236.9	236.7	238.2	238.8	242.0	249.5	246.6
Spinning Reserve (5%) (e)	11.5	11.7	11.9	12.1	12.0	11.8	11.8	11.9	11.9	12.1	12.5	12.3
Total Demand (f)=(d)+(e)	242.4	246.1	249.8	254.7	251.1	248.7	248.5	250.1	250.7	254.1	262.0	258.9
Margin (g)=(c)-(f)	-7.4	3.9	-7.8	-4.7	-1.1	6.3	33.6	17.0	18.4	5.0	21.1	-0.9
Margin (%) (g)/(d)	-3.2	1.7	-3.3	-1.9	-0.4	2.6	14.2	7.1	7.7	2.1	8.5	-0.4

Table 9.2.13 POWER DEMAND AND SUPPLY IN 1999 (BASE CASE)

Unit : MW

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fort George 1	24	24	24	24	24	24	24			24	24	24
Fort George 2	24	24	24			24	24	24	24	24	24	24
Fort George 3	29			29	29	29	29	29	29	29	29	29
Fort George 4	29	29	29	29	29	29	29	29			29	29
St. Louis	50	50	50	50	50	50	50	50	50	50	50	50
Fort Victoria 1	24	24	24	24	24	24	24	24	24	24	24	24
Fort Victoria 2	9	18	18	18	18	9	9	18	18	9	18	18
Nicolay 1	23	23		23	23	23	23	23	23	23	23	23
Nicolay 2	23	23	23	23	23	23		23	23	23	23	23
Nicolay 3	34	34	34	34	34	34	34	34	34	34		34
Hydro	10	25	45	45	30	20	15	15	15	10	10	10
FUEL	23	23	23			18	18	18	18	18	18	18
Medine							4	4	6	6	6	
Riche en Eau							5	5	5	5	5	
Union St. Aubin							5	5	5	5	5	
Mon Desert Alma							4.5	4.5	4.5	4.5	4.5	
Mon Tresor Mon Desert							2	2	2	2	2	
Mon Loiser							4.5	4.5	4.5	4.5	4.5	
Beau Champ			15	15	15	15	12	12	12	12	12	15
Savannah							5	5	5	5		
Other Bagasse							1.1	1.1	1.1	1.1	1.1	
Total Supply Capacity (a)	302.0	297.0	309.0	314.0	299.0	322.0	322.1	330.1	303.1	29.0	312.1	321.0
Biggest Unit Capacity (b)	34	34	34	34	34	34	34	34	34	34	29	34
Available Supply Capacity (c)=(a)-(b)	268.0	263.0	275.0	280.0	265.0	288.0	288.1	296.1	269.1	-5.0	283.1	287.0
Peak Demand (d)	249.4	253.2	257.0	262.0	258.2	255.8	255.6	257.2	257.9	261.4	269.5	266.4
Spinning Reserve (5%) (e)	12.5	12.7	12.9	13.1	12.9	12.8	12.8	12.9	12.9	13.1	13.5	13.3
Total Demand (f)=(d)+(e)	261.9	265.9	269.9	275.1	271.1	268.6	268.4	270.1	270.8	274.5	283.0	279.7
Margin (g)=(c)-(f)	6.1	-2.9	5.1	4.9	-6.1	19.4	19.7	26.0	-1.7	-279.5	0.1	7.3
Margin (%) (g)/(d)	2.5	-1.1	2.0	1.9	-2.4	7.6	7.7	10.1	-0.7	-106.9	0.0	2.7

Table 9.2.14 POWER DEMAND AND SUPPLY IN 2000 (BASE CASE)

Unit : MW

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fort George 1	24	24	24	24	24	24	24			24	24	24
Fort George 2	24	24	24			24	24	24	24	24	24	24
Fort George 3	29	29	29	29	29	29			29	29	29	29
Fort George 4	29	29	29	29	29	29	29	29			29	29
St. Louis	60	60	60	60	60	50	50	50	50	40	40	40
Fort Victoria 1	24	24	24	24	20	20	20	20	20	16	16	16
Fort Victoria 2	18	18	9	18	18	18	18	9	9	18	18	18
Nicolay 1	23	23	23	23	23	23		23	23	23	23	23
Nicolay 2	23	23	23	23	23	23		23	23	23	23	23
Nicolay 3	34	34	34	34	34	34	34	34	34	34		34
Hydro	10	25	45	45	30	20	20	15	15	10	10	10
FUEL	23	23			23	23	18	18	18	18	18	18
Medine							4	4	6	6	6	
Riche en Eau							5	5	5	5	5	
Union St. Aubin							5	5	5	5	5	
Mon Desert Alma							4.5	4.5	4.5	4.5	4.5	
Mon Tresor Mon Desert							2	2	2	2	2	
Mon Loiser							4.5	4.5	4.5	4.5	4.5	
Beau Champ			15	15	15	15	12	12	12	12	12	15
Savannah							5	5	5	5	5	
Belle Vue							40	40	40	40	40	40
Other Bagasse							1.1	1.1	1.1	29	1.1	
Total Supply Capacity (a)	321.0	336.0	339.0	324.0	328.0	332.0	320.1	328.1	330.1	372.0	339.1	343.0
Biggest Unit Capacity (b)	34	34	34	34	34	34	34	34	34	34	29	34
Available Supply Capacity (c)=(a)-(b)	287.0	302.0	305.0	290.0	294.0	298.0	286.1	294.1	296.1	338.0	310.1	309.0
Peak Demand (d)	269.4	273.5	277.5	283.0	278.9	276.3	276.0	277.8	278.5	282.5	291.0	287.7
Spinning Reserve (5%) (e)	13.5	13.7	13.9	14.2	13.9	13.8	13.8	13.9	13.9	14.1	14.6	14.4
Total Demand (f)=(d)+(e)	282.9	287.2	291.4	297.2	292.8	290.1	289.8	291.7	292.4	296.6	305.6	302.1
Margin (g)=(c)-(f)	4.1	14.8	13.6	-7.1	1.2	7.9	-3.7	2.4	3.7	41.4	4.6	6.9
Margin (%) (g)/(d)	1.5	5.4	4.9	-2.5	0.4	2.9	-1.3	0.9	1.3	14.6	1.6	2.4

Table 9.2.15 SHORT TERM TRANSMISSION PLANNING

SCENARIO-1

NO	PROJECT		FOREIGN	LOCAL	1994	ENGINEERING	TOTAL COST			PHASING					
							COSTS IN 1994 PRICES			96	97	98	99	00	TOTAL
			COSTS IN US$ 1000			5%	TOTAL	FOREIGN	LOCAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	1995-2000
1	132kV OH LINE NOCOLAY/L'AVENIR/WOOTON	MATERIAL	1180		1738	87	1825	1239	0			1825			1825
	19.5KM	ERECTION	311	247				327	259						0
2	132kV OH LINE L'AVENIR/AMOURY	MATERIAL	907		1337	67	1404	952	0			1404			1404
	15KM	ERECTION	240	190				252	200						0
3	132kV TRANSFORMERS ROSE HILL	MATERIAL	815	215	1200	60	1260	856	226						0
		ERECTION		170				0	179						0
4	66kV OH LINE NICOLAY-MONT CHOIS	MATERIAL	1089		1605	80	1685	1143	0						0
	18KM	ERECTION	288	228				302	239						0
5	66/132kV SUBSTATION NICOLAY	MATERIAL	5225	1742	10450	550	11000	5486	1829		5500	5500			11000
		ERECTION	1742	1742				1829	1829						0
6	132kV SUBSTATION L'AVENIR	MATERIAL	2195	732	4389	231	4620	2304	768		2310	2310			4620
		ERECTION	732	732				768	768						0
7	66/132kV SUBSTATION WOOTON	MATERIAL	349	116	697	37	734	366	122		367	367			734
		ERECTION	116	116				122	122						0
8	132/66kV SUBSTATION AMOURY	MATERIAL	1164	388	2328	123	2450	1222	407		1225	1225			2450
		ERECTION	388	388				407	407						0
9	132kV SUBSTATION ST. LOUIS	MATERIAL	118	39	236	12	248	124	41		124	124			248
		ERECTION	39	39				41	41						0
10	132kv SUBSTATION ROSE HILL	MATERIAL	118	39	236	12	248	124	41		124	124			248
		ERECTION	39	39				41	41						0
11	132kV OH LINE ST. LOUIS/ROSE HILL	MATERIAL	454		669	33	702	477	0				702		702
	7.5KM	ERECTION	120	95				126	100						0
12	132kV OH LINE ROSE HILL/WOOTON	MATERIAL	605		891	45	936	635	0				936		936
	10KM	ERECTION	160	126				168	132						0
13	66kV OH LINE /CABLE WOOTON/HENRIETTA	MATERIAL			0	0	0	0	0						0
		ERECTION						0	0						0
14	66kV OH LINE BELLE VUE/MONT CHOIS	MATERIAL	140		215	11	226	147	0						0
	5KM	ERECTION	40	35				42	37						0
15	66kV OH LINE HENRIETTA/CHAMAREL	MATERIAL	420		645	32	677	441	0						0
	15KM	ERECTION	120	105				126	110						0
															24167
17															
	CAPITAL COST									0	9650	12879	1638	0	24167
	MAINTENANCE									0	193	450.58	483.34	483.34	
	SYSTEM LOSSES									492	578	670	782	918	
	TOTAL									492	10421	14000	2903	1401	
	NPV IN MILLION US$	21.35													

Table 9.2.16 DISTRIBUTED FORECAST OF EVENING PEAK LOADS, 1995-1999

YEAR	Feb-95	MVA	PEAK 95	MVA	PEAK 96	MVA	PEAK 97	MVA	PEAK 98	MVA	PEAK 99	MVA
BELLE VUE	853	33	925	36	1000	39	1070	41	1140	44	1220	47
BELLE VUE-2												
AMOURY												
GOODLANDS												
FUEL	494	19	555	21	555	21	610	24	665	26	720	28
FUEL-2												
FERNEY	488	19	557	22	626	24	695	27	764	30	833	32
WOOTON	767	30	829	32	891	34	953	37	1015	39	1077	42
FLOREAL												
ROSE HILL	432	17	492	19	534	21	576	22	618	24	660	25
CANDOS												
HENRIETTA	544	21	600	23	650	25	700	27	755	29	810	31
COMBO												
CHAUMIERE	583	23	647	25	709	27	771	30	833	32	895	35
PALMA												
ST. LOUIS	506	20	528	20	546	21	565	22	585	23	606	23
PORT LOUIS												
FT. GEORGE												
NICOLAY	727	28	810	31	890	34	960	37	1030	40	1110	43
ARSENAL												
TOTAL FEEDERS	5394		5943		6401		6900		7405		7931	
MVA	208	208	230	230	247	247	267	267	286	286	306	306
MW LOAD	177		195		210		227		243		260	

Table 9.2.17 EXPANSION PLAN OF TRANSMISSIONS AND SUBSTATIONS

YEAR	NEW LINE	000 US$	NEW SUBSTASTION/BAY	000 US$	NEW TRANSFORMERS	000 US$	CAPIT.COST	2% MAINTEN.	SYSTEM LOSSES	TOTAL
1996		0		0		0	0	0	1089	1089
1997		0	Nicolay, Wooton	6353	Wooton(50)	600	6953	139	1281	8373
		0	L`Avenir, Amoury	0		0	0	0	0	0
1998	Nicolay-Wooton, L`Avenir-Amoury	3229	St. Louis, R.Hill	14825	Chaumiiere(30)	360	18414	507	1485	20406
1999	St. Louis-R.Hill, R.Hill-Wooton	1638		0		0	1638	540	1732	3910
2000		0		0	Femey(20)	240	240	545	2033	2818
2001		0	R.Hill	660	R.Hill(30)	360	1020	565	1335	2920
2002		0	Wooton, Henrietta	700	St.Louis(20)	240	940	584	1554	3078
2003		0	Amoury	1320	Amoury(90)	1080	2400	632	1565	4597
2004		0	Nicolay	660	Nicolay(30)	360	1020	653	1580	3253
2005	Wooton-Henrietta	5468		0	Henrietta(30)	360	5828	769	1810	8407
2006	Nicolay-B.Vue, St. Louis-Nicolay	1984	Nicolay, B.Vue	700	Femey(40)	480	3164	832	1675	5671
2007	Wooton-Champagne	1684	Fuel	660	FUEL(30)+Nicolay(180)	2360	4704	926	1971	7601
2008	Henrietta-Combo	684	St. Louis	660	St. Louis(30)	360	1704	961	2392	5057
2009	R.Hill-Candos-Henrietta, B.Vue-B.Vue2	950	Candos	1320	Candos(90)+Amoury(180)	3080	5350	1068	2828	9246
2010	Nicolay-Arsenal, FUEL-FUEL2	1000	Arsenal	4620	Arsenal(45)+Nicolay(90)	3540	9160	1251	3024	13435
		0		0	Wooton(180)	0	0	0	0	0
2011	Candos-Floreal	500	Florel+Ft.George	5100	Florel(90)+Ft. George(30)	1440	7040	1392	4186	12618
2012		0	Fuel+Femey	2640	Fuel+Femey(50)	600	3240	1456	4631	9327
2013	Ft.William-Avenir	1350	Palma	4620	Palma(90)	1080	7050	1597	4936	13583
2014		0	Port-Louis2	4620	P. Louis2(90)	1080	5700	1711	5085	12496
2015	B.V.-Avenir-Goodlands	1000	Goodlands+Nicolay2	5940	Goodland(90), Nicolay2(45)	1620	8560	1883	5678	16121

Table 9.2.18 BULK SUPPLY POINT TRANSFORMERS(MVA)

YEAR	PEAK 95	PEAK 00	PEAK 05	PEAK 10	PEAK 15
BELLE VUE	90	90	90	90	90
BELLE VUE-2				60	60
AMOURY			90	90	90
GOODLANDS					90
FUEL	60	60	60	60	90
FUEL-2				40	60
FERNEY	40	60	60	90	90
WOOTON	40	90	90	90	90
FLOREAL					90
ROSE HILL	60	60	90	90	90
CANDOS				90	90
HENRIEETTA	60	60	90	90	90
COMBO	60	60	60	60	60
CHAUMIERE	60	90	90	90	90
PALMA					90
ST. LOUIS	40	40	60	90	90
PORT LOUIS					90
FT. GEORGE	60	60	60	60	90
NICOLAY	60	60	90	90	90
ARSENAL				45	90

YEAR	PEAK 95	PEAK 00	PEAK 05	PEAK 10	PEAK 15
TOTAL INSTALLED	630	730	930	1225	1710

LOAD(BASE SCENARIO)	208	326	480	675	950
MVA INSTALLED PER BSP	57	66	78	77	86

YEAR	PEAK 95	PEAK 00	PEAK 05	PEAK 10	PEAK 15
INSTALLED/LOAD RATIO	3.03	2.24	1.94	1.81	1.8

Table 9.2.19 DISTRIBUTED FORECAST OF EVENING PEAK LOADS

REGION	STATION	PEAK FEB 1995 MVA	PEAK 2000 MVA	PEAK 2005 MVA	PEAK 2010 MVA	PEAK 2015 MVA
GREATER P. LOUIS	ST. LOUIS	20	24			
	FT. GEORGE	0	16			
	NICOLAY	28	30			
SUBTOTAL		48	70	105	150	220
PLAINE WILHEMS/	ROSE HILL	17	27			
RURAL WEST	CHAUMIERE	23	37			
SUBTOTAL	WOOTON	30	44			
	HENRIETTA	21	33			
SUBTOTAL		91	141	190	260	350
RURAL NORTH	BELLE VUE	33	50	90	125	180
RURAL EAST	FUEL	19	30	45	65	90
RURAL SOUTH	FERNEY	19	20			
	COMBO	0	15			
SUBTOTAL		19	35	50	75	110
TOTAL MVA		210	326	480	675	950
TOTAL MW		179	277	408	574	808

NOTES:
The above forecast is based on the following assumptions:
1.Population will be concentrated in already built-up areas and their suburbs
2.Minimum encroachment on the agriculture lands as well as environmentally sensitive areas
3.All major developments located close to main centres of population
4.The new port near Mahebourg will be developed after 2015

Table 9.2.20 DISTRIBUTED FORECAST OF EVENING PEAK LOADS, 2000-2015

YEAR	PEAK 00	MVA	MVAR	PEAK 05	MVA	MVAR	PEAK 10	MVA	MVAR	PEAK 15	MVA	MVAR
BELLE VUE	1285	50	16	1165	45	20	1165	45	20	1165	45	20
BELLE VUE-2							906	35		1165	45	
AMOURY				1165	45	20	1165	45	30	1424	55	30
GOODLANDS									20	1424	55	20
FUEL	775	30		1165	45		1165	45		1424	55	
FUEL-2							518	20	16	1165	45	16
FERNEY	490	19	10	751	29	10	1139	44	20	1424	55	20
WOOTON	1140	44	16	1424	55	20	1553	60	20	1285	50	20
FLOREAL										1165	45	
ROSE HILL	701	27	10	906	35	20	1036	40	10	1036	40	10
CANDOS							1165	45	16	1165	45	16
HENRIETTA	865	33		1243	48	16	1553	60		1285	50	
COMBO	412	16	10	544	21	16	803	31	16	1165	45	16
CHAUMIERE	957	37		1346	52		1424	55		1424	55	20
PALMA										1165	45	
ST. LOUIS	630	24	10	932	36	16	1372	53		1036	40	
PORT LOUIS										1125	43	20
FT. GEORGE	513	20		621	24		906	35		1165	45	
NICOLAY	667	26		1165	45		1036	40		1165	45	
ARSENAL							570	22		1215	47	20
TOTAL FEEDERS	8435		72	12427		138	17476		168	24587		228
MVA	326	326		480	480		675	675		950	950	
MW LOAD	277			408			574			807		

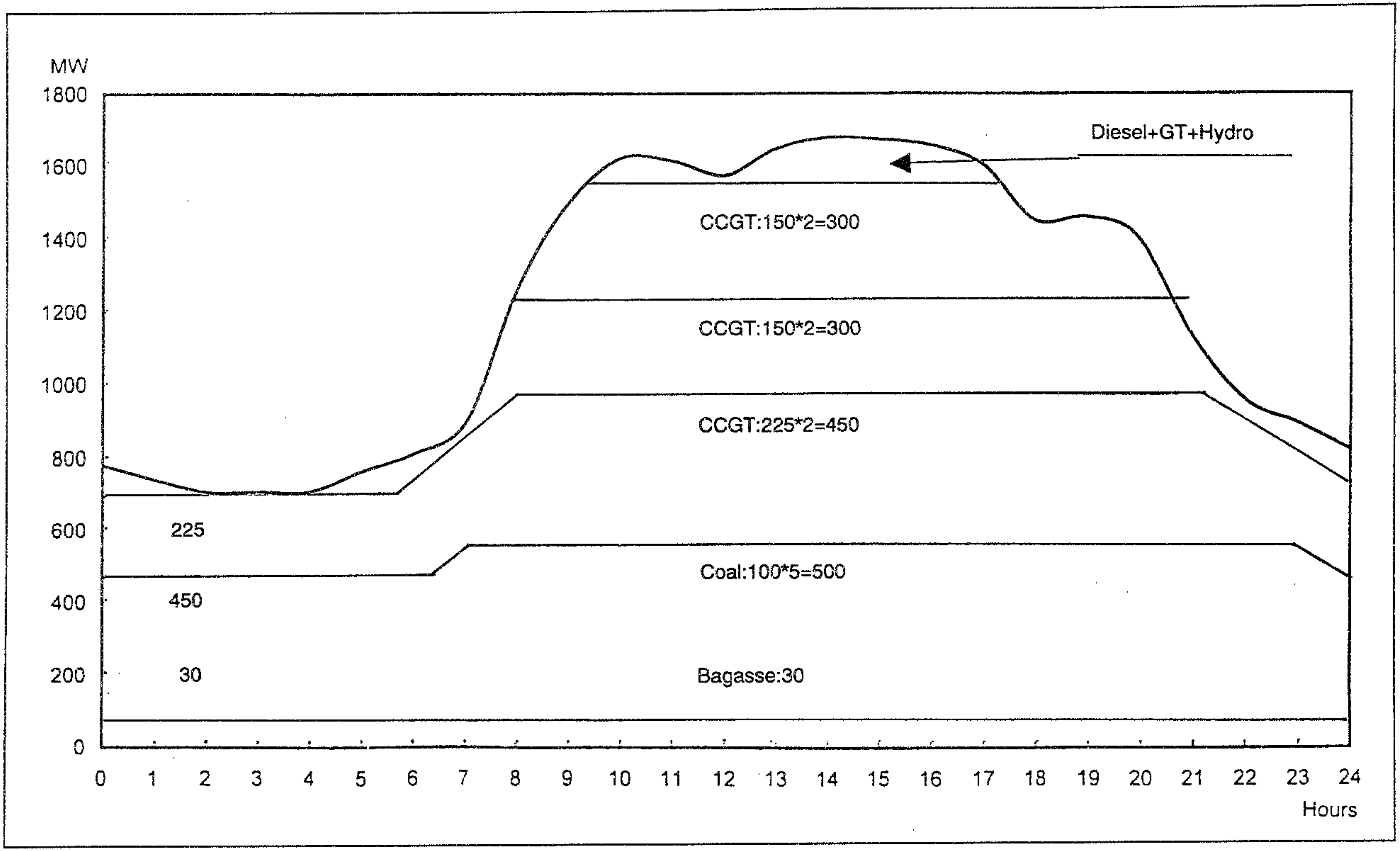


Figure 9.2.1 **FORECASTED TYPICAL OPERATION PATTERN OF MAIN EQUIPMENTS ON MAXIMUM LOAD DAY IN 2025**

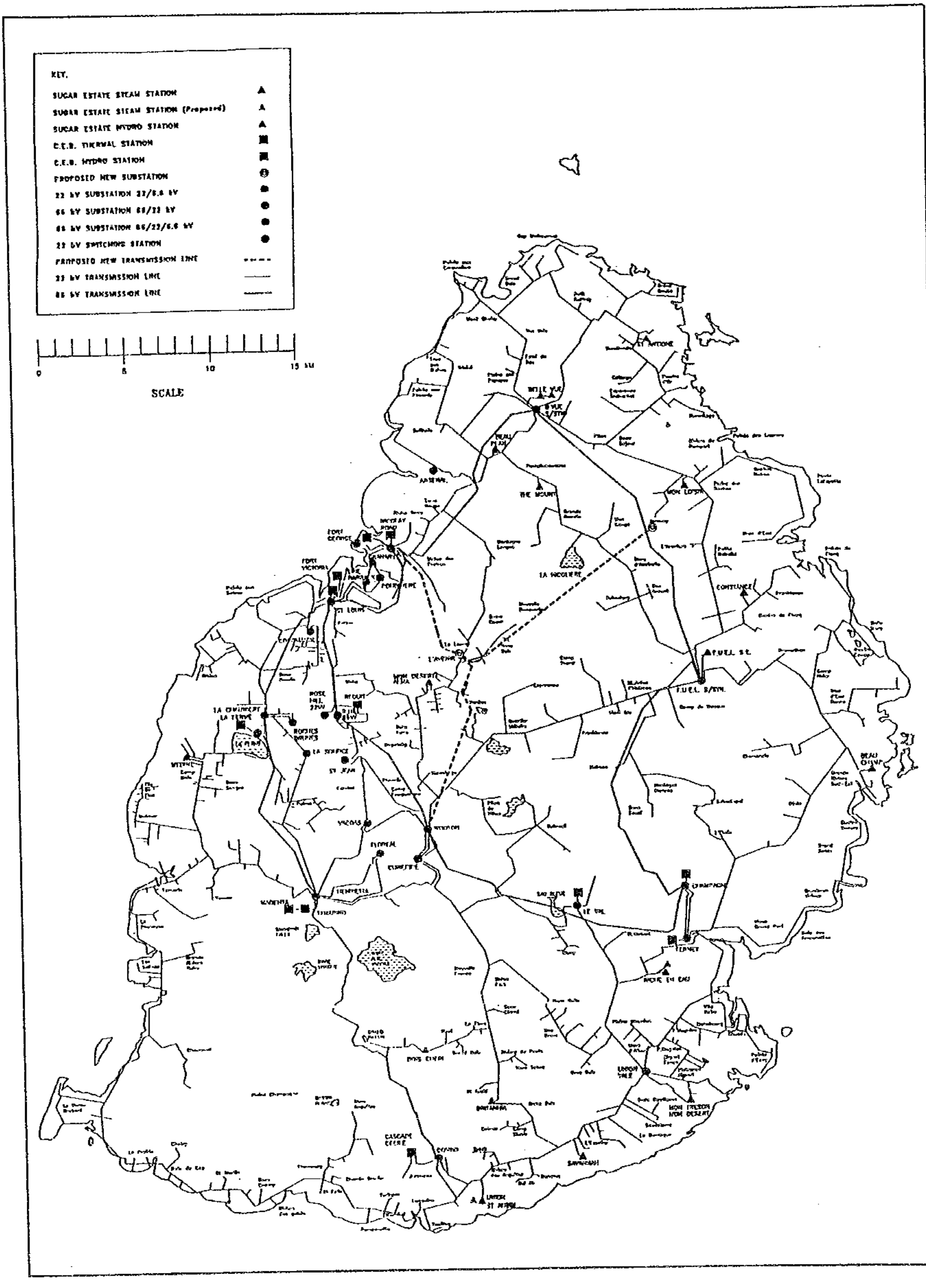


Figure 9.2.2 EXISTING TRANSMISSION LINE & PROPOSED NEW TRANSMISSION LINE (2000)

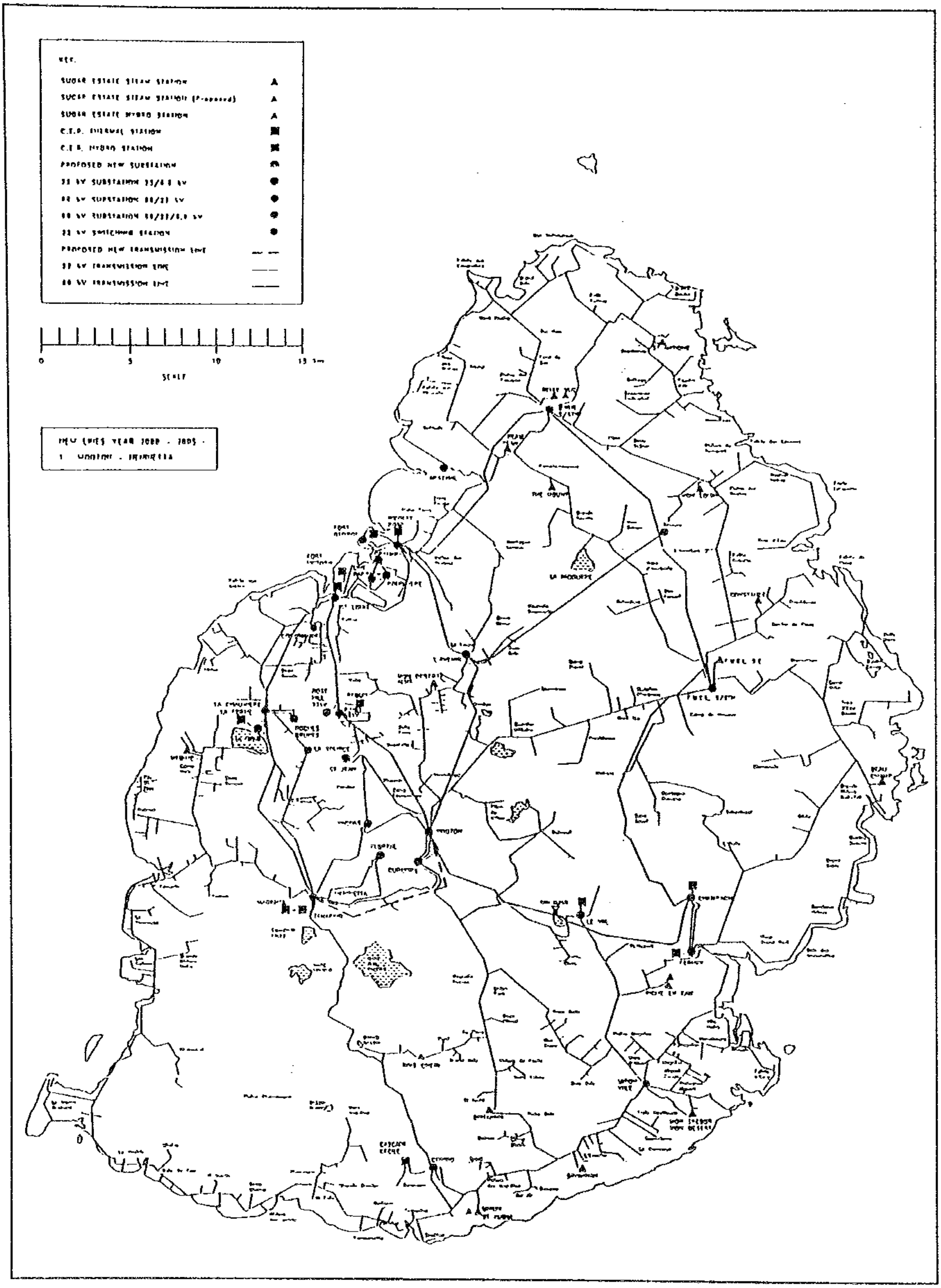


Figure 9.2.3 EXISTING TRANSMISSION LINE & PROPOSED NEW TRANSMISSION LINE (2005)

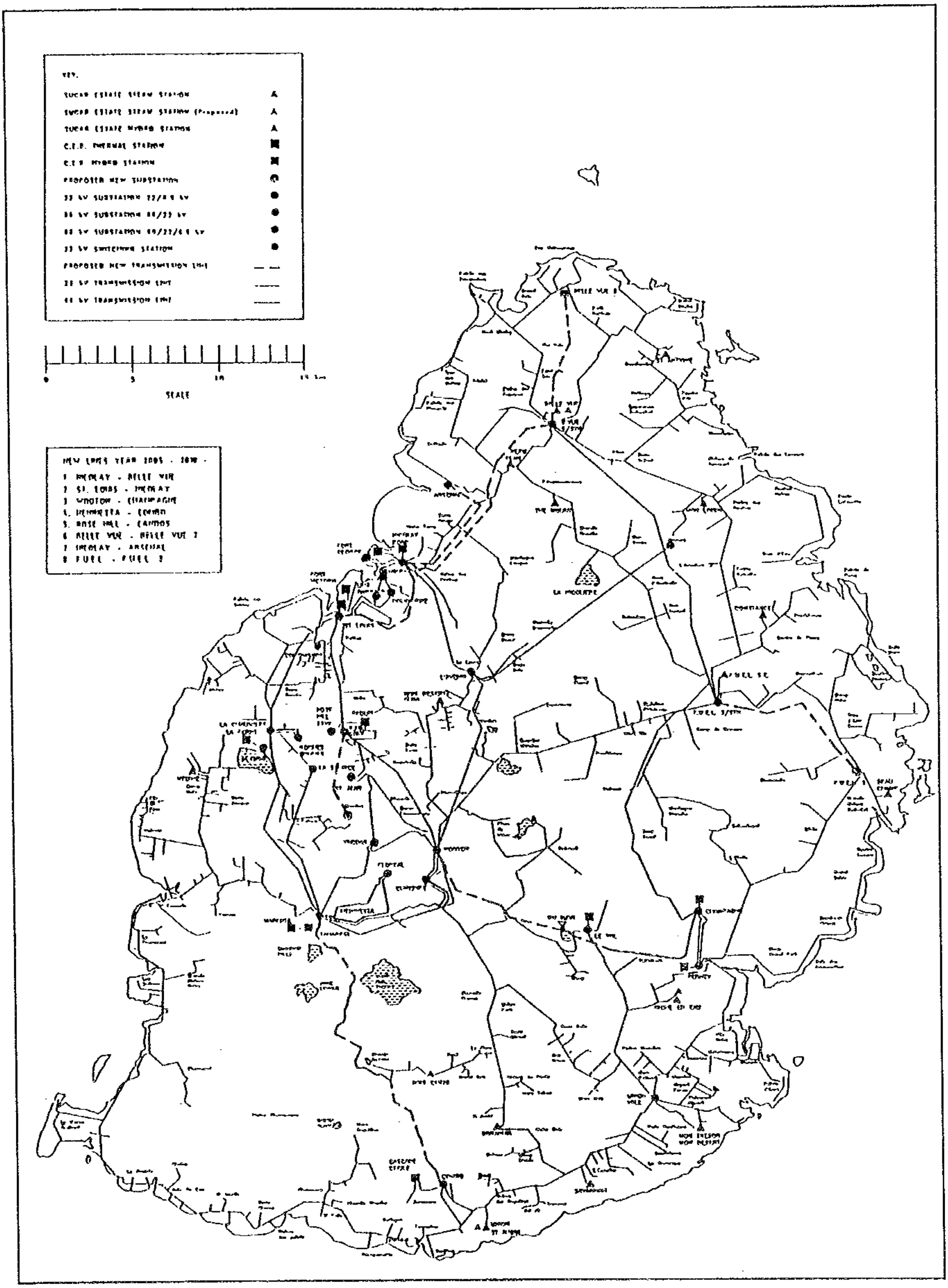


Figure 9.2.4 EXISTING TRANSMISSION LINE & PROPOSED NEW TRANSMISSION LINE (2010)

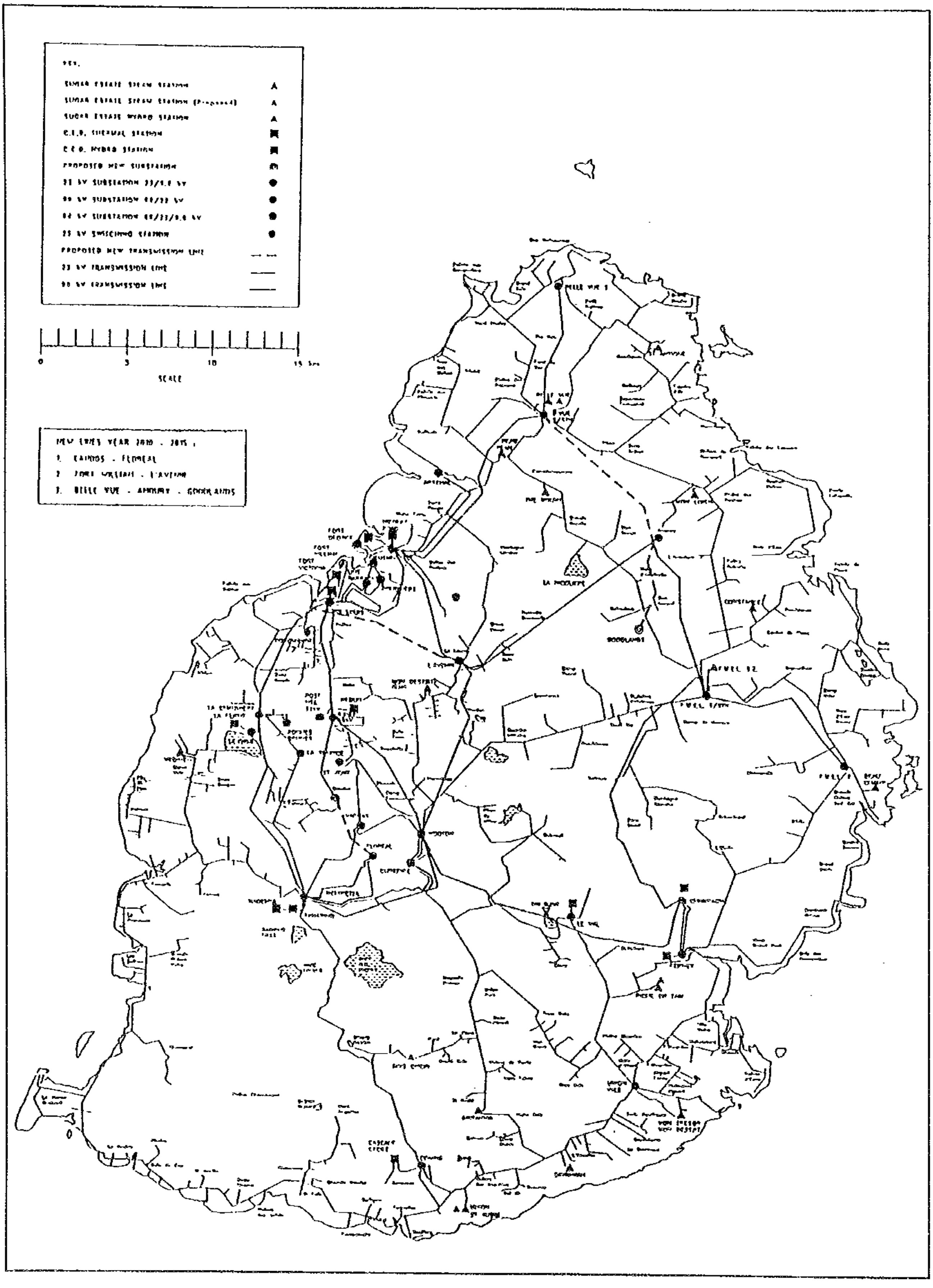


Figure 9.2.5 EXISTING TRANSMISSION LINE & PROPOSED NEW TRANSMISSION LINE (2015)