◆ *Chapter 2 Action Plan Toward the Year of 2000* ◆

Chapter 2 Action Plan Toward the Year of 2000

Energy development and utilization are an integral part of any comprehensive economic and social development plan, and not only affect diverse fields but also extend over a medium to long time span. Such an energy development and utilization plan depends much on the demand forecast employed. Therefore, it is important to establish a scientific base first on which to formulate the plan. In the present study, the study team initially extended cooperation in development through the creation of an energy data base and the development of an energy demand forecast model. Then, the study team presented proposals for energy development in Mauritius which were derived from the study results. In this report, an action plan which should be implemented by the year 2000 is presented. The action plan is explained below.

2.1 Improvement of CEB's Financial Condition

Here, the study team presents the fund procurement plan to be adopted by the CEB that is the chief entity in the electric power sector in Mauritius. The financial condition of the CEB is analyzed in detail in 6.2 of this report. In a word, it is fragile. This is due mainly to large amounts of loans, interest payments, and exchange losses, as well as the electricity tariffs that have been kept comparatively low. Under these circumstances, the huge debts will not decrease. To improve the present financial condition of the CEB, drastic measures are called for. They include, for example, the privatization of the CEB entailing the elimination of its debts, the raising of tariff rates, and the diversification of the CEB business. Since these measures have to do with the basic energy policy of Mauritius, they will not be able to be implemented easily. However, without drastic reform, it is difficult to improve the financial condition of the CEB. This in turn makes difficult the procurement of funds for new investment.

On the premise that the CEB tackles the above long-term task, the action plan the CEB should take for the moment to improve its financial condition is to review the operation costs of its existing facilities and restrain new investments.

(1) Reviewing existing costs equipment and restraining new investments

Of the total cost of power generation at the CEB, about 30% can be controlled by the CEB for itself. Since 10% accounts for labor cost, even if the power generating equipment is carefully reviewed and controlled, it might not be possible to cut the cost significantly. However, characteristically, CEB has continually made investment in small generators. Some of its old facilities have become inefficient, pushing up the power generation cost. Reviewing the cost of the existing facilities is reportedly under way at the power stations of CEB. It is necessary for CEB to continue such efforts and consider shutting down extremely inefficient power stations, if any.

Restraining new investment may seem inconsistent with the above effort to reduce the existing equipment cost. The rationale is that, so far as CEB cannot afford to make investment in new equipment, it should for the moment concentrate on improving its financial condition. Concerning a power supply-demand gap which may occur in the meantime, the government and CEB should pave the way for the entry of private enterprises into the business to fill the gap.

In addition to the action plan described above, the CEB should consider ways to increase its revenues, including the raising of the tariff rates and financial support from the government.

When the CEB becomes financially capable of making new investment and start procuring funds in the future, it should keep in mind the following points which the study team has learned important from a variety of experience.

In procuring funds for investment in plant and equipment,

- Select medium-term loans with low interest rates by taking into consideration the future depreciation of rupee.
- Avoid repayment in a currency which is likely to appreciate in the future.

- As far as possible, provide a hedge against exchange risk through exchange contracts, etc.
- As far as possible, use ODA funds and select the most preferable conditions on terms of loans and interest rates.

2.2 Energy Prices and Taxation System

Generally, import tariffs are classified into protective duties intended to protect domestic industries, and fiscal duties which primary purpose is to increase government revenues. In Mauritius where there are no petroleum and mineral resources to be protected or developed and where no petroleum refining is carried out, tariffs imposed on imported petroleum products and coal are considered to be imposed for pure fiscal purposes. In a political perspective, tariff rates are adjusted to protect people (such as the low income class) adversely affected by such tariffs. The current energy tariff policy, which seeks to secure financial revenues from energy imports while reflecting detailed energy policy in tariff, needs to be maintained in future. The taxation system, however, should be reviewed in order to align it with the current national energy policy.

As repeatedly mentioned in Chapter 1, the basic energy policy which the country needs to pursue is to ensure stable supply of energy while managing economic development in harmony with environmental preservation. To accomplish the objective, energy prices and taxes need to be established on the basis of the basic policy by taking into account characteristics of different energy sources so as to allow an appropriate mix of fair competition under the market mechanism and optimum supply, while ensuring equitable tax burdens among energy sources. In this conjunction, the following taxation and pricing measures are proposed for immediate implementation by the Mauritius government:

(1) The imposition of a kerosene tax and promotion of LPG;
(2) Reduction of taxation on coal, to promote diversification of energy sources;
(3) Price liberalization by introducing a retail price capping system; and
(4) Establishment of an ad-hoc tax for national petroleum stockpiling and new energy development.

The proposals are described in more detail as follows.

(1) The imposition of a kerosene tax and promotion of LPG

In Mauritius, kerosene has been widely used by low income people and in remote islands

due to its relative low price and the ease of use. The government has been encouraging kerosene consumption by exempting it from tax, in an effort to keep retail prices low. This is clearly reflected in the significantly low markup for imported kerosene in the country (around 40%) compared to other petroleum products. Kerosene, due to a low flashing point, often causes fires and other accidents at homes in Mauritius. On the other hand, LPG is relatively safe to handle and is recommended as a clean energy source alternative to petroleum.

LPG, however, is more expensive than kerosene in terms of per calorie cost. In Mauritius, both kerosene and LPG are tax-exempt now, and the retail price of LPG (per calorie) including distribution costs is approximately 50% higher than that of kerosene. By imposing a tax on the kerosene (excluding jet fuel), the price differential between them will be narrowed to encourage consumption of LPG. The tax rate should be set at a level comparable to fuel oil under the assumption that kerosene will be limited to industrial use (power generation). Meanwhile, the policy objective of giving relief to the low income class, which is a major reason for tax exemption, should be addressed through welfare policy.

(2) Reduction of taxation on coal for diversification of energy sources

When energy input to the electricity sector in the country is analyzed as to the share of each source, fuel oil is found to hold a predominantly high share. The risk related to excessive dependency on a specific energy source (energy input for electricity production in particular) is fully realized by the Mauritius government, that has promoted bagasse-fired power generation as part of its efforts to diversify energy sources. So far, diesel power generation is the main generation system in Mauritius due to small power consumption. However, it is absolutely necessary to develop an appropriate energy mix by introducing a full-scale CCGT or a coal power station in the future. From this point of view, the more effective use of coal is a viable option to cut down the operation cost and to commercialize bagasse - fired power generation for all the year round. Thus, it is proposed to reduce the import duty on coal for power generation to below 15% (the tariff rate applied to countries under preferential treatment) for the purpose of reducing operating costs of coal users, thereby to promote coal use and diversify energy sources.

(3) Price liberalization by introducing a retail price capping system

At present, the government sets official prices for petroleum products, including retail prices. As a result, there is virtually no price competition in the domestic market, thus eliminating the opportunity to nurture the energy sector through competition by leveraging the market mechanism. At the same time, uniform pricing deprives users of privileges in the freedom to choose and the enjoyment of better service, which leads to loss of economic vitality.

It is undeniable that STC's price adjustment mechanism has played some role in maintaining price stability. In recent years, however, it often worked to drive costs up rather than stabilize them, and it has become apparent that the traditional price stabilization policy does not fit the economic reality in Mauritius which has developed to a middle-income country. It is now time to let the market mechanism work in the energy pricing process if the economy is to be invigorated. It is therefore proposed to introduce the retail price capping system under which STC's transfer price does not include the price adjustment portion, while the government only specifies the upper limit for retail prices of petroleum products, within which wholesalers will be allowed to determine retail prices freely. After the price capping system is accepted by the market, complete price liberalization should be considered. To monitor prices and distribution channels in the price liberalization process, Supervising Committee will be established with the MLGPU acting as secretariat.

(4) Establishment of an ad-hoc tax for national petroleum stockpiling and new energy development

As mentioned earlier, it is critical as well as imperative for any country's energy policy to work toward stable supply of energy and the optimum energy mix. In particular, Mauritius, which depends on overseas sources for 70% of primary energy supply, must always strive to fulfill these objectives. As part of such efforts, the study team proposes petroleum stockpiling by the government.

At the same time, the development and commercialization of new energy sources suitable

for the country's needs and conditions will become a critical factor in reducing dependency on overseas energy sources. This should primarily be promoted by private initiatives (including that of foreign investors) to collect and utilize information on developed and verified technologies in foreign countries for commercialization in Mauritius, so that government expenditures can be limited to the minimum-required level. At the same time, the government is expected to be involved in basic research and development projects in a leadership role.

To reserve funds for petroleum stockpiling and new energy development initiatives, it is proposed to impose an ad-hoc tax on petroleum products. The tax rate should be set at a level to be determined by taking into account the actual amount of stockpiling and its related costs, the required budget for new energy development, and taxable capacity.

When the construction cost for petroleum stockpiling is to be financed by the revenue from the above ad-hoc tax, the tax rate can be calculated as follows. The required costs for storage tanks for petroleum products (a gasoline, diesel oil and fuel oil) are presented in Table 2.1.1.

Table 2.1.1 CONST. COST FOR STRATEGIC STORAGE FACILITIES

	2000	2005	2010	2015	2020	2025
Gasoline	7,000 kl x 3	7,000 kl x 1	7,000 kl x 1	7,000 kl x 1	7,000 kl x 1	7,000 kl x 1
Total Cost	4,116,000	1,372,000	1,372,000	1,372,000	1,372,000	1,372,000
Diesel	7,000 kl x 3	7,000 kl x 1	-	-	7,000 kl x 1	7,000 kl x 1
Total Cost	2,679,000	893,000			893,000	893,000
Fuel Oil	7,000 kl x 2	-	7,000 kl x 1	7,000 kl x 1	7,000 kl x 2	7,000 kl x 3
Total Cost	1,786,000		893,000	893,000	1,786,000	2,679,000
Total	8,581,000	2,265,000	2,265,000	2,265,000	4,051,000	4,944,000

The total cost required up to 2025 is estimated at about US$ 24.4 million, it is equivalent to about Rs 481 million as the end of March 1997. On the assumption that the all costs are disbursed from the collected ad-hoc tax over the next 25 years, a reasonable tax rate by petroleum products is as follows. These rates are based on a retail prices as of the end of December, 1996, without consideration of future inflation. Therefore, the actual tax rate

have to consider the increased price range inflation rate and so on.

<Ad-hoc Tax Rates>

Gasoline	0.0062%/litre
Diesel Oil	0.0042%/litre
Fuel Oil	0.0052%/litre

2.3 Energy Policy and Management

2.3.1 Reformation of Legislation System and Strengthening of Institutional Set Up

Within the Government of Mauritius, primary responsibility for public administration in the field of energy rests with the Ministry of Local Government and Public Utilities (MLGPU). Generally speaking, however, energy policy administration is multidisciplinary in nature, covering a myriad of economic and political areas, and is affected and controlled by a complex web of authority and power held by related agencies. Mauritius is certainly no exception to this. However, it differs from many other countries in that the development and management of petroleum and other mineral resources are not issues, and the government is primarily expected to secure energy resources and ensure their stable supply. In this context, the MLGPU has been playing a leading role with collaboration by other agencies. Global energy issues and the rise in environmental concern urge Mauritius to develop an organization for energy policy administration as well as laws which can address and cope with the emerging issues.

Naturally, organizational reforms including delegation of authority and power, and the development of the legal environment to meet the objective take considerable time, and it is difficult to accomplish all tasks by 2000. In this study, however, the following proposals are made to set forth actions which must be initiated immediately from the medium- and long-term viewpoint:

(1) Empowerment of MLGPU and additional staffing;
(2) Formulation of a "National Energy Plan" and "(Comprehensive) National Energy Act;" and
(3) Development and maintenance of an energy database.

The proposals are described in more detail as follows.

(1) Empowerment of MLGPU and additional staffing

The proposal aims to empower the MLGPU as the center of energy policy administration,

capable of playing a leadership role, and to increase staffing and budget. At present, the MLGPU is more devoted to stable supply of electricity and development of new energy sources, while the Ministry of Industry and Commerce (MIC) assumes a larger role in securing energy resources as well as in market and distribution areas. The desirable direction of energy policy administration in the country, as identified from the above analysis, indicates the need for organizational reforms to allow policy formulation, regulation, and supervision to be integrated as far as possible within the framework of the medium- and long-term energy development plan. For this purpose, the MIC functions such as on supervision of petroleum product markets have to be merged into MLGPU.

Then, councils on "electricity" and "petroleum products" should be established under MLGPU, consisting of representatives of related agencies, industries, and other organizations and groups. These councils serve as advisory bodies for the MLGPU, to provide an opportunity for deliberation and coordination of energy policy among related parties.

The reformed and empowered MLGPU will be responsible for the following areas of energy policy administration:

- Formulation of energy development policy
- Coordination and direction of energy policy
- Supervision of petroleum product markets
- Development and maintenance of the energy database
- Update long term energy demand faorecast model
- Update long term energy sector development plan
- Promotion of energy saving and development of new energy sources
- Protection of the environment and public safety

MLGPU in the present form has a relatively large number of staff compared to other government agencies mainly because it provides postal service which employs a large number of workers. In fact, its staffs in the energy-related field, including office clerks, amount to around 40, with some vacancies in senior positions. Thus, the energy department needs to be reinforced urgently including those posts responsible for planning

and coordination of energy policy. In particular, construction and maintenance of the energy database, which is currently handled by the officers of CSO seconded to the MLGPU, should be managed by MLGPU's own staff, which should preferably be organized into an independent department in consideration to the importance of data management as the basis of policy formulation.

(2) Formulation of a "National Energy Plan" and "Comprehensive Energy Act"

At present, there is a move to encourage the entry of independent power producers into the electricity industry. To realize this, however, a national energy supply and demand plan needs to be developed and made known to all the related parties in and outside the country, and within the plan's context, the role of such producers should be clearly defined. In this connection, the forecast of energy supply and demand in the country is closely associated with individual plans and targets, such as the target level of energy saving, the development of new energy sources, the establishment of reasonable energy prices, and the optimum energy mix. It is proposed to develop a "National Energy Plan" which sets forth a comprehensive plan to address the issues in the energy field as a whole. It should effectively rely on the energy demand forecast model to be constructed as part of this study as well as the result of the study, supplemented by opinions of the private and public sectors on energy saving.

On the other hand, the proposed "Comprehensive Energy Act" is designed to ensure the proper implementation of "National Energy Plan" and covers a wide range of targets to be achieved under the plan. In particular, the proposed law should address the following areas:

- Implementation of the energy saving plan
- Increased supply of domestic energy resources
- Regulatory control of the electricity industry (including independent power producers)
- The establishment and management of the petroleum strategic stockpiling
- Promotion of new energy development
- Energy tax

The reviewing of Electricity Act currently underway is limited to the electricity business, mainly focusing on introduction of the market mechanism through deregulation and the establishment of stable supply capability. This only supports a part of the national energy plan, however. Various laws must be enacted to cover other critical areas, including the promotion of energy saving and deregulation of petroleum product markets. These laws are already enacted and in operation in industrialized countries, and based on their experience, those tailored to local conditions peculiar to Mauritius are to be drafted. Furthermore, these laws should not be limited to regulatory control and procedures, but contain incentives for the affected parties, e.g., an Electricity Business Control Act (tentative name) should set forth the obligation of power companies to purchase electricity produced by independent power producers and the relief of independent power producers from the supply cost principle in their pricing.

(3) Development and maintenance of an energy database

Collection and compilation of energy related data are entirely handled by CSO's staff which are assigned to the MLGPU. As energy-related fields are broad-based, statistics and data are diverse and massive. Although basic statistical data on energy supply and demand, including electricity, are collected and compiled by the great efforts of related organizations, the government does not collect statistical data on energy consumption as well as supply and demand of petroleum products (distribution). As these data are vital to policymaking, the MLGPU needs to secure the necessary budget allocation and develop and operate an integrated data collection and compilation system. In this connection, Central Statistical Office (CSO) has established a highly efficient work system and is capable of supporting the MLGPU in developing the proposed database within a reasonable period of time.

2.3.2 Development of Indiginous Energy

(1) Integration of future BEDP and IPP Program

In order to improve the efficiency of the power generation sector of CEB without imposing a undue financial burden on the government, the introduction of IPP of private financial source is now considered as high priority policy of the government for sustainable

economic growth of the country.

There are many common elements between BEDP and IPP related to the supply of electricity to the national power grid from the power plants which are built and operated by private entrepreneurs.

The BEDP has special factors in relation to modernization/rationalization of the sugar mills, but both programs must be on the same ground to avoid possible criticism of unfair treatment of either program.

The restructuring of legislation governing the electrical sector must include the clear definition of current and future BEDP and other IPP to clearly inform all the potential applicants of conditions applicable to the both programs in future as well as the differences between them. In particular, it is important to define the interface between CEB and BEDP/IPP and the obligation of BEDP and IPP to connect their generation/transmission system to the national grid which is presently controlled by CEB.

At present, the promotion of BEDP projects and realization of IPP participation in the power sector is considered as the high priority policy of the country. Therefore, certain potential commercial risk of power supply from private sectors is expected to be absorbed by CEB. Although the contract between CEB and BEDP/IPP will include some penalty clauses to minimize such loss, other commercial risks, such as the delay of the commencement of electricity supply from BEDP/IPP to the national grid, and frequent interruption of supply during the initial operation of the BEDP/IPP power plant, will not be fully covered.

Further as it is analyzed in para 5.7 there is a few elements which may impose some commercial loss to CEB, to encourage the implementation of the BEDP project and the IPP project in the initial stage of the project.

However, in the long range, the CEB itself must be restructured to have its financial viability, and the cost associated with the entire generation business must be shared by the all parties involved in the power supply business.

The general rules required to share the cost and benefits of the national power generation system evenly any CEB, BEDP and IPP ensure a fair sharing of overhead such as the cost of maintaining spinning reserve capacity for the total system, as the cost for total generation system increases during the time a new large facility is constructed while demand does not grow fast enough to avoid the lowering of capacity factor of total available facilities and other costs.

The overhead will be very difficult to be identified in advance, and therefore the income of each party should be adjusted in the ensuing year, depending on the actual cost occurred in the previous year.

(2) The long term coordination plan for the sugar industry modernization and the development of bagasse energy utilization program.

Presently, the modernization of every sugar mills and the implementation of bagasse power projects are being advanced based on the willingness of the individual owners of sugar mills. The government approves the proposed project plan as it is submitted. However, the development of efficient use of bagasse energy is very important for the national energy supply security, and therefore it is very clear that the optimization of use of all bagasse produced in the country and also the whole power generation system must be achieved by the cooperation of the sugar industry and CEB under the leadership of the MLGPU.

Notably, the size of future BEDP plants will get larger and larger in search of financial viability and the impact of BEDP on the total power supply system of the country will be significant. Therefore, the long-term coordination plan among current and future BEDP and CEP/IPP power plant programs must be developed as soon as possible (see 5.3.2, 5.8).

(3) Research on technology for improving the property of bagasse in relation to storing and transportation

The study conducted for bagasse energy use in the early 1980's in Mauritius and the sugar farms in Australia could not identify economically attractive technology which allows the

storage of bagasse for a long time and the reduction of transportation cost by increasing bulk density.

It is recommended that the bricketting of bagasse by application of a small amount of binder such as pitch or waste poly-olefine etc. should be developed urgently. The know-how related to bio-coal technology, which has been developed to use coal in an environmentally friendly way by way of mixing coal with bagasse or other vegetable fiber, will be applicable to bagasse bricketting.

2.4 Energy Sector Development and Environment Management

2.4.1 Establishment of Environment Monitoring System

Recently, the Ministry of Environment Mauritius issued a regulation in relation to the national standards of emission from industrial plants, air quality, water quality in the island and the standard of noise level from industries.

The future power plants of Mauritius must be equipped with facilities to mitigate potential pollution or the quality of fuel to be used must be improved, as the new environment standards will be applied to the existing plants within two years after the regulations become effective.

At present, prices of industrial products and services in Mauritius including electricity are set by the government based on cost estimation by an authorized accountant.

This means the prices may increase when additional investment for improved emission/effluent control become necessary to meet the new regulations. In order to avoid the unnecessary cost increase, the extent of such improvement is to be determined by environmental impacts imposed by the project. These impacts can not be assessed without comprehensive data on the present level of pollution which must be measured through the comprehensive monitoring system.

2.4.2 High Priority Environment Related Action Plan

(1) Environment Monitoring of Port Louis Area

According to the current program for the construction of the new power generation plant of the CEB, the additional diesel engine generators will be installed at the Fort George site. Further, the construction of additional power plants is also expected in the Port Louis area .

The current regulations call for the concerned ministry to assume responsibility observing the national environmental standards in relation to the power sector project. Pursuant to the environment act, the CEB must observe the national standards in relation to the construction of new power plants.

It is highly recommended that CEB must conduct the monitoring of the current air and water pollution levels including sea water in the vicinities of the sites where the new plants will be constructed, in order to obtain comprehensive data for determining the acceptable level of emission and discharge from new projects to the environment by taking into account the specific meteorological conditions in the area.

For instance, the height of chimneys of Mauritius is low in comparison with that of other countries because of cyclones. The technique to assess the cost advantage of heightening the chimneys against the installation of pollution control equipment is available internationally. But again the assessment work requires reliable data collected by a comprehensive monitoring system.

(2) Issue of Emission-effluent Standards for Power Plants

Paragraph 1.2.1 (2), discusses the need for establishing design standards which are to be adopted by the BEDP/IPP project for improving the transparency and the ease of selection of the most desirable bidder in the competitive bidding for BEDP/IPP contract.

Design standards for power plants in relation to emission and effluent levels should be established as soon as possible.

It is very important that the purchase price of electricity from the BEDP/IPP party must reflect the quality of its plant in relation to environmental pollution. Otherwise, the government may end up in helping a polluting source, to increase profits by cutting the pollution control cost .

It should be noted that the impacts of emission and effluent from these plants on the natural/social environment of Mauritius will be very significant because the amount of fuel to be consumed in future is estimated to reach 2000 ton/day by AD2010.

The current emission and effluent regulations enforced by the Ministry of Environment are primarily based on concentration of specific pollutants contained in the emission and

effluent. However, in the long term, the absolute quantity of pollutant and discharge points of major industrial facilities are to be controlled to achieve the adequate environmental conditions in residential areas and as well as in the natural environment.

Therefore, MLGPU should work together with relevant ministries to set design standard for control of emission and effluent from different type of power plants, so as to ensure that future projects will not require undue costs for pollution control, which may endanger the financial viability of the project, and that entrepreneurs of BEDP/IPP can accurately estimate the required investment for environment control of their projects at the time of project preparation.

PART III DETAILED DISCUSSIONS

◆ Chapter 3 Economic Development & Future Prospect ◆

Chapter 3 Economic Development & Future Prospect

3.1 Trends of Macro Economy

3.1.1 Social & Political Development

(1) The state of Mauritius comprises the islands of Mauritius and Rodrigues, Agalega, St Brandon and several other small, uninhabited islands. The population of Mauritius is crammed into a land area of 2,040 square kilometers, giving it a very high population density of 570 per square kilometer. The country has an Exclusive Economic Zone of 1.7 million square kilometers. Mauritius has a pleasant tropical climate, beautiful beaches and a friendly people, making the island attractive to tourists. However, it is subject to cyclones between December and March; these can cause serious damage, especially to agricultural production and physical infrastructure.

(2) Mauritius presents a complex multi-racial, multi-lingual and multi-religious microcosm of the world. It had no indigenous population of its own. It was visited by traders and unsuccessful settlers as early as the 12th century -- these included the Portuguese and the Dutch. The first permanent settlers were the French in the mid-eighteenth century. Slaves from Madagascar, and later from East Africa, were brought in to work on sugar plantations established by the French. With the abolition of slavery in 1830, slaves were replaced by indentured laborers from India. Petty traders and assorted workers also arrived from China and India at nearly the same time. By the time of the first population census in 1846, the population had reached 158,000, and near the end of the 19th century (1891), it had more than doubled to 370,600.

(3) The population of Mauritius is an ethnic-mix of Hindu Indians (50%); French, African and Creoles (30%); Muslims (17%); and Chinese (3%). This diversity of ethnic and religious origins lends a distinctive flavor to the cultural, political and economic life of the country. On the cultural front, the government has successfully reconciled the preservation of the various traditions of the major groups, while

promoting the emergence of a national culture and forging a national identity. The interaction of the various ethnic groups has had an important impact on the political and economic life of the country, creating a vibrant political climate where the basic principles of democracy and freedom are jealously guarded. This diversity has also been economically beneficial: the close ties that Mauritius has managed to maintain with several major cultural poles of the world -- France, India and China -- are due to these unbroken links to their mother countries retained by various ethnic groups comprising the Mauritian nation.

(4) The administrative structure is indicated in Table 3.1.1. There are many ministries, with respective sizes being widely different. Local government plays little role in administration. However, the administrative system is very flexible. Administrative structures and ranking have changed year by year.

Table 3.1.1 GOVERNMENT SERVICES: EMPLOYMENT BY MINISTRY, JANUARY 1996

Government Services	No.of Employee
1. CENTRAL GOVERNMENT	
1. Office of the President, Judicial, National Assembly, etc.	532
2. Audit, Public and Police Service Commissions, Ombudsman's Office etc.	473
3. Prime Minister's Office	15,074
4. Deputy Prime Minister's Office and Ministry of Foreign Affairs, International and Regional Co-operation	126
5. Ministry of Economic Planning, International Trade & Telecommunication s	721
6. Ministry of Industry & Commerce	98
7. Ministry of Employment, Manpower Resources and Training	190
8. Ministry of Finance	2,747
9. Ministry of Land Transport, Shipping & Public Safety	353
10. Atorney - General's Office, Ministry of Labour and Industrial Relations	339
11. Ministry of Housing & Land Development	2,392
12. Ministry of Education, Science and Technology	9,992
13. Ministry of Social Security and Naitonal Solidarity	1,000
14. Ministry of Trade and Shipping	206
15. Ministry of Agriculture and Natural Resources	6,290
16. Ministry of Arts, Culture & Leisure	197
17. Ministry of Fisheries and Marine Resource	422
18. Ministry of Tourism	78
19. Ministry of Women, Family Welfare and Child Development	147
20. Ministry of Public Infrastructure	3,185
21. Ministry of Co-operatives, Fisheries & Marine Resources Development	163
22. Ministry of Health	9,613
23. Ministry of Energy and Water Resource	1,655
24. Ministry of Environment and Quality of life	476
25. Ministry of Youth and Sports	359
Total Central Government	**56,828**
2. LOCAL GOVERNMENT	
1. Municipalities	4,107
2. District Councils	1,401
Total Local Government	**5,508**
Total General government Services	**62,336**

Source: Central Statistical Office

3.1.2 Macro Economic Development

(1) Mauritius achieved considerable economic development in the 1980s so much, so that this period is termed an economic miracle in international circles. The country rapidly moved from a mono-crop economy and low per-capita income, as a result of drastic changes in the economic structure which permitted diversification of the economic base of the country and development of sectors like EPZ, tourism and

financial services. EPZ registered annual double-digit growth . However, since 1989, production growth and foreign direct investment has slowed down and the number of employees in EPZ has decreased slightly. Nevertheless, the economy of Mauritius has continued to grow favorably, partly due to tourism and financial sector as well as construction, transport and communication. Inflation has gradually been brought down.

Table 3.1.2 GROWTH RATE OF GDP

	1976-80	1981-85	1986-90	1991-95	1996 Esti.
GDP	0.9	4.4	6.7	5.6	5.8
Agriculture	-0.9	8.0	1.0	-0.4	4.3
of which Sugar	-12.0	8.9	-0.4	-3.6	9.0
Mining	-	-	5.3	6.9	6.0
Manufacturing	2.7	8.3	8.8	5.4	6.3
of which Sugar	-12.0	7.7	-0.4	-3.3	9.0
EPZ	14.7	16.3	11.6	5.3	7.0
Elec. Gas & Water	8.5	9.9	5.6	7.9	7.5
Construction	-1.0	1.7	12.0	4.7	4.0
Transport and Communication	4.4	4.3	8.3	7.7	6.7
Wholesale, Retail & Trade	3.8	3.1	11.1	6.9	7.9
of which Rt.Hotels	6.7	7.2	13.3	5.9	16.0
Gov. Services	3.4	1.6	2.7	4.3	3.5
Other Services	6.3	4.2	6.4	8.6	4.5
GDP Deflator	14.3	7.4	10.8	6.7	6.3
CPI	18.6	9.1	7.5	7.1	7.0

Sources : Mauritius Central Statistical Office ; Ministry of Economic Planning & Development

(2) The Mauritian banking system had developed continuously over the years. The ratio of M2 to GDP shows a betterindication of the evolution of the banking sector. Interest rates have remained moderate. The Mauritian people have a strong propensity to save showing that they have confidence in the banking system and the government and are willing to accumulate development resources for the future. The government has succeeded in its inflation management policies.

Table 3.1.3 MONEY SUPPLY AND INTEREST RATE

	Money Supply (Rs million)		Increase ratio (%)		Interest rate (%) of Commercial Banks		CPI
	Currency	Time Deposit	M_1	M_2	Saving Deposit	Credit	increase ratio (%)
1985	1096	5029	15.7	19.4	8.5-9	11^2-17	6.7
86	1305	6496	12.6	23.9	8.5-9	11^5-17	1.8
87	1663	10069	21.2	45.2	8	10^5-16^5	0.6
88	2009	13748	17.9	32.0	8	11-17	9.2
89	2404	15765	18.1	15.4	12	12^5-20	12.6
90	2848	18990	23.6	21.2	12	13-21	13.5
91	3407	23278	19.7	21.9	11	13-20	7.0
92	3820	27195	12.4	15.8	7	10-19	4.6
93	4230	32850	-1.1	16.1	8	10-19^5	10.5
94	4412	36174	19.4	11.8	9	10-23^5	7.3
95	4847	43214	8.0	17.2	8-9	10-21^5	6.0
96 Ju.	4162	45274	-14.0	1.4	8	10-21^5	

Note: Money Supply and Interest rate are at the end of the year. CPI is the yearly change of the annual average level.

Sources: Bank of Mauritius "annual Report" in 1986, 1988, 1990, 1992, 1994 and 1995;
"Monthly Bulletin" June 1996

(3) International trade has been comparatively active. The country's structural weakness -- as seen in its trade deficit, transport-related service deficit and non-factor service deficit -- has been fully compensated by the stable development of tourism, large remittance transfers, active foreign capital inflows and a constant surplus in the errors and omission account.

The overall balance of payment has been in the surplus and foreign reserves have increased steadily, except for the year 1994. Import pressures are still strong due to slower economic growth. Also, Mauritius bears a considerable burden in the investment income payment sector. It is expected that the balance of payment problem can be eased in future through a combination of moderate economic growth, import substitution, a more aggressive export oriented strategy, and the careful management of foreign debt.

(4) The budget deficit is presently a source of great concern in Mauritius. Current

expenditures have increased at a rate much greater than that of tax revenue. Although the Government has increased its non-tax revenue, and has restricted capital expenditure and net lending, the budget deficit has been three times higher than GDP for the past five years. The new Government has modified its tax system, raising the sales tax from 5% to 8% on June 1996.

Table 3.1.4 BALANCE OF PAYMENT

(Rs million)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Trade Balance	-411	762	-208	-2173	-3129	-4007	-3193	-2659	-4487	-7471	-4764
Export	6639	9056	11493	13455	15166	17914	19019	20272	23020	24130	26756
Import	-7050	-8294	-11701	-15628	-18295	-21921	-22212	-22931	-27507	-31601	-31520
Service Trade Balance	43	525	577	791	847	1339	1632	1493	1518	1863	
Invest/.Income Balance	-641	-704	-1052	-634	-370	-553	3	-290	-446	-443	
Transfer Balance	556	670	856	1286	1149	1438	1273	1432	1766	1773	
Current Balance	-459	1253	815	-770	-1593	-1783	-285	-24	-1649	-4278	
Long-term Capital	221	370	767	2120	1376	1627	1569	174	331	2039	
Direct Investment	124	100	221	317	537	601	127	-445	-326	340	
Others	97	270	546	1803	839	1026	1442	619	657	1699	
Short-term Capital	-200	-112	14	-77	-601	123	-270	-288	379	-471	
Government	156	-15	230	-207	24	-162	-344	-540	25	-254	
Balance of Capital	177	243	1011	1836	799	1588	955	-654	735	1314	
Errors & Ommission	790	428	1260	1608	3292	3809	2580	975	1449	2231	
Overall Balance of Payments	507	1924	3086	2674	2498	3614	3250	297	535	-733	2000
(cf)Foreign Reserves	882	2450	4478	6428	8049	11063	13906	14556	15145	14283	18604
Bank of Mauritius	472	1830	4225	6174	7836	10633	13260	13867	14008	13235	15129
Commercial banks	403	611	241	250	213	428	617	542	949	856	3475
Weeks of foreign reserves against import bills	6.5	15.4	19.9	21.4	22.9	26.2	32.6	33.0	28.6	23.5	30.8

Sources : Bank of Mauritius " Annual Report " 1988, 1990, 1992, 1994 & 1995

3.2 Future Development and Main Policy Issues

3.2.1 Mauritius Strengths

Mauritius is a small island with only one million people. In order to realize their development potentials, it has many strengths that bode well for future development. Among the people there are inherent strengths which will permit them to deal with potential problems over the next three decades.

(1) The first strength is political stability and the flexibility of the people. Mauritius is comparatively young, not bounded by historical, religious or racial conflicts. Political and social stability are essential to promote economic policies. The Mauritian people are flexible, and having high literacy level able to adapt to new business environments. This flexibility contributes to good governability.

(2) Second, Mauritians are bilingual, speaking French and English plus the local Creole. This ability in international languages opens the door to interaction with foreign countries. The people can use this cultural heritage in international business more easily than can others elsewhere. International businesses follow trends, growing more rapidly under advantages offered by trade liberalization policies and advanced technologies fostering transport and communication. The challenge lies in how to materialize this bilingual ability to develop profitable businesses.

(3) The third positive factor is well-developed legislation. The Mauritian legal system, based on a hybrid of British and French law, is more advanced than that of developing countries in Asia, and prevents many business troubles. This is a great asset for the future. Procedural law applied in both criminal and civil litigation is mainly British, while substantive law is mainly based on the French Napoleonic Code. Corporate law is basically modeled on British law.

(4) The fourth strength is the high saving ratio of the people, and their confidence in banks. Some Mauritians have large deposits in banks, in order to buy a house or have their children study abroad. This is a great advantage for financial business development, human resources development, and the formation of international

human networks, including international financial organizations.

3.2.2 Constraints

(1) On the other hand, Mauritius must overcome three considerable constraints in its development process, which will be the true hardle for her advancement.

The first constraint is the shortage of domestic savings for necessary investments. Economic conditions have totally changed. In the past, economic growth was achieved through an unexpected increase in the labour activity rate, with comparatively small capital investments made because of high unemployment. However, since 1989 the labor market has been very tight. The unemployment rate dropped precipitously from 14.8% in 1985 to 1.7% in 1995. Attractive jobs are being found in the service sector at a time when the need for workers in agriculture and manufacturing is declining. The labor force can increase only 1.5% annually between 1995 and 2000, 1.4% between 2000 and 2010, and 0.7% between 2010 and 2025.

Economic growth mainly depends on productivity promoted through capital-intensive investment. The country will need large-scale investment in every economic field, but this will increase pressure on money markets and jeopardize the balance of payments, in light of large outlays for the import of machinery and equipment. Investments for infrastructure were comparatively lighter burden in the former stage of development, as cost saving has been realized to use existing assets and natural benefits. However, at this stage costly projects must be undertaken on a large scale.

The Government hopes to maintain a high capital investment ratio, at about 30% of GDP (similar to the level in the 1980s). The domestic savings ratio stood at 22% in 1995, and the individual saving ratio is still comparatively high. The main problems are the budget and trade deficits. If the Government cannot rectify the macroeconomic imbalance, it will have to choose a more realistic path -- slower economic growth at lower investment levels, or higher growth based on budget restructuring and foreign capital.

(2) Tax reform is exceedingly difficult in any democratic country. Mauritian economic policy stands on tax incentives for foreign investors. The people have long been accustomed to a lower tax burden, lower public utility rates, and a free education. The government will find it difficult to increase tax revenue in order to catch up with necessary expenditures. The trade deficit problem depends on the balance of investment activities and the export of commodities and services.

Under regional cooperative arrangements such as COMESA and SADC, Mauritius will transform current import duties into excise taxes, and move from the current sales tax to a value-added tax by 2000. However, it may be too optimistic to assume that the present import duty on petroleum products will be reduced or lifted in the near future.

(3) Foreign loans are beset by two problems -- interest payments and foreign exchange losses. Extremely healthy entities in Mauritius can obtain foreign loans under government guarantee, but the interest rate (LIBOR + 0.75%) is higher than that levied on entities in industrialized countries, because Mauritius is located in the African region, the highest risk area. Interest payments are an uncomfortable burden, not only worsening the nation's balance of payments but also hurting the borrowing entities themselves. The other problem is foreign exchange losses. The Mauritian rupee has been depreciated moderately. In the meantime, investment funds are borrowed from overseas for the relatively long term of ten to fifteen years. During this period, the rupee could depreciate considerably, forcing the debtor to make additional payments. Foreign loans are a convenient way to promote investments, but the potential burden and the possibility of a future drop in credibility because of a huge debt load must also be considered carefully.

As one capital expenditure budgetary measure, the Ministry of Finance created a National Infrastructure Development Fund in July 1995, with a view to issuing five-year treasury bonds in the international capital market valued at a total of US$ 150 million, at an interest rate of LIBOR (4.5%) + 0.9 %. This is a new attempt for the government to borrow money on a commercial basis. In the past, the Government

tended to borrow from international financial organizations on a concessional base using such institutions as the IBRD, African Development Bank, Arab Bank of Economic Development in Africa, Cerisse Frasane de Developement, European Investment Fund, and Nordic Investment Fund. Plans call for the National Infrastructure Development Fund to promote urgently needed projects such as airport and port developments, telecommunications network expansion, housing improvements, and water supply and road network development. The Fund's interest rate stands at 11.5~12.0 % a year for a five-year term. This program offers advantages, developing a new financing source that will share potential foreign exchange losses between the government and borrowers, but the loan period of five years is too short to promote large projects.

The burden of foreign loans can quickly rise over time. If foreign loans are secured to the amount of 8% of GDP (the shortfall in local savings required for necessary investments using foreign resources), this amount, US$ 300 million in 1996, will double in 2003, be 10 times greater in 2018, and 20 times greater in 2025, even though nominal GDP has increased 10% a year. Such a burden would not be sustainable for Mauritius, so debt management must be strict.

(4) BOO or BOT are important ways to promote new investments for some infrastructure, such as a mass transit system, the Pouce Mountain tunnel, power generation, bus terminals and car parking lots. Investors would be private companies which place priority on the rate of return for each project. The Mauritian Government or parastatal body offer bid conditions, which include regulations, incentives and utility charges.

Public utility charges will be the most controversial subject from now on. From the standpoint of the supplier, high tariff rates promise a high rate of return -- this encourages new investment. From the standpoint of the user, rate increases are the same as a tax increase, pushing up operation costs. Low tariff levels are one important cost factor that can enable companies in the EPZ and tourist businesses to survive worldwide competition. Furthermore, the Government wants to maintain low tariff levels to protect the livelihood of the people. The Government has to fix

utility charges at an appropriate level, coordinating the burden & benefits between investors and users .

(5) The second constraint confronting Mauritius is human resources development. The population increases by 1.1~1.2 % a year, which is equal to an 11 or 12 thousand net increase, if one calculates 20,000 live births, 7,000 deaths and 2,000 emigrants annually. The Mauritian economy is developing considerably quickly, boosting income levels, which means that the economy serves to motivate youth and promotes the tendency to seek higher education. The number of work force with high level education is not sufficient to meet the rapidly increasing of its requirement.

(6) Mauritius has employed foreigners in areas experiencing a dearth of local human resources, such as manufacturing, tourism, construction, financial services, telecommunications and civil aviation. The Ministry of Employment, Manpower Resources and Training and Reform Institutions regulates foreign workers, issuing work permits in accordance with the following principles.

a. Reasons to employ foreigners
   The local company, who can only apply has to clarify the necessity of the foreigners for a specific job.
b. 1 : 3 principle to a bulk foreign workers
   If the local company want to employ a number of foreign workers at a same time , it has to employ local worker three times more than the number of foreigners.
c. Teams of years, families, and wage
   Skilled labours shall go back after the period of three years, shall not accompany with families, and shall be paid as the same level of local workers which is regulated by the government minimum wage by job category. Engineers, professionals or managers can stay on the base of the projects, can accompany with families and shall be paid at the international level.

The number of work permits issued has been stable over the last two years, at 8 ~ 10

thousand per year. The number of foreign workers in the labor market is increasing by 1,000 a year. The number of valid work permits stood at 8,500 as of January 1996, of which 80% of all permit holders were engaged in manufacturing, particularly the textile industry. More than 10% are working in speciality fields such as financing, telecommunications or civil aviation. 85% of all foreigners are skilled workers from such places as China, India, Sri Lanka and Madagascar. The remaining 15% are mainly managers and professionals of affiliated companies in industrialized countries.

Table 3.2.1 WORK PERMITS ISSUED TO FOREIGNERS

	Textile	Construction	Hotel & catering	Others	Total
1989	-	-	-	-	1,849
90	-	-	-	-	2,703
91	-	-	-	-	2,573
92	1,870	1,454	272	1,155	4,751
93	3,282	1,331	302	1,375	6,290
94	6,916	1,379	345	1,823	10,463
95	5,497	593	301	1,654	8,045
Jan. ~ May 96	2,291	373	35	440	3,139
Valid as of January 1996	6,993	207	252	1,069	8,521

Note: Work permit issued by nationality in 1995

(developing countries)		(developed countries)	
China	4672	France	353
India	1556	South Africa	229
Sri Lanka	234	U.K	176
Madagascar	212	Italy	78
Bangladesh	72	Germany	54
Malaysia	47	Belgium	38
		Australia	33
		Japan	31
		USA	22

Source: Ministry of Employment " Statistical Review on Employment"

(7) Technology transfers are another issue. The 1:3 principle embodies the goal of on-the-job training (OJT) and job creation for the local people. Working together at the same place with well-trained workers or highly educated professionals provides excellent OJT opportunities. Yet there still exist many problems which inhibit achievement of these ultimate aims. OJT is very popular in Japan, backed by a life-time job guarantee and offering rewards under the seniority system. Such a case is

rare in Mauritius. Generally speaking, skilled workers and professionals do not want to share their knowledge and expertise with others, considering that this could reduce their own competitive level of professionalism. It is felt that Mauritius may require to take positive steps towards receiving the benefits of technology transfers.

Another problem is the limited capability to introduce advanced technologies to her industry. Certain reformation of the present education system of Mauritius may require to solve the problem

(8) The last constraint facing Mauritius is institutional rigidity. In the former development process, the nation's institutional framework functioned well, and many regulations were developed within a systematized institutional organization. These regulations have contributed to social stability, but some surely impede future developments.

In Mauritius, the employees of government and parastatal body employees have been paid higher salaries than the private sector. The Pay Research Bureau compiles a recommendation report in September every four years which covers job description in detail, working hours, remuneration and fringe benefit such as vacation, air ticket etc. The National Remuneration Board determines the private labour conditions every four years such as working hours, vacation, minimum wage and overtime charge for 30 sectors. Managers of private businesses fix the actual wage through bargaining with trade unions, using the minimum wage as a point of reference. Under the present full employment situation, professionals such as engineers, bankers, lawyers and accountants can enjoy two to three times the compensation of manual workers. Remuneration and wage are adjusted by inflation in July every year through negotiation among three representatives, Ministry of Finance, trade union and employers' federation. Such a wage system gives unfavourable influence to sectoral allocation of human resources. Maurician people have a strong tendency to work in service sector than manufacturing, and privatization will be discouraged in the traditional sectors.

Employees in the public sector work 33 ¾ ~ 40 hours a week while private ones work

for 45 hours average (8 hours for 5 weekdays and 5 hours on Saturday), with wide range of 40 for bus drivers to 72 hours for security. Some of these practices are deeply rooted in historical background and their lifestyle, combined with a transport problem between working places and thier residences. Higher compensation for overtime (50% more than the regular hourly wage in normal days and 100% for first 8 hours on holiday, 200% for more than 8 hours on holiday) is the main reason discouraging employers from utilizing their employees effectively.

Now Mauritius is expected to integrate itself within the international economy and follow the trend of deregulation. The deregulation of business activities & employment conditions and the restructuring of institutional bodies, will be the important actions to be considered. There are still large fluctuations in the global economy -- in petroleum prices and stability of supply, in commodity markets, stock markets, exchange rates, interest rates and so on. The common question for all countries is how to find ways to ensure that these fluctuations do not cause adverse effects. The challenge facing Mauritius today is to creatively manage its economy under the most appropriate system.

3.3 Financial and Monetary Prospect

3.3.1 International Financial Market

(1) The international financial system has grown speedily in size, complexity and geographical scope. The international bank lending activity has revived from the sharp fall in 1991 to $652 bil. in 1995. Out of which more than 80% was the claims on BIS inside-area countries, and $108 bil. were the claims on outside-area countries. Lending to Asia amounted $84 bil. and Latin America continued to rely more heavily on international securities ($18 bil.) than on international bank loans ($7 bil.). The syndicated credit was also buoyant in 1995, with a record volume of $320 bil. for refinancing at lower cost, sovereign borrowing, bridging loans, project-related deal and M&A package finance.

The ample liquidity position of banks in industrial countries and increase of participants into a financial market give benefits to borrowers, which contributes to lower interest rate, maturing extension and other relaxed lending conditions. LIBOR (London Interbank Offering Rate) has been below 6% except spring 1995 since summer 1991.

(2) Aggregate net resource flows to developing countries reached a record $231 bil. in 1995. This volume is 2.3 times five years ago. Money flow to developing countries has grown 3 times their GDP growth rate, which has spurred their economic development remarkably. The Institute of International Finance (IIF) estimates that these resource flows would be $239 bil. in 1996 and $243 bil. in 1997, out of which 56% will flow into Asia-Pacific region. According to the World Bank, East Asia need the big finance of $1.3 - 1.5 trillion only for the infrastructure coming ten years 1996 - 2004. Money inflow is the key to develop their economies because local saving is not sufficient.

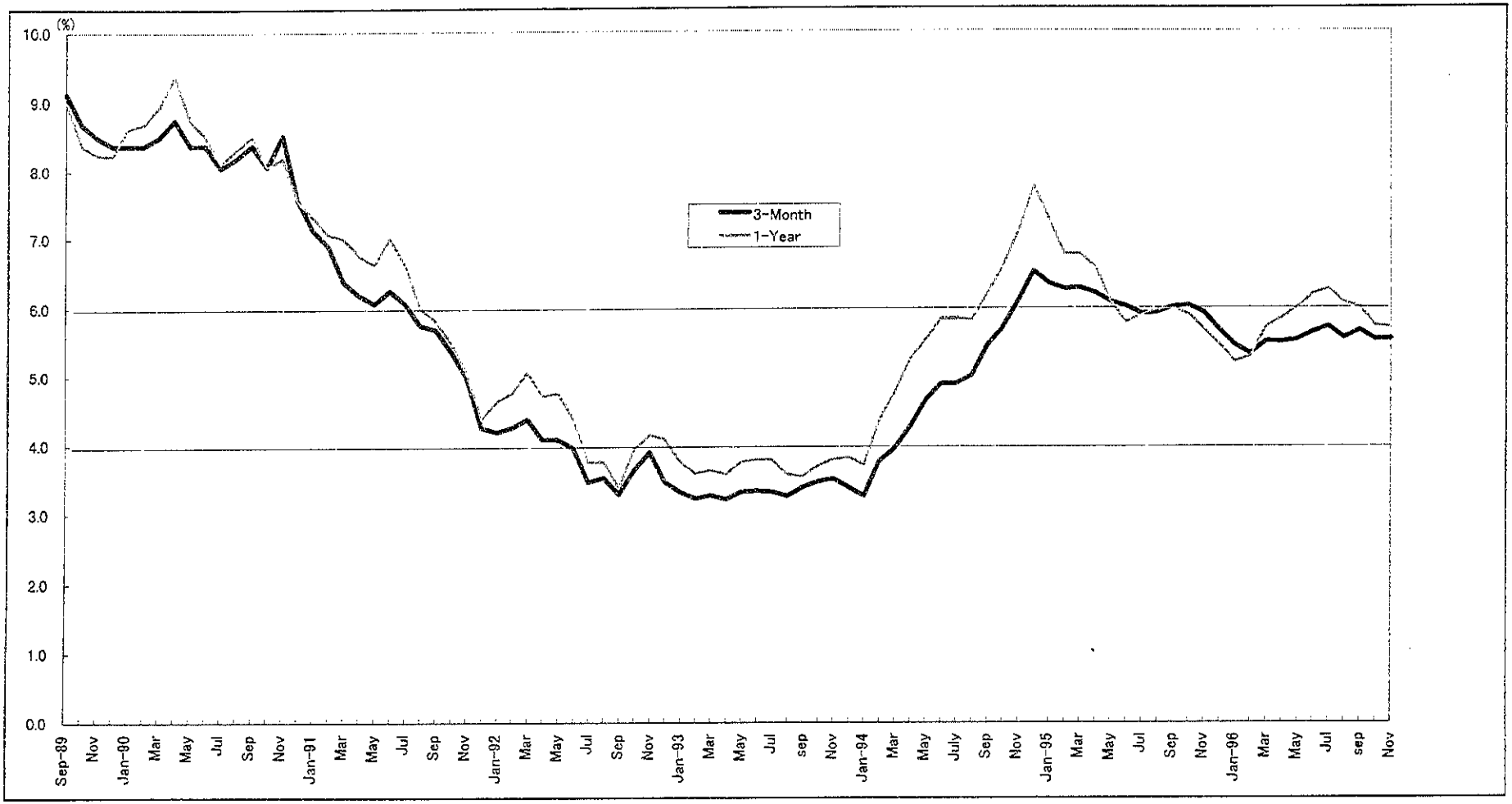


Figure 3.3.1 TRENDS OF LIBOR

In the great volume of this flow, private capital has continued to grow dominating total net flows to developing countries. Official development finance has been squeezed up to 1994, and revamped in 1995 by exceptional finance package with $11 bil. for Mexico from official bilateral and multilateral sources. Export finance continues to expand, but official loan is declining especially in a form of multilateral loans except Mexico case. Official grants remain at the same level. Private flows which are increasing ruppidly, have three characters. The first, commercial banks came back again to this market, which experienced a long slump years after enforced debt reduction led by the Brady proposal. The second, securities of bonds or equities were buoyant two times in 1992 and 1993, but equity flows decline afterwards. The third, foreign direct investment (FDI) is growing continuously every year, overpassing ODA total in 1993 and occupies 38% of the aggregate net resource flows in 1995.

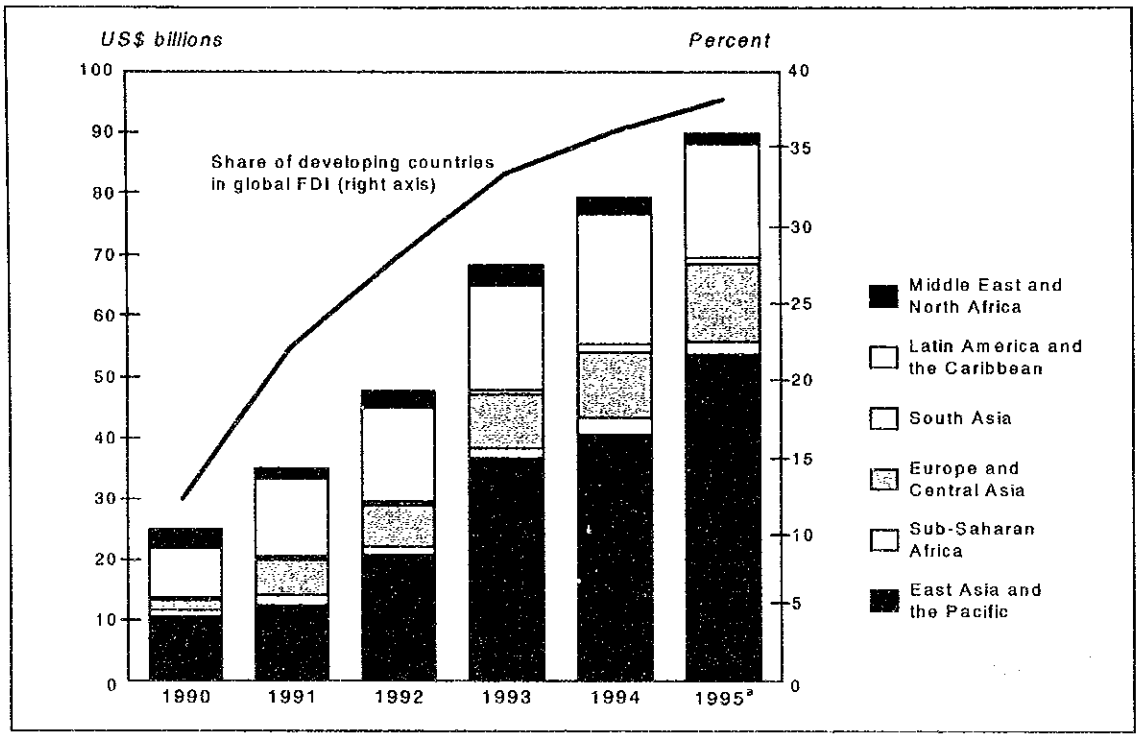
Table 3.3.1 AGGREGATE NET LONG-TERM RESOURCE FLOWS TO DEVELOPING COUNTRIES, 1990-95

(US$ billions)

Indicator	1990	1991	1992	1993	1994	1995[a]
Aggregate net resource flows	101.9	127.1	155.3	207.2	207.4	231.3
Official development finance	57.9	65.5	55.0	53.0	48.6	64.2
Official grants	29.4	37.5	31.9	29.4	32.5	32.9
Official loans	28.5	28.0	23.1	23.6	16.1	31.3
Bilateral	13.5	13.2	10.8	9.4	6.1	18.8
Multilateral	15.0	14.8	12.3	14.2	10.0	12.5
Total private flows	44.0	61.6	100.3	154.2	158.8	167.1
Private debt flows	15.3	19.0	39.6	40.3	43.8	54.8
Commercial banks	1.7	2.5	13.8	-4.9	9.2	17.1
Bonds	3.0	12.8	13.2	38.3	32.2	33.7
Others	10.6	3.7	12.6	6.9	2.4	4.0
Foreign direct investment	25.0	35.0	46.6	68.3	80.1	90.3
Portfolio equity flows	3.7	7.6	14.1	45.6	34.9	22.0

a. Preliminary.

Source: World Bank, "World Debt Tables 1996".



a. Preliminary.
Source: World Bank, "World Debt Tables 1996"

Figure 3.3.2 DEVELOPING COUNTRIES' SHARE IN GLOBAL FDI

(3) Developing countries can expect current trends of money flow in the future. ODA volume will remain stagnant, because of slow new disbursements & large repayments by budget reforms in developed countries, and of easier availability of the private resources. Aid resources has become scarce in the public sector. The ODA is changing its role, stressing poverty reduction and sound policies in the recipient countries, slipping down from the traditional role for long-term development. On the other hand, private flows will continue bright in the emerging economies. Private investment to developing countries will be pushed by portfolio diversification. Globalization of the financial market is being promoted by financial portfolio innovation, technological change and falling transport & communication cost.

The boom in world trade will provide continuing impetus for private flows to developing countries, especially by FDI. Appreciation of currencies in some high-income economies will accelerate the transfer of production to low-cost sites in

developing countries through outward FDI. Sustainable economic growth accompanied with export increase in developing countries is attractive to foreign investors. Their continuous structural reforms will be necessary for this purpose. FDI's participation in infrastructure projects will be promoted in a form of BOO or BOT.

3.3.2 Financial Development in Mauritius

(1) Mauritius has a well-developed banking system with the major commercial banks having branches in all parts of the country. The Bank of Mauritius, the central bank was set up in 1967 just before her independence from UK. It has played an important role in creating a financial environment conductives for economic development. It has speeded up the liberalization of exchange control and interest rate, and has embarked on a phased program of monetary policy reforms since July 1991.

There are twelve commercial banks, 7 local ones and 5 foreigns as follows.

Locally - incorporated

- The Mauritius Commercial Bank Ltd.
- The State Bank of Mauritius Ltd.
- Indian Ocean International Bank Ltd.
- The Mauritius Cooperative Central Bank Ltd.
- South East Asian Bank Ltd.
- Union International Bank Ltd.
- Delphis Bank Ltd.

Foreign Banks

- Barclays Bank PLC
- Bank of Baroda
- Banque Nationale de Paris Intercontinentale
- Habib Bank Ltd.
- Hong Kong & Shanghai Banking Corporation Ltd.

These banks offer standard banking services for domestic and foreign transactions. Some banks already established cash dispenser services same as in developed countries. They have correspondents in the major cities around the world and transaction can be effected in about twenty currencies.

The Mauritius Stock Exchange was set up in 1989. The number of listed companies rises to 40, but the activity is far behind from money market. The insurance is also established with all types of risks accept. Larger risks are usually reinsured abroad. Several international insures like Lloyd's of London have representatives here. Offshore activities are also active.

(2) Monetary resources are growing by 10% a year owing to increase of saving and time deposit. There are two problems of the present monetary management. First, government borrowing still increases competing to private borrowing. Second, net foreign asset is decreasing as a whole, though central bank's one increased in 1996.

Table 3.3.3 MAURITIUS MONETARY AGGREGATE

(Rs. million)

	June 92	June 93	June 94	June 95	June 96
1. Net Foreign Assets	**16297.8**	**15935.0**	**15324.8**	**14809.8**	**19110.0**
(a) Bank of Mauritius	14712.4	13691.7	12729.4	11719.9	15561.0
(b) Commercial Banks	1585.4	2243.3	2595.4	3089.8	3548.0
2. Domestic Credit	**23169.0**	**28689.0**	**37444.8**	**44114.4**	**47055.0**
(a) Net Claims on Govt.	6968.0	8190.4	10870.5	13529.4	14798.0
(b) Claims on Private Sector	16107.2	20387.5	26463.1	30473.9	32257.0
(c) Claims on other Bank like Institutions	93.8	111.1	111.1	111.1	---
3. Assets/Liabilities	**39466.8**	**44624.0**	**52769.6**	**58924.2**	
4. Aggregate Monetary Resources	**32105.0**	**36380.1**	**42504.9**	**46649.1**	**53509.0**
(a) Money Supply	6590.9	6959.1	7030.9	8134.3	8235.0
(i) Currency with public	2972.0	3315.9	3570.3	3767.4	4162.0
(ii) Demand Deposits	3618.9	3643.2	3460.6	4366.9	4073.0
(b) Quasi-Money	25514.1	29421.0	35474.0	38514.8	45274.0
(i) Savings Deposits	11643.0	14715.5	16675.6	16885.6	20114.0
(ii) Time Deposits	13871.1	14705.5	18798.4	21629.2	25160.0
5. Other Items net	**7361.8**	**8243.9**	**10264.7**	**12275.1**	**---**

Sources: Bank of Mauritius "Annual Report Year Ended 30 June 1995", "Monthly Bulletin October 1996"

Interest rate is changeable reflecting demand-supply relations of the money market. In autumn 1994 it jumped sharply, but it has decreased since January 1995 up to now. The level of interest rate is about two times higher than UK or France. Main reason is higher inflation and strong demand of money comparatively.

Table 3.3.4 MAURITIUS INTEREST RATE (%)

	Weighted Average Interbank Market Rate of Interest	Overall Auction Rate of Government Bills
1994		
July	9.70	10.20
September	12.66	12.35
December	12.23	11.66
1995		
March	10.47	9.96
June	10.36	9.80
December	9.83	9.86
1996		
March	10.23	--
June	9.79	--
September	9.93	9.40
Average		
1993-94	**8.27**	**7.96**
1994-95	**10.97**	**10.86**

Sources: Bank of Mauritius "Annual Report Year Ended 30 June 1995", "Monthly Bulletin October 1996"

(3) ODA is stagnated. Further Mauritius per capita GDP is considerably high for ODA recipient. But recent development of the international financial market benefit Mauritius with favorable terms. Also foreign direct investment is hopefully expanding to developing countries. Investors are watching all the countries & regions including Mauritius, to compare the rate of investment return and risks. Mauritius banking system, telecommunication and air transportation are well arranged. They can get favorite wind of above international financial market and FDI, if they can continue the favorable economic performance with higher GDP growth rate, lower inflation, smaller budget deficit and sound balance of payment. If Mauritius succeeded in putting her credibility at a better rank in the international financial market, the spread on the LIBOR shall be reduced and the maturity will be expanded. Many infrastructure projects can be promoted by foreign direct investment in a form of BOO & BOT as well as by foreign borrowing. Power generation is one of the most adequate project of BOO or BOT to recover the investment cost in a shorter period, especially while the power demand increases strongly.

(4) The Bank of Mauritius administers the exchange rate based on a trade-weighted basket of currencies. Since July 1994, foreign exchange controls have been suspended. The Mauritian rupee has been depreciated by 35% in the past ten years which is partly due to fluctuations in international currency markets.

Table 3.3.5 FOREIGN EXCHANGE RATE

(Monthly Average, Selling Rate, Rs/US dollar)

	1985	1986	1987	1988	1989	1990
March	15.943	13.897	12.809	12.912	15.176	15.191
June	15.943	13.541	13.158	14.091	15.774	15.566
September	14.860	13.332	13.502	14.452	15.737	14.796
December	14.454	13.272	12.299	13.974	15.148	14.467

	1991	1992	1993	1994	1995	1996
March	15.921	16.122	17.345	18.372	17.568	19.112
June	17.084	15.251	17.766	17.803	17.588	20.218
September	16.180	15.003	17.978	17.845	18.052	
December	14.944	17.169	18.843	18.221	18.440	

Sources : Bank of Mauritius " Annual Report" 1986, 1987, 1988, 1990, 1991, 1992, 1993, 1994 and 1995;
"Monthly Bulletin" June 1996

◆ Chapter 4 Development Process and Current State ◆

Chapter 4 Development Process and Current State of the Energy Sector

4.1 Energy Supply and Demand Structure

As discussed in the previous chapter, Mauritius has successfully transformed its economy characterized by monocultural structure through diversification. Based on GDP growth rates during the recent decade, the country is said to have achieved steady growth from international economic growth level. The healthy economy has spurred domestic energy demand to grow year after year, resulting in a significant change in energy supply structure including electricity.

Table 4.1.1 shows the country's energy balance in 1995. From the table, major findings in energy supply and demand conditions in the country are summarized as follows. Note that the table does not show data on supply of new energy sources including solar energy due to the lack of data (their quantitative consumption is minimal):

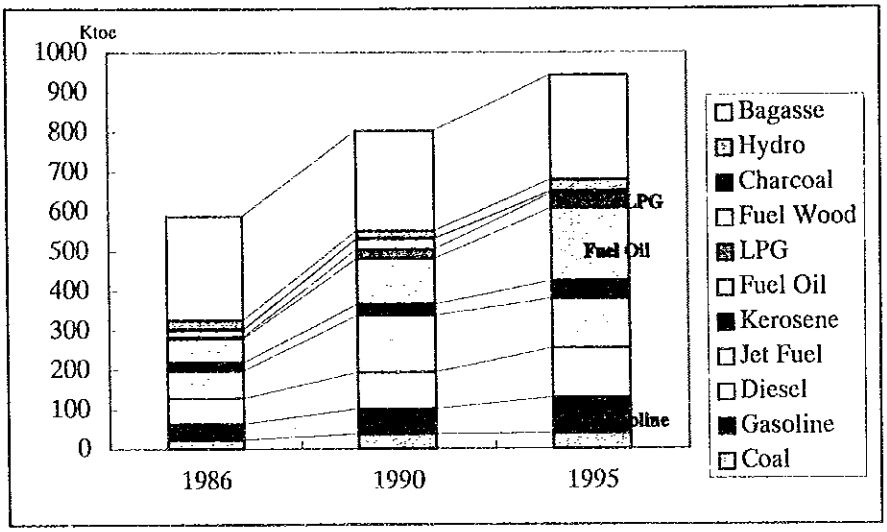
a) Total primary energy supply (TPES) in 1995 was 930,000 tons including jet fuel exported, of which locally produced energy accounted for 32% and the remaining 68% represented imported energy sources. The percentage of imported energy has been steadily on the rise during the past decade (1986 - 1995).

b) Among primary energy sources, LPG shows the highest rate of growth. However, it is essentially imported in small quantities and accounted for only 4% of total primary energy supply in 1995, although consumption increased nearly tenfold during the decade. In this meaning, energy sources recording relatively high growth rates with significant quantities are fuel oil that is mainly used for power generation and gasoline consumed by the transportation sector (see Figure 4.1.1).

Table 4.1.1 1995 MAURITIUS ENERGY BALANCE

(in TOE)

	Coal	Gasoline	Diesel	Jet Fuel	Kerosene	Fuel Oil	LPG	Fuel Wood	Charcoal	Hydro	Bagasse	New Energy	Electricity	Total
Primary Energy Supply														
Domestic Production								4,940	962	29,568	262,370			297,840
Import	39,113	90,675	121,510	125,041	44,639	175,436	36,396							632,810
Total Primary Energy Supply	39,113	90,675	121,510	125,041	44,639	175,436	36,396	4,940	962	29,568	262,370			930,650
Export				- 125,041										- 125,041
Stock Change														
Domestic Primary Energy Supply	39,113	90,675	121,510	-	44,639	175,436	36,396	4,940	962	29,568	262,370			805,609
Energy Conversion & Own use														
Electricity Generation	- 18,779		- 2,625		- 33,625	- 137,171				- 10,752	- 47,689		76,987	- 173,654
Own use & Losses										- 18,816			- 983	- 19,799
Final Energy Consumption	20,334	90,675	118,885	-	11,014	38,266	36,396	4,940	962	-	214,681		76,004	612,157
Industry Sector	20,334		17,428			38,266	2,754	1,482			214,681		28,005	322,950
Transport Sector		90,675	101,458											192,133
Commercial Sector							3,402		592				19,550	23,544
Residential Sector					11,014		30,240	3,458	370				28,448	73,530



Source: CSO

Figure 4.1.1 GROWTH OF PRIMARY ENERGY CONSUMPTION

c) New energy initiatives have started in solar heaters which are increasingly used as a source of hot water, with an installed base of 18,000 units as of May 1996. On the other hand, the use of wind and solar energies as community energy supply systems is limited to small-scale, experimental projects. It will take years to come before it has some influence in the nation's energy balance.

d) Domestic energy sources include bagasse, hydropower, charcoal, and fire wood. However, their supply remained almost unchanged during the past decade due to flattened production of sugarcane and the rise in environmental concern. In particular, charcoal and fire wood account for a meager 0.6% of total energy supply.

e) The electricity sector is only one major sector responsible for energy conversion. As of 1995, 76.7% of energy input by the sector were imported energy sources. Domestic energy sources are hydropower and bagasse, however, consensus is building up that hydropower development is considered to be socially and economically infeasible. Thus, the more effective use of bagasse is only one area where domestic energy input can be increased.

f) Total energy consumption in 1995 was 613,000 TOE. Bagasse is the largest energy source in the country, and 80% are consumed by sugar refineries as a major heat energy source. The industrial sector including the sugar refinery industry is the largest energy consumer, accounting for 52.8%, followed by transportation (31.4%), household (12.0%), and industry (3.8%).

Then, international comparison was made for energy supply and demand patterns. Note that the country's energy supply and demand is governed by numerous factors including national economy's structure and size, population, income, and availability of energy resources. Thus, the comparison made here indicates the country's relative position in terms of energy supply and consumption.

Table 4.1.2 compares major regions by energy consumption per capita in 1991. Mauritius's 0.82 TOE is very close to the average level in Africa. However, the regional average is skewed by a significantly high level in South Africa, 2.57 TOE, and if it is taken into account, Mauritius ranks relatively high in the region. Yet it is far below the average for East Asia and Latin America. Countries positioned at a similar level to Mauritius are Thailand (0.77), Brazil (0.89) and Columbia (0.81).

Table 4.1.2 PER CAPITA ENERGY CONSUMPTION IN 1991

Region	toe
South Asia	0.28
East Asia	0.92
Latin America	1.19
Africa	0.83
OECD Countries	4.84
Mauritius	0.82

Note:Regional totals refers to the sum of the identified countries as follows
South Asia–Bangladish,India,Pakistan
East Asia–Hong Kong, Indonesia, Malaysia, Philippines, Singapore, S.Korea, Taiwan, Thailand
Latin America–Argentina, Brazil, Colombia, Mexico, Venezuela
Africa–Algeria, Egypt, Morocco, Nigeria, S.Africa
Source: 「Energy in Developing Countries」,OECD

Then, Table 4.1.3 compares growth rates of total primary energy supply (TPES) and gross domestic product (GDP) in the same regions between 1981 and 1991. During the period, Mauritius showed very high growth rates of both TPES and GDP compared to other countries, 10.6% and 6.2% respectively. These figures are comparable to two countries which experienced rapid growth during the period, namely Malaysia (TPES 10.2% and GDP 6.2%) and Thailand (10.3% and 8,0%). The similar trend can be observed in correlation between economic growth and growth of energy consumption.

Table 4.1.3 TPES AND GDP GROWTH RATES FOR 1980-91

(%)

Region	TPES	GDP
South Asia	6.5	5.2
East Asia	7.7	6.6
Latin America	2.9	1.8
Africa	4.1	2.7
OECD Countries	1.4	3.7
Mauritius	10.6	6.2

Source: 「Energy in Developing Countries」,OECD

The above findings indicate that Mauritius is positioned as a middle-income country in terms of economy as well as growth of energy consumption. At the same time, it totally depends its petroleum and mineral resources on imports, and expansion of domestic energy consumption directly leads to increased imports. Although its geographical location in the subtropical climate zone offers prospects for exploitation of new energy sources including solar, wind and wave, any of them has still to be developed to a commercially and technically viable stage. Thus, immediate targets for the country's energy sector and future development should be placed on the effective use of bagasse which is a major byproduct of the country's primary industry, and optimization of energy supply sources as a whole.

4.2 Existing Electric Power Facilities

4.2.1 Electric Power Facilities

(1) Power Demand and Supply

The historical trend of electric power demand and supply in Mauritius is summarized in Table 4.2.1 through 4.2.2 and Figure 4.2.1.

Table 4.2.1 indicates also the historical trend of sales of electricity in the past 10 years in Mauritius.
Sales of electricity has continuously increased from 318 GWh in 1985, to 895 GWh in 1995.
The average growth rate of sales per annum during 1985-1995 was 9.8 %.

The domestic sector has increased from 138 GWh to 334 GWh, and the average growth rate per annum during 10 years was 9.1 %.
The commercial sector has increased from 73 GWh to 230 GWh, and the average growth rate was 10.8 %.
The industrial sector has increased from 96 GWh to 308 GWh, and the average growth rate was 10.8 %.

The irrigation sector has increased from 5 GWh to 17 GWh during 10 years.
Sales for domestic sector was accounting for 37 % of the total sales, followed by the industrial sector was 34 %, the commercial sector was 25 %, and the irrigation sector was a minor user of electricity.
1,008 GWh is forecasted in 1996.

Table 4.2.2 indicates the historical trend of energy production in the past 10 years in Mauritius.
Production of electricity also has continuously increased from 390 GWh in 1985, to 1,046 GWh in 1995. The average growth rate of energy production per annum during 1985-1995 was 9.4 %.
Thermal has increased from 173 GWh to 787 GWh, and the average growth rate per annum

during 10 years was 13.2 %.

In case of Hydro, it has increased from 114 GWh to 134 GWh, but among these 10 years, amount of production is different every year due to amount of rain.

Production of Thermal was accounting for 75 % of the total production, followed by Hydro and bagasse were 12-13 % respectively.

1,1164GWh is forecasted in 1996, 10.1 % up in comparison with 1995.

Table 4.2.1 SALES OF ELECTRICITY IN THE PAST 10 YEARS (GWh)

Year	Domestic	Commercial	Industrial	Irrigation	Others	Total
1985	138	73	96	5	6	318
1986	143	82	119	7	6	357
1987	154	92	142	7	6	401
1988	167	102	162	11	7	449
1989	180	109	184	7	7	487
1990	199	126	213	14	7	559
1991	220	149	232	14	9	624
1992	249	168	245	16	10	688
1993	274	185	258	15	11	743
1994	296	207	277	18	12	810
1995	334	230	308	17	6	895
1996	Forecasted					1008

Source : CEB annual report

Table 4.2.2 ENERGY PRODUCTION IN THE PAST 10 YEARS (GWh)

Year	Thermal	Hydro	Other	Total
1985	173	114	103	390
1986	213	109	115	437
1987	243	139	104	486
1988	339	98	106	543
1989	310	147	125	582
1990	484	84	97	665
1991	538	74	124	736
1992	567	112	129	808
1993	654	102	111	867
1994	746	75	122	943
1995	787	134	125	1,046
1996	Forecasted			1,164

Source : CEB annual report

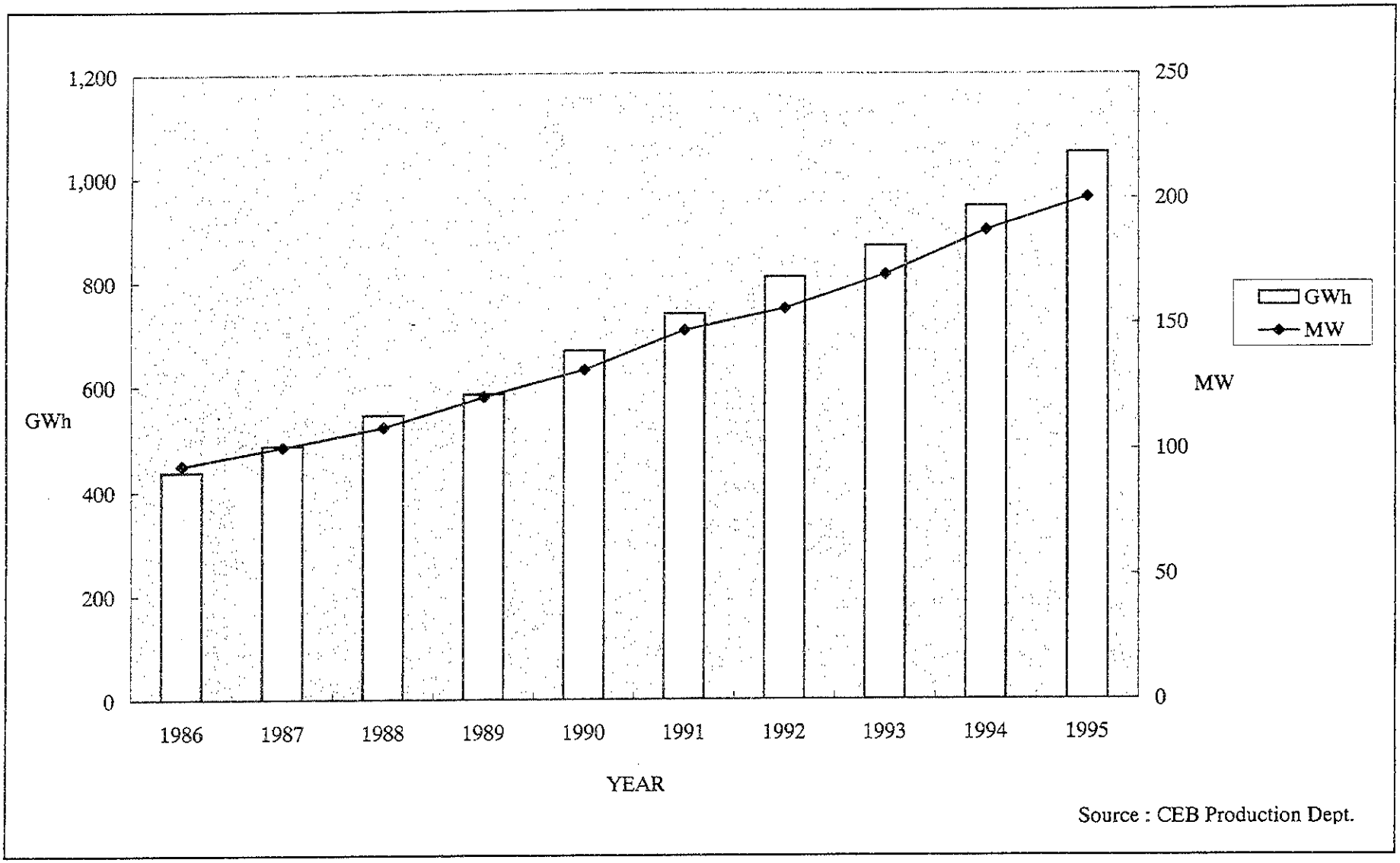


Figure 4.2.1 ELECTRICITY CONSUMPTION

(2) Monthly Peak and Daily Load Curve

Monthly peak load curves in the past 10 years and typical daily load curves in the past 10 years are shown in Figure 4.2.2 through 4.2.3 and maximum power supply in the past 10 years is shown in Table 4.2.3.

In general, the maximum value of monthly peak load is recorded in November or December (the hottest season) in Mauritius, and also the minimum value of monthly peak load is recorded in June or July (the coldest season).

As shown in daily load curves, the daily peak takes place between 18:00 and 20:00.
Electricity consumption in this zone is so high due to water heater demand for taking a shower in the household.
The electric power consumption in the day time is supposed to be raised by industrial or commercial sector demand, the load difference between the day-time and evening time might be lightened relatively.

Table 4.2.3 indicates maximum power supply in the past 10 years.
Maximum power supply also has increased constantly from 93.8 MW in 1986 to 200.5 MW in 1995. The average growth rate per annum during 10 years was 8.1 %.

Table 4.2.3 MAXIMUM POWER SUPPLY IN THE PAST 10 YEARS (MW)

Year	Demand	Date
1986	93.8	on 11, NOVEMBER
1987	101.1	on 19, NOVEMBER
1988	108.8	on 21, NOVEMBER
1989	120.8	on 19, DECEMBER
1990	131.3	on 20, NOVEMBER
1991	147.1	on 10, DECEMBER
1992	155.7	on 28, OCTOBER
1993	169.6	on 7, DECEMBER
1994	187.2	on 13, DECEMBER
1995	200.5	on 15, NOVEMBER
1996	215	Forecasted

Source : CEB Production Dept.

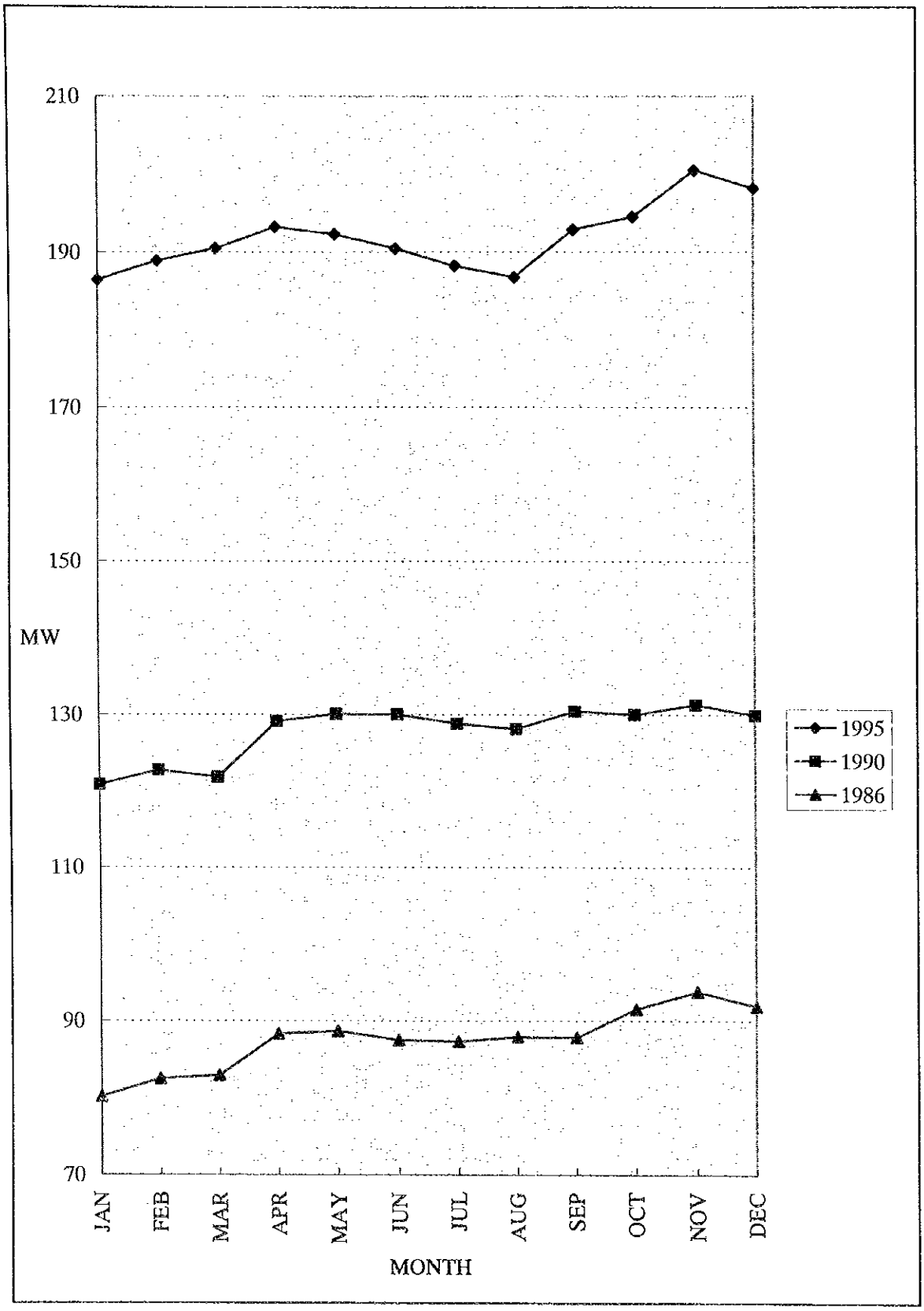


Figure 4.2.2 MONTHLY PEAK LOAD CURVE

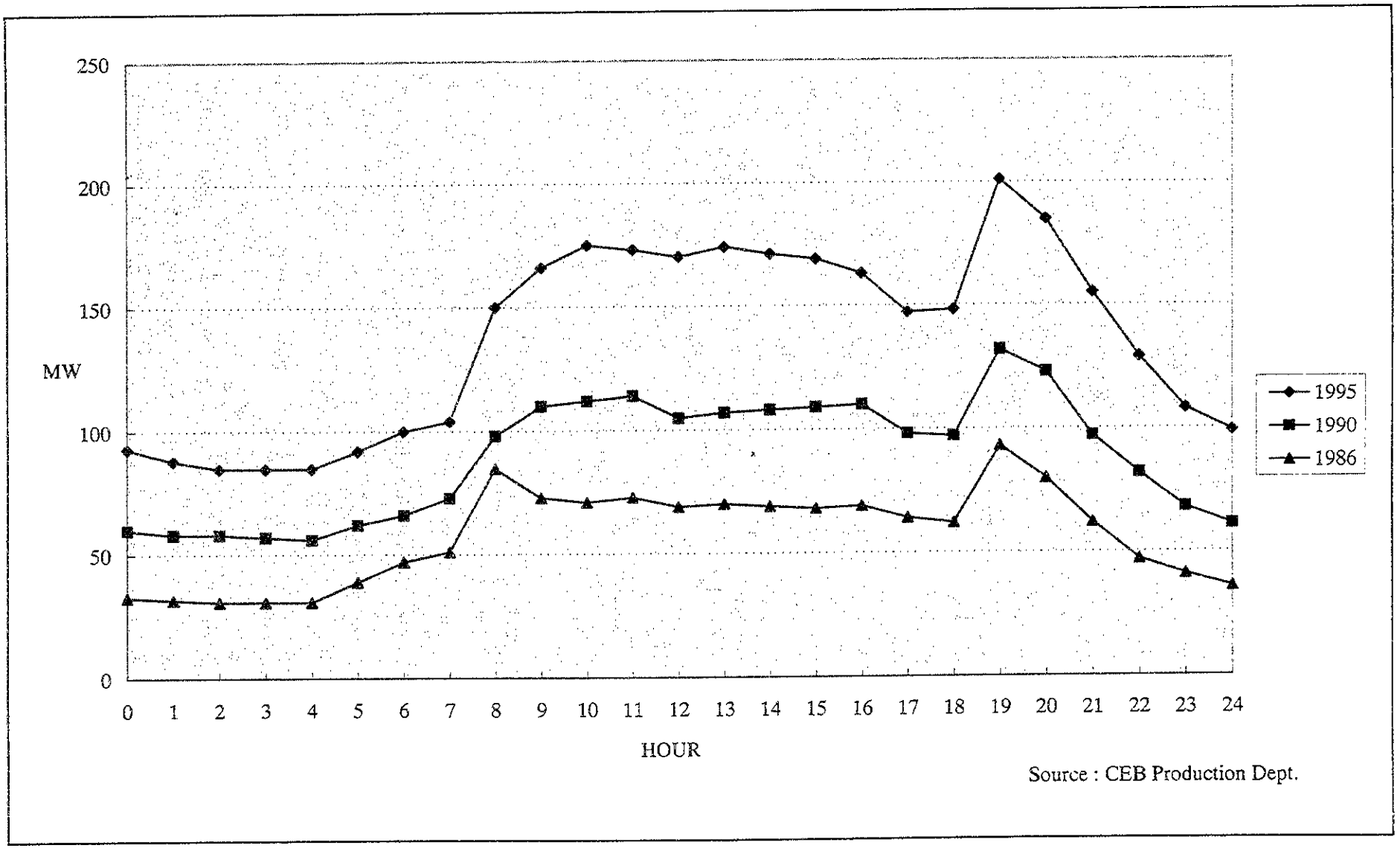


Figure 4.2.3 DAILY LOAD CURVE

(3) Power Generating Facilities

Table 4.2.4 indicates installed capacity in the past 10 years and Table 4.2.5 shows the capacity of each station as of end 1996 in Mauritius.
The installed capacity has continuously increased from 249 MW in 1985, to 393 MW in 1996. The average growth rate per annum during 10 years was 4.0 %.

Table 4.2.4 INSTALLED CAPACITY IN THE PAST 10 YEARS (MW)

Year	Thermal	Hydro	Other	Total		
1985	146	54	49	249		
1986	146	54	49	249		
1987	146	54	49	249		
1988	169	59	49	277	Nicolay 1	23MW
1989	189	59	49	297		
1990	189	59	49	297	Nicolay 2	23MW
1991	212	59	49	320		
1992	224	59	49	332	F-G 1	24MW
1993	227	59	53	339	F-G 2	24MW
1994	227	59	53	339		
1995	253	59	52	364	Nicolay 3	34MW
1996	282	59	52	393	F-G 3	29MW

Source : CEB annual report

Thermal has continuously increased from 146 MW to 253MW, and the average growth rate per annum during 10 years was 5.9 %.

Hydro had increased from 54 MW to 59 MW in 1987, but no hydro was developed due to potential after 1988.
As for each portion of these categories in 1996, thermal was 72 % of the total installed capacity, followed by hydro and bagasse were 15.1 %, 13.3 % respectively.

Around 10 years ago, growth rate of power demand was not so high in comparison with these days, but from now on, construction of new power station will be necessary every year according to a sharp increase of demand. End of 1996 also, 29 MW was commissioned at Fort-George No.3 as scheduled in spite of delayed construction start.

Table 4.2.5 CAPACITY OF EACH STATION AS OF END 1996 (MW)

Plant	Capacity (MW)		
	Name plate	Nominal	Effecient
Hydro CEB			
Champagne	30	28	
Ferney	10	10	
Tamarind Falls	11.1	8	
Le Val	4	4	
Reduit	1.2	1.2	
Cascade Cecile	1	1	
Magenda	0.94	0.8	
La Ferme	1.2	1.2	
Total Hydro	59.44	54.2	10
Thermal CEB			
St.Louis	72	60	60
Fort-Victoria	54	47.6	46
Nicolay	80	80	80
Fort-Grorge	77	77	77
Total Thermal	253	234.6	263
Total CEB	312.44	288.8	273
Hydro Purchases			
Riche En Eau	0.2	0.2	0.2
Bois Cheri	0.1	0.1	0.1
Total Hydro Purchase	0.3	0.3	0.3
Thermal Purchases			
F.U.E.L.	21.7	18	12
Savannah	1.3	1.2	
Medine	10	8	
Belle Vue	0.8	0.8	
Constance	1	1	
Britannia	0.6	0.5	
Beau Champ	1.25	1.1	
Mon Desert Alma	1.4	1.4	
Mon Loisir	1.1	1.1	
Beau Plan	0.4	0.4	
Riche en Eau	5	2.5	
Union St.Aubin	2.3	1.8	
Mon Tresor Mon Desert	5	5	
Total Thermal Purchase	51.85	42.8	12
Total Purchase	52.15	43.1	12
Grand Total	394.59	361.9	285

Note

1:Source CEB annual report

2:Efficientcapacity is a firm capacity without scheduled outage

1) Thermal Power Generating Facilities

The CEB owns four thermal power stations, three diesel power stations at Fort-George, St. Louis, and Fort-Victoria, one Gas turbine power station at Nicolay.
All of power stations concentrate in Port-Louis area.

Fort-George Power Station

The Fort - George power station is located on the north side of the harbour.
The power station contains two(2) Sulzer Engines rated at 24MW each and one(1) Mitsui Engine rated at 29MW.

It is the newest diesel power station in Mauritius and uses HFO 380 as its fuel.
The first unit was commissioned in 1992, the second in 1993 and the third unit was commissioned in 1996.

The power station has been operated as the base load power source since commissioning, and the average running hour per year is nearly 8,000 hours.

The overhaul is conducted every 7,000 hours, it takes one month and no major incident has been reported at present. Although the station is in a suburb of the capital city of Port - Louis, there have been no problem such as flue gas because the wind constantly blows away from the city.

Recently, the No.3 unit was commissioned, and No.4, No.5 units are supposed to be commissioned 1999, 2001 respectively. Therefore, as civil works including housing and machines bases have been finished the order of machines should be hurried up.

St. Louis Power Station

The St. Louis power station is located on the south of Port - Louis, consists of old and new generation facilities.

The old facilities are equipped with seven (7) Mirrlees Engines which were installed between 1955 and 1962, but recently, they are not in operation because of oldness and high generation cost.

The new facilities are equipped with six (6) Pielstick Engines which were installed between 1978 and 1979, and the average running hours per year is nearly 6,000 hours.
Operationally, the new facilities had been operated as a base power source unit until Fort - George came on line, but recently it is operated as a semi - base power source.

Regarding environmental problem, disposal of used oil and sludge from the fuel and lubricating oil have become a serious problem.
CEB purchased an incinerator so that they can dispose of these material, also handle the waste oil from Fort - Victoria as well.(Fort - George power station is already equipped with such an incinerator.)
The overhaul is conducted every 6,500 hours, it takes two months.

However, as these equipment are too old, Mirrlees Engines should be retired because of low efficiency and high generation cost as soon as possible.

Fort-Victoria Power Station

The Fort - Victoria power station is located on the south side of the harbour, consists of old and new generation facilities.

The old facilities are equipped with seven (7) Mirrlees Engines which installed between 1974 and 1976, but recently they are not often operated due to a history of trouble and low operation efficiency.

The new facilities are equipped with two (2) MAN Engines which installed in 1989 and availability has been generally good.
Engines are very efficient so that these are operated as a semi - base power source and average running hours per year is nearly 7,000 hours.

Concerning environmental problem, station is surrounded by residential area, its operation is restricted to a period between 22:00 and 4:00 due to noise problem during the late night hours.
Regarding maintenance, overhaul is conducted every 6,000 hours, it takes 6 week.

However, old Mirrlees Engines had better retired because of same reason as St. Louis as soon as possible.

Nicolay Power Station

The Nicolay power station is located on the north of the Port - Louis.

The power station is equipped with three (3) gas turbine, two units are 23MW and one unit is 34MW rated.

The power station burns inexpensive kerosene as fuel, because CEB can purchase cheaper one than diesel oil.

This power station has been operated originally as a peak power source, but recently has tend to be operated mainly as a semi - base power source especially No.3 due to increasing power demand.

Regarding environmental problem, since generating units are installed outdoors, recently their noise and air pollution have become a serious become target of complain of neighborhood for neighborhood. So CEB is preparing some effective countermeasure.

2) Hydro Power Generation Facilities

CEB owns 10 hydro power stations which are all small-scaled in comparison with thermal power stations and are operated only as a peak power source.

The three major hydro power stations are shown hereunder.

Champagne Power Station

The Champagne power station is located on the bank of the river Champagne and takes water from the Sans Souci reservoir located on the Grand River South East.

The power station contains two (2) horizontal shaft, Francis type, reaction water turbines each 14,000kW output at 192m net head have been installed together with two (2) three-phase generators each 17,000kVA, 66kV and associated equipment.

It is the biggest hydro power station in Mauritius and commissioned in 1984.

Since commissioning of station, the power station has been operating as a peak power source, because it can continue to generate only three (3) hours if operating full capacity.
This means that it can not depend on this plant during dry season due to small storage capacity.

Regarding maintenance, the regular inspection is conducted during the months of September and October when inflow is low.
After 1999, generated energy will be decreased due to construction of the Midland Dam which uses water for irrigation of the north of the reservoir.

Ferney Power Station

The Ferney power station is located in the southern part of Mauritius and takes water from the Riche en Eau reservoir.

The power station contains two (2) horizontal shaft, Francis type, reaction water turbines each 5,225kW output at 118m net head have been installed together with two (2) three-phase generators commissioned in 1971.

Since commissioning of station, the power station has been operating high load factor comparison with other hydro power station and is considered very reliable.

Regarding maintenance, regular inspection is conducted once a year and no major incident has been reported so far.

Tamarind Fall Power Station

The Tamarind Fall power station is located on the banks of the river Tamarind and takes water from the Tamarind reservoir located upstream of the same river.

The power station contains four (4) type water turbines which classify old and new facilities.
The unit No.3～5 are Gilkes Turgo turbines which commissioned from 1945～1953 and The unit No.1 is Pelton turbine which commissioned in 1987.

The power station is regulated by the upstream reservoirs Mare Longue and Mare Aux Vacoas located on two separate tributary.
Mare Longue water is used for irrigation and some amount of water is continuous discharged to
Tamarind reservoir for downstream irrigation.
Mare Aux Vacoas is a reservoir which is used for town water supply and only small amount of water is discharged for Tamarind reservoir.

Regarding operation, installed capacity of power station is 11.38MW, but there is restriction of operation to 7.8MW because of suited irrigation water and penstock loss.

4.2.2 Transmission and Substation facilities

JICA`s study team has reviewed the past reports, ESMAP and Rust Kennedy & Donkin`s, regarding the transmission and substation facilities.
Some site survey has been done also. Figure 4.2.5 shows existing main transmission lines and substations in Mauritius.
Main feature of these facilities are summarized as follows,

(1) Transmission Line

Table 4.2.6 indicates existing 66kV transmission line.
CEB has adopted 66kV for its transmission lines and consists of nearly 140km.

The system load is mainly dominated in Port - Louis and Curepipe.
These area can not cope with present peak load conditions, especially transmission line between St. Louis and Wooton and, in future, Nicolay to Belle Vue will become same conditions.

Table 4.2.7 shows the transmission line loss from 1986 to 1995.
Transmission line loss is serious problem, but loss factor has been improved from 16.5 % in 1986 to 11.0 % in 1995.

Furthermore, CEB is taking a measure for improving this situation by rising a transmission voltage or replacing the old equipment step by step.

(2) Substation

Table 4.2.8 indicates major existing substations.
The CEB has a total eleven substations which provide a total capacity of 650MVA. The substation are remotely monitored and controlled from the CEB head office.

4.2.3 Power Facilities in Rodrigues Island

(1) Demand and Supply

The CEB Started its operation in Rodrigues in 1972 and the supply was initially extended to Port-Mathurin and its outskirts only. After that CEB completed electrification whole area in 1994.

Electricity power consumption increased from 1,626MWh in 1985, to 9,950MWh in 1995.
The Figure 4.2.4 shows the gradual growth in the electricity consumption as well as the peak demand during the period 1986-1995.
Installed capacity in Rodrigues, 336kW in 1977, 4050kW in 1995.

(2) Power Generation Facilities

Port-Mathurin Power Station

Port-Mathurin Power Station is located in Port-Mathurin.
The Power station was commissioned in 1972 and comprises two power station buildings.

The old building contains 6 MW diesel engines, installed between 1985 and 1993.
The new building contains one MAN B&W engine in 1995.
CEB plans installing new diesel engine No.2 and No.3 in 1996, 1997 respectively.

Trefles Wind Power Station

The Power station is located at Trefles where the wind conditions are deem to be most favorable.

It was commissioned on 15 December 1988. It consisted of four wind energy converters of 30kW each.

Four units produced altogether 392 MWh in 1989, corresponding to 8.4% of the total energy generated during that year. However , following the passage of cyclone Bella in 1991, the four units sustained heavy damages, whilst one of them fell to the ground and was completely destroyed.

Now, only one unit is being operated , and repairing schedule isn't fixed yet.

Table4.2.6 EXISTING TRANSMISSION LINES

Name of transmission line	St.Louis-Ebene	Ebene-Wooton	Champagne-Wooton		St.Louis-Nicolay	Nicolay-B.Vue	B.Vue-Fuel	St.Louis-Chaumiere	Chaumiere-Henrietta	Champagne-Fuel	F.George-Nicolay	Henrietta Combo
Rated voltage (kV)	66	66	66	66	66	66	66	66	66	66	66	66
Distance (km)	7.106	9.525	3.406	16.87	7.91	13.61	19.63	8.25	12.58	16.467	2.3	23
Connected substation from	St.Louis	Ebene	Champagne	Ferney	St.Louis	Nicolay	B.Vue	St.Louis	Chaumiere	Champagne	F.George	Henrietta
Connected substation to	Ebene	Wooton	Ferney	Wooton	Nicolay	B.Vue	Fuel	Chaumiere	Henrietta	Fuel	Nicolay	Combo
Number of circuit	2	2	1	1	2	2	2	2	2	1	2	1
Current capacity per circuit	310	310	550	620	400	400	400	800	800	550	1130	400
Conductor (mm^2)	100	100	228	100	150	150	150	150	150	228	570	150
Commissioned year	1963	1963	1983	1970	1972	1978	1978	1978	1982	1983	1992	1996

Source : CEB Transmission & Distribution Dept.

Table4.2.7 TRANSMISSION LOSS

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995		
Transmission loss (%)	16.5	15.3	14.9	14.5	13.8	12.9	12.6	11.9	11.6	11		

Source : CEB Transmission & Distribution Dept.

Table4.2.8 MAJOR EXISTING SUBSTATION

Name of substation	St Louis	Ebene	Wooton	Champagne	Nicolay	Belle Vue	Chaumiere	Henrietta	Fuel	F.George	Combo
Location	St Louis	Ebene	Wooton	Champagne	Nicolay	Belle Vue	Chaumiere	Henrietta	Fuel	F.George	Combo
Rated capacity (MVA)	40	40	40	34	40	72	40	40	40	60	20
Rated voltage primary (kV)	66	66	66	66	66	66	66	66	66	66	66
Rated voltage secondary (kV)	22	22	22	6.6	22	22	22	22	22	11	22
Commissioned year	1972	1985	1972	1984	1982	1985	1985	1985	1985	1992	1996

Source : CEB Transmission & Distribution Dept.

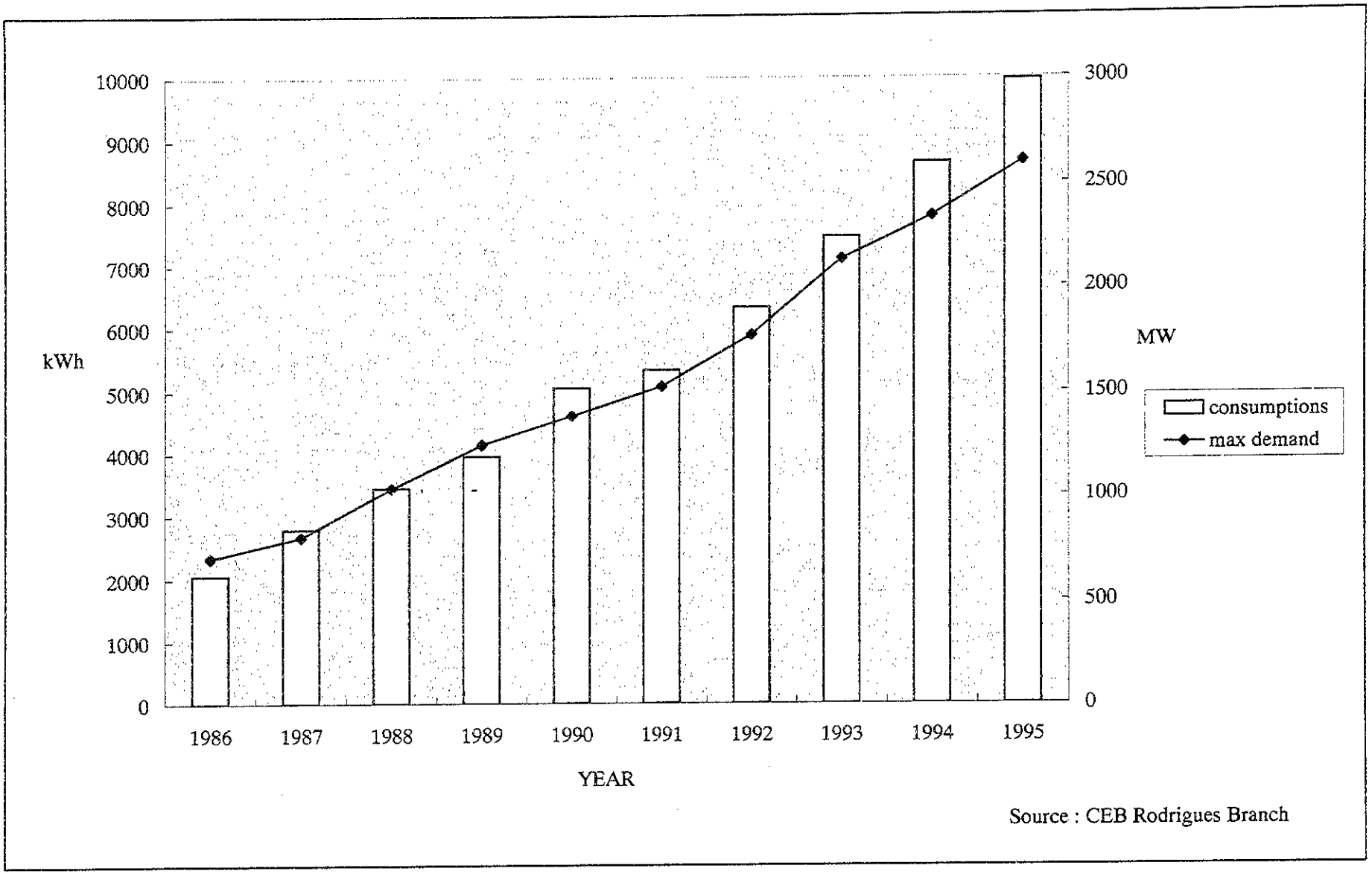


Figure 4.2.4 ELECTIRCITY CONSUMPTION (RODRIGUES)

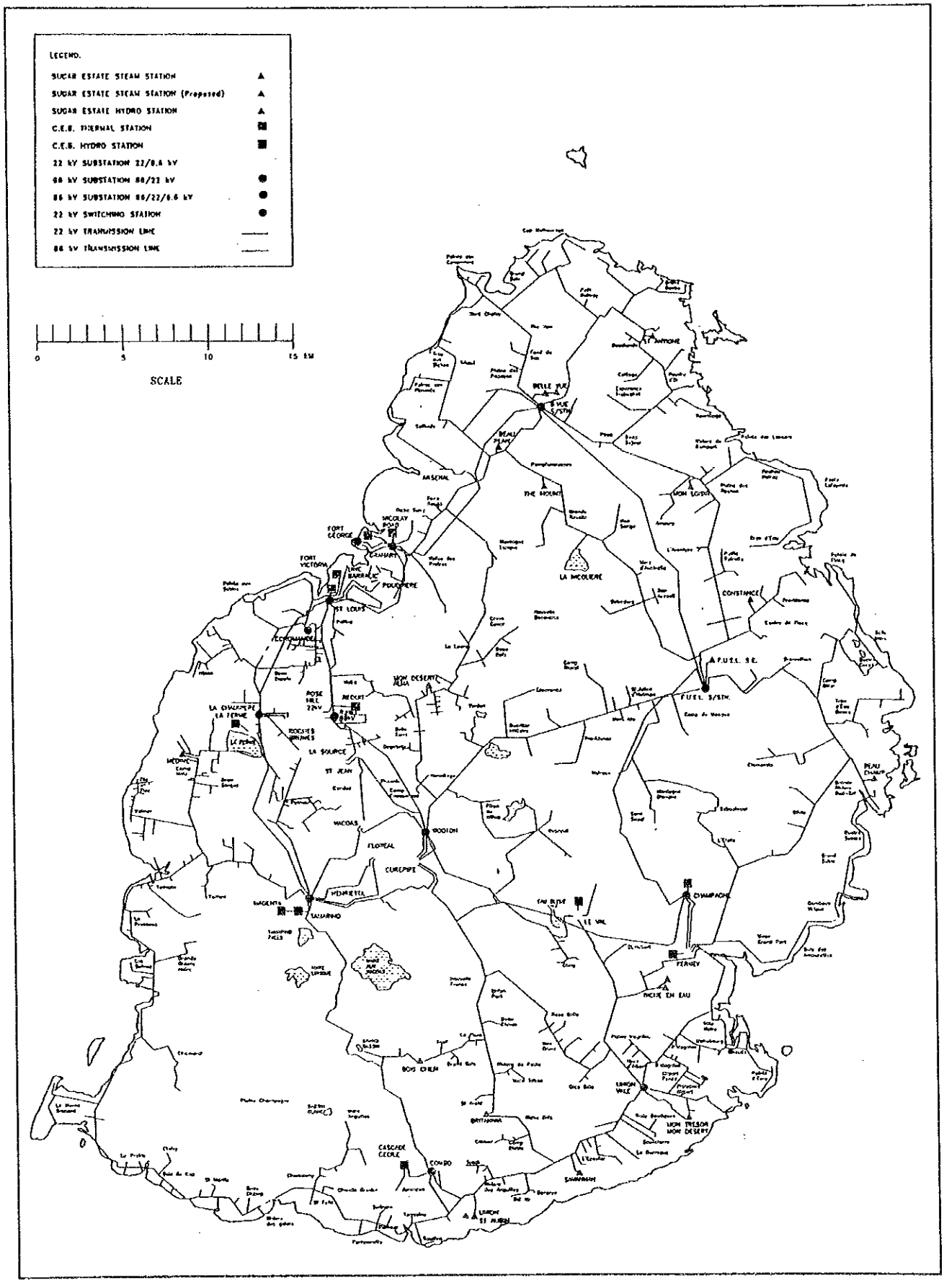


Figure 4.2.5 EXISTING MAIN TRANSMISSION LINE AND SUBSTATION

4.3 Petroleum Products and Coal Supply and Facilities

(1) The Present Condition of Storage Facilities

With increasing stored quantity, the existing petroleum products storage facilities located in the inner part of the port area fears port function from risk of oil leakage and etc.. MMA requested the oil companies to relocate their facilities into newly developed port area. According to MMA, both parties have reached such agreement that storage tanks for gasoline, kerosene (jet fuel) and LPG shall be relocated to the new area and others shall be modernized by applying latest international design standards.

Due to growth of tourism and active national economy, demand of jet fuel for international flight is expected being increased. Gasoline and diesel oil for transport is also expected rapid growth due to increased cargo and motorization being motivated by improved living standards. Considering the above, it is anticipated to develop in near future of safe and economical transport system for petroleum products to east side of the main island, especially jet fuel oil to the air port.

New power plant is planned to locate in the east side of the island aiming at efficient transmission and improvement of reliability of electric power supply. Primary energy for this power plant is planned to use coal taking account of economical advantage and also diversification of energy source as measures of national energy security. To enjoy higher cost performance, coal must be unloaded to power plant directly from ocean ship to plant. There was port with dolphin in the area of Mahebourg, and this area is expected good point to build coal power plant with coal unloading jetty according to observation of the chart and site visit. (In connection with provisions of new energy terminal composed of coal power plant and petroleum products storage and distribution facilities, detail discussion on saving of transportation fuel and other benefit is made in Section 8.2).

(1) Transport Fuel

Gasoline and diesel oil are used for inland transportation is no appropriate alternative fuel. So that, effort to reduce petroleum products dependency shall be necessary by promotion of diversification of transportation from personal car to such mass transfer system as public

bus and planned new system.

Recent rapid growth of transport fuel consumption realizes environmental pollution caused by such pollutant as lead and sulfur contained in fuels and exhaust gas. This is caused by use of rather old type specification, insufficient maintenance and traffic congestion in populated area. Considering world trend and impression to foreign tourists, the government is planning to introduce low lead content and lead free gasoline and low sulfur diesel oil in a few years.

After introduction of ecological transport fuel, investment is required for adaptation of related facilities to handle two types of gasoline. Although this modification is to be carried out by oil companies according to their business policy on sales of new gasoline, the government is required financial support to additional investment for promoting conversion to lead free gasoline. Such financial support will be justified in consideration of government's fixed pricing system or fixed margins to oil companies and will be achieved by additional sales margin to retailers.

(2) Fuel for Industry

Industry sector uses petroleum products of fuel oil, diesel oil and LPG. No energy intensive heavy industry is prospected, however high growth rate of energy consumption will be continued due to development of industries. With increasing fuel consumption, pollution problem caused by emission from fuel combustion equipment becomes realizing and the government has accelerated to establish environment protection regulation.

Especially in fuel oil, of which sulfur content is as high as 4.5%, realization of air pollution by sulfur oxides and solid particles is anxious about emissions from stack without pollution preventive measures. The government is going to issue new regulation standard of 3.5% max. sulfur content in fuel oil. However, this is not clean enough and establishment of synthetic regulation standard by integration of fuel quality and emission conditions. More attention will be required to consumers located in central and east of the island considering dominant wind direction.

Fuel oil for electric power generation in CEB is independent from general use and its specification can be selected according to own policy.
Diesel oil for industrial use will be same quality as for transport because of minor quantity compared to transport use.

Fuel oil used in industry is possibly substituted by alternative fuel such as coal and Orimulsion. The government is required to promote diversion of petroleum products to substitute according to user's condition.

(3) Coal and Orimulsion

Coal demand in industry sector is expected to increase from economical point of view. Coal for general use is unloaded in port of Port Louis and then distributed to consumers by truck. The important point to promote use of coal is to establish economical and pollution preventive handling,storage and transport system. MMA allocates coal storage yard close to a quay, unloading to the yard would be made by closed type belt conveyor to prevent pollution by dispersion of coal powder. This stock yard is sufficient for transient use until arrival of next ship, therefore unloaded coal is to be transported to consumer quickly.
Ash produced by combustion of coal is now dumped in hollow point. Considering amount to be produced in future, early establishment of measures for utilization ash or area for dumping without pollution problem.

For promotion of use of coal, even small consumers can burn it in high efficiency with simple handling and without special care about ash disposal. To achieve the above, such countries as Japan and Germany are performing development of a series of coal handling system from coal storage through disposal of ash including processing for high efficiency combustion. In case of Japan , this system which is called as "Coal Cartridge System", is aimed at promoting use of coal by supplying, in low cost and with high supply reliability, pulverized coal to small and medium size boiler and industrial furnace located in inland area. This is a total system composed of processing and adjusting coal for constant quality, transportation and distribution, and collection of ash for utilization. This system may make small consumers possible to burn coal easily as oil and to be released from troublesome handling.

Development of this technology is in final stage and it is advised to apply this kind of system for future growth of coal demand.

Among various processing of coal ash applied in various countries, followings are considered applicable in this country.

- Component for cement and concrete
- Block
- Brick ceramics
- road construction

Mauritius is importing large amount cement, coal ash has possibility to change to valuable resources and the government is required to support development of utilization technology.

Environment pollution regulation on solid particle and required complicated handling may become one of restriction to use coal in small scale consumers. To promote diversification of petroleum products, Orimulsion is also to be studied compared with coal.

(4) LPG

For environmental conservation, the government has promoted utilization of petroleum products as residential fuel. After a few times of accident occurred, LPG has been used in most houses due to convenience. LPG is supplied to house by bomb. With improving living standard, rate of consumption is expected to increase and larger size bomb will substitute current small one. There is possibility to increase LPG consumption due to change of energy source for instant water heater from electric power. The government is required to promote to use solar water heater to reduce dependency on imported petroleum products.

LPG consumption is expected rapid increase in industrial use. For big consumers, lorry truck is used for distribution to user tank. Safe inland transportation system is required to establish to cope with future consumption growth and road congestion.

(5) Bunker Fuel

With increasing trade cargo volume, ocean ship calling at Port Louis will increase.

However, fuel demand for ocean ship may not increase in proportion because ship can refill fuel in cheapest available port in general, as well as jet fuel. Bunker fuel is not controlled by national environmental regulation and will be different from inland use. Piping for loading is provided by MMA up to quay.

(6) Jet Fuel

Increase of tourists and business passengers visiting Mauritius and air cargo growth due to increase of high value material trade expected to boost flight called at this island. Accordingly, jet fuel demand in 2025 is prospected to increase by 1.8 times of 1995's. To transport huge amount of jet fuel smooth and safely, proposal for establishment of second oil terminal adjacent to coal power plant is referred to Section 8.2.

(7) Fuel for Electric Power Generation

CEB has own facilities for electric power generation fuels except kerosene for gas turbine generator and distributes to each power station by pipeline. Kerosene is supplied by oil companies utilizing lorry truck. Storage of power generation fuel shall be applied same standard as CEB and born by power generation company.

Coal to be used for power generation in Bell Vue sugar estate is planned to transport by truck. Coal requirement in off crop season is considerably big amount and traffic congestion from port storage yard to north is to be checked carefully. Coal for future large scale electric power generation plant shall be unloaded directly to the plant for enjoying economical benefit.

4.4 Coal and Other Energy Sector

(1) The Use of Coal

The history of coal use in Mauritius can be seen from past statistics of coal consumption in the country. The statistics for United Nations indicates that coal imports by Mauritius during 1950s were around 50,000 ton/y and the amount rapidly decreased to only about one thousand tons per year during the 1960s to 70s.

This phenomenon underscores the fact that petroleum based fuels rapidly replaced coal during that period. Similar occurrences can be observed in many countries where indigenous coal is not available. However, imports of coal increased gradually after the middle 1980s, when coal use by the FUEL project commenced; current import levels are now approximately 60,000 tons annually. This is as a result of price increases in petroleum fuels; the substitution of coal for petroleum fuels in industrial boilers took place in a similar manner as had occurred in many countries after the oil crisis in the 1970s.

At present, all coal consumption (other than the 30,000 tons destined for FUEL-IS power generation) is dedicated to steam generation for users in miscellaneous industries which consume significant amount of steam continuously. On a calorific basis, the cost of coal in the international market is currently lower than petroleum based fuels by some 40-50%; therefore industries already possessing facilities capable of using coal continue its use. However, the problems associated with coal dust during both handling and combustion, particularly when adequate operation and maintenance are not in place to deal with these, will prevent further replacements of petroleum fuel with coal unless the cost advantage of coal increases further.

The primary users of coal are the textile, oil (edible), brewery/distilling, and food processing sectors. It is expected that when large-scale expansion in the above industries takes place in the country, coal will be used as an economical fuel. However, the introduction of technology to eliminate potential environmental problems arising from the use of coal should be considered as coal use is developed. Technology such as cartridge systems for coal handling and dedusting facilities for coal boiler emissions will be required.

At present, the CIF cost of coal delivered to Mauritius is comparable to the international level, 50-60 US$/ton, but the cost at the user's end is comparatively high, 70-80 US$/ton, because the amounts of coal being imported are relatively small. It is recommend that coal handling and transportation systems be improved to effect cost reductions for the end user.

(2) Fire Wood and Charcoal

According to CSO statistics on primary energy use in Mauritius, wood/charcoal supplied some 2.8% of the total in 1993. This amount lags behind petroleum products, bagasse and hydro energy supplies. However, it is well known that real figures on fire wood consumption and other bio-mass fuel uses in a country are very difficult to measure.

Similarly, in Mauritius it is believed there is significant fire wood consumption which is not accounted for in the formal statistics. According to estimates of experts in the Forestry Service Department of the Ministry of Agriculture, the consumption of wood and charcoal for fuel in the country is as follows:

Table 4.4.1 1983/1995 Wood and Related Product (M^3 · Round Wood)

	1983	1993
Timber		
Hard Wood	590	52
Soft Wood	6,840	7,910
Poles		
Hard Wood	1,541	2,218
Soft Wood	1,209	2,564
Fuel Wood		
Fire Wood	10,370	10,758
Charcoal	1,645	456

Note: The above figures only indicate the quantity produced (and formally recorded) from the national forests.

In addition to the above commercially sold quantities, there are significant amounts of fire

wood which are informally collected by people for their own consumption. The experts (referred to above) estimate that the amounts of such non-commercial fire wood will be 2-3 times that of commercial quantities. Furthermore, statistics covering firewood/charcoal production from privately managed forests are not kept.

1993 statistics indicate a projected consumption of some 60,000 m3 of firewood consumption. This may be interpreted as 30,000 m3 from national forests (including non-commercial firewood plus a similar amount from privately managed forests). There is data to support the above estimates.

MEW/CEB conducted audits of domestic energy consumption in 1984-85. The survey was conducted by interviewing a sample of 1,000 households throughout the country to find out what types of energy sources are being used, and how these sources are used including firewood/charcoal.

The results indicated that a total of about 50,000 households use firewood (averaging 90-115 kg/month) while charcoal is used by 20,000 households (averaging 30 kg/month.) This is equivalent to 70,000 tons/year of firewood and 8,000 tons/year of charcoal.

It is believed that the use of both firewood and charcoal in the country has been reduced significantly in the last 10 years due to replacement by LPG. LPG consumption for domestic/commercial use increased from 2,400 tons/year in 1984 to 31,569 tons/year by 1995; the major part of this increase is considered to be replacing firewood/charcoal. The 1993 CSO estimates for firewood 60,000 ton/year and charcoal 2,000 ton/year thus appear to be reasonable.

It has been considered that even if significant increases in the price of kerosene and LPG were to occur in future, given the limited access of the majority of the people to forests, and further given the progressive urbanization of housing areas, the use of firewood and charcoal will not change significantly from its present status.

However, growing forests in unused arable land should be encouraged for both environmental improvement and underground water preservation as well as for systematic

renewable bio-mass fuels production.

(3) Use of Solar Energy

At present, solar energy is being used as one renewable energy by mean of solar water heater in domestic use and hotels. The total number of solar water heater in the country is estimated as about 18,000 units. When we assume these heaters supply every day about 200 kg hot water (40℃ above tap water) and sunny days in one year accounts more htan 250 days, the total saving of energy is equivalent to 3,000 TOE in one year.

The amount is about 10% of domestic fuel consumption, but when the solar water heaters are used in the 50% of house-hold the saving of fuel can be more than 20,000 ton a year.

4.5 Prospect of New Energy Introduction by 2025

4.5.1 Potential of Development of New Energy

(1) Solar Energy

Mauritius has rich sunshine and its location is ideal for solar energy utilization. The following is a rough estimate of the potential of solar energy:
It is generally estimated that the usable solar energy is 1 kW/m2 on the earth surface. Table 4.5.1 shows the record of sunshine hours. From this, the annual mean daily sunshine time is 6.7 hours. With a conversion efficiency of 10%, the daily mean power generation is 0.67 kWh/m2, and annual mean power generation is 245 kWh/m2. From the viewpoint of calorific value, annual mean value is 2.1 x 105 kcal/m2. With a total national land area of 1,950 km2, the potential over the entire country is 477.8 billion kWh. With 10% of this assumed available for use, 47.8 billion kWh is, therefore, available.(Refer to Appendix 4)

(2) Wind Power

With the presence of the southeastern trade wind, Mauritius is ideally located for a wind power generation. As the first wind utilization study conducted in 1980 provided insufficient data, a wind energy availability study was conducted under UNDP support between 1983 and 1985. First, the Meteorological Service measured wind velocity at 11 locations around the island and in one location measurement was taken at varying heights. The results are shown in Table 4.5.2 and it is seen that the southeastern and northeastern shores receive the most wind. The southeastern highlands are also strongly influenced by the trade wind. At present, there is no project related to wind energy power generation, but Bel Ombre, Gris Gris, Grand Port and Saint Antoine are viewed as highly possible locations. The potential of generating 160GWh is expected. Similar wind velocity studies were conducted between 1986 and 1987 at four locations on Rodrigues Island. The results are shown in Table 4.5.2. A 2kW wind energy power generator was once installed at Anse Quitor, one of these observation points, to power water delivery pumps and for the illumination of 17 households in the neighborhood. An example of case studies on the possibility of wind power development in Mauritius is introduced in Appendix 4.

Table 4.5.1 MEAN SUNSHINE DURATION

Unit : hours/day

Period	1961-1990	1961-1990	1961-1990	1961-1990	1961-1990	1961-1990	1961-1990	1961-1990
Location	Vacoas	Pamplemousses	Reduit	Union Park	Belle Rive	Plaisance	Union Flacq	Rodrigues
January	7.3	8.3	7.9	6.2	6.7	8.0	7.1	8.9
February	6.9	7.9	7.5	5.9	6.3	7.7	6.9	8.5
March	7.2	7.4	7.2	5.4	6.3	6.9	6.6	8.3
April	6.8	7.4	6.7	4.9	6.0	6.3	6.1	8.1
May	7.4	7.6	7.2	5.1	6.5	6.2	6.2	7.8
June	7.0	7.3	7.0	4.7	6.1	5.9	6.0	7.5
July	7.2	7.6	7.1	4.5	6.1	5.8	6.0	7.4
August	7.2	7.7	7.1	4.6	6.1	6.1	6.0	7.8
September	7.3	7.4	7.2	5.0	6.5	6.6	6.3	8.0
October	7.5	8.1	7.8	5.7	6.7	7.6	6.7	8.9
November	7.5	8.5	7.9	6.3	7.0	8.1	7.0	9.1
December	6.9	7.8	6.7	5.6	6.4	7.9	6.9	8.9
Average	7.2	7.7	7.3	5.3	6.4	6.9	6.5	8.3

Period	1981-1990	1971-1990	1971-1990	1971-1990	1971-1990	1971-1990	1961-1970
Location	Medine	Digue Seche	Sans Souci	Britannia	Case Noyale	Bois Cheri	Tamarin
January	7.5	8.1	6.5	6.8	6.9	6.1	7.5
February	7.1	7.3	5.9	6.4	6.6	5.6	7.7
March	7.3	7.6	6.3	6.0	6.7	5.5	6.8
April	6.9	7.0	5.5	5.3	6.3	5.2	6.6
May	7.4	7.1	5.8	5.6	6.9	5.3	7.1
June	7.0	6.8	5.3	5.3	6.8	4.7	6.6
July	7.3	7.1	5.4	5.0	7.0	4.8	7.1
August	7.3	7.0	5.4	5.1	6.7	4.9	7.1
September	7.2	7.5	5.7	5.4	6.7	5.3	6.7
October	7.3	8.2	6.4	6.1	6.9	6.1	7.5
November	7.0	8.6	6.7	7.2	7.2	6.4	7.0
December	7.2	8.3	6.5	7.0	5.8	6.1	6.8
Average	7.2	7.5	5.9	5.9	6.7	5.5	7.0

Table 4.5.2 WIND DATA COLLECTED BY UNDP

Mauritius			
Site	Mean Speed m/s	Calm %	Annual Average Power W/m^2
Grand Basin	5.1	6.87	112
Bois Cheri	3.7	19.4	46.6
Gris Gris	6.07	3.17	214.7
St Felix	4.1	18.11	74.6
Bel Ombre	6.0	22.0	201.2
Union Park	3.4	24.4	54.7
Grand Port	5.6	18.7	196.0
Palmar	4.6	8.9	83.6
St Antonie	5.3	12.6	141.3
M.G.I(Moka)	4.1	30.2	83.0
Bigara(10m)	5.0	3.0	109.2
Bigara(32m)	6.4	4.0	203.9
Bigara(80m)	7.8	5.0	398.9
Bigara(132m)	8.1	4.2	570.7
Rodrigues			
Site	Mean Speed m/s	Calm %	Annual Average Power W/m^2
Batarand	4.9	7.74	225.6
Anse Quitor	5.9	6.11	209.0
Roche Bon Dieu	5.1	7.2	136.9
Rivere Coco	4.9	7.95	11.8

(3) Wave Energy

As energy resources other than the above, in view of the ocean surrounding this island nation, various types of ocean energy sources are possible. Of these, wave energy deserves the greatest attention due to the feasibility it affords.

The wave energy project was conceived in 1958 focusing on the possibility of converting wave energy into electricity in the southern coast. Major investigations were carried out during the early seventies. However, progress has been minimal became the technical and economic viability of the project were not proved.

The installed capacity of this project was expected to be 20 MW spanning around 5 km and the total power production was estimated with 100 GWh. In Mauritius, potential of the annual wave energy is estimated with 455 MWh per meter. The problem on wave energy is environmental impact for surrounding areas such as lagoon.

(4) Biomass

Considering the utilization of biomas excluding Bagasse and Wood, investigation on the production of biogas from animal wastes, such as cow dung, chicken droppings and pig manure, were started in 1975.

The first digester plant was installed in 1986. Following this, several biogas plants were installed between 1987 to 1989. As the number of households keeping animals had declined considerably by 1990, interest in further development dwindled. There is currently very little potential to develop this technology for domestic energy production.

(5) Waste Power

Waste power generation is another possible energy resource. At present, approximately 500 tons of waste are disposed daily in Mauritius. In the future, with the development of industry, the rising of the nation's living level and the expansion of the tourist industry as the basic industry of Mauritius, a great increase in the volume of waste is expected. However, while all waste is presently used for land reclamation , the availability of land areas for dumping will become a problem, as it is in Japan. When the expansion of the tourist industry is also considered, limitations in the dumping of waste will certainly intensify. In the future, waste power generation will have to be considered not only as an energy resource, but also as an effective means of waste disposal.
Appendix 4 is referred for some supplement technical information of new energy.

4.5.2 Present situation of new energy utilization in other countries

Here, the present situation of new energy introduction in Japan in the main, in the U.S.A., in Germany and in the UK is described.

(1) Japan

In Japan, the ratio of power obtained from new energy in the primary energy is presently stagnant at 1%. However, the "Oil Alternative Energy Supply" adopted in 1990, plans developments aimed at increasing this figure to 3% by 2000 and to 5.3% by 2010.

In 1980, toward promoting the development and introduction of new energy technologies, the Government of Japan enacted the "Law for the Promotion of the Development and Introduction of Oil Alternative Energy ". To promote large-scale and complex new energy technology comprehensively and effectively beyond the scope of private industrial efforts, the government also established a central organization called the New Energy Development Organization (NEDO). NEDO's new energy projects include energy-related technology development, resource development and energy-related technology introduction and distribution promotion. In Fiscal 1993, the government appropriated 79.8 billion for these projects. In addition, it started the "New Sunshine" project in 1993 aiming at promoting new energy commercialization and at energy-saving technology development.

The government also appropriated budget for various other new energy distribution promotion plans and technology developments, and initiated low interest loans and tax benefits for new energy users.

The new energy utilization and development state of Japan is summarized below:

(a) Photovoltaic power generation

As of 1993, some 3,600kW of power is generated mainly by the power companies and government organizations. From Fiscal 1994, the government subsidized 50% of the installation cost to residential photovoltaic power generation systems, and appointed the private installers as official monitors. As of 1974, the manufacturing cost of a photovoltaic system was 20,000 to 30,000 per Watt (module unit price), but this lowered to approximately 600 YEN/W in 1990. The cost of photovoltaic power generation system for residential users (low voltage connected system in the power generation scale of 3kW) is presently 2,500 to 3.300 YEN/W for installation and 230 to 300 YEN/kWh for generation. While this is approximately 10 times the power rate of ordinary residents, the present goal is to reduce the installation cost to 100 to 200 YEN/W and to lower the generation cost to 20 to 30 YEN/kWh by 2000.

(b) Solar thermal energy

During the peak years, 60,000 solar thermal systems and 800,000 solar water heaters were installed annually. A total of 4.4million units are estimated to now be in use.

(c) Wind power generation

The use of wind energy for power generation is limited to research, remote island power supply, demonstration, etc. As of 1995, the total capacity was 12MW, generated by a total of 63 units. This capacity is expected to increase to 44MW by 2000. In 1996, 500 to 600 kW class units were introduced and its cost is 200,000 YEN/kW level.

(d) Waste power generation

There are approximately 1,900 waste incineration facilities in Japan. Of these, about 7 %, or 123 generate power. The total generation capacity is approximately 398 MW. At present, various technologies including that to improve the efficiency from the current low level of 15 % to 30 %, one to obtaining methane by fusing the waste, and one to liquefying mainly plastic waste are under development. There is, however, a highly promising development which aims at converting waste edible oils and other waste oils into fuel. Refuse Derived Fuel (RDF) is now being introduced to several installations. Waste power generation cost varies depending on the scale of the facilities. With the waste incineration cost (incinerator and waste collection cost) assumed as zero, the power generation cost for a unit with an incineration performance of 300ton/day with a generation capacity of 5,000 kW, is tentatively calculated at 7 - 7.5 YEN/kWh.

(e) Cogeneration

As of Fiscal 1993, there were 3,236 facilities with a total generation capacity of 13,328 MW, representing approximately 7 % of the total power generation capacity. The cost is tentatively calculated at 150,000 - 350,000 YEN/kW.

(f) Fuel Cell

Fuel cell development began in 1981. The basic technology for the phosphoric acid fuel cell had been established and several 19 MW generation facilities are now in operation. These are, however, mostly demonstration plants which are not yet in the stage of commercial operation at this time. The cost for 1MW and 5 MW units is 1.1 - 1.4 million YEN/kW

(g) Unutilized energy utilization heat supply

Various local community heat supply projects utilizing unutilized energy such as plant waste heat, substation waste heat, seawater, river water and sewage temperature difference are in operation at 17 locations.

(h) Other energy sources

Under the category of ocean energy, ocean thermal energy conversion and wave power generation are under development. Their generation cost is, according to certain trial calculations, 50 - 70 YEN/kWh with small ocean thermal energy conversion, and the generation cost with wave power generators, including mole construction costs, is 60 - 130 YEN/kWh. Biomass utilization technology to produce fuel for transportation motors is under development, and unused waste utilization technology is also under development.

(2) USA.

The representative new energy and energy-saving systems and regulations of the U.S.A are as follows:

(a) Public Utility Regulation Policy Act (PURPA)

Enacted in 1978, this law requires, for the purpose of promoting the introduction of renewable energy and cogeneration facilities, power utility companies to purchase electric power from small-scale power generation facilities and cogeneration facilities (those authorized by the Federal Energy Regulatory Commission) at an avoided cost.

(b) Energy Policy Act

Enacted in 1992, this law requires the Department of Energy (DOE) to establish renewable energy demonstration and commercial utilization projects, to study the taxation and tax rate setting for renewable energy projects, to establish working groups for renewable energy export, and to establish renewable energy technology transfer programs.

In addition, the DOE is to pay 1.5 ¢/kWh to the business establishments which buy or sell power using renewable energy sources, as incentives. The DOE is to give a tax reduction of 1.5 ¢/kWh for 10 years following the commissioning of wind power and biomass power generation facilities, and to give permanent tax exemption to solar energy and geothermal energy utilization projects.

Under the above policy, the DOE has appropriated a huge budget to the development of renewable energy projects. In the early 1980s, the budget for solar energy alone was approximately US$900 million, and that for wind power generation for the years prior to and following 1980 was US$60 to US$80 million. Although the annual budget declined during the latter half of the 1980s, as development began to run smoothly, it rose again in the early 1990s, registering US$10 to US$30 million. The cumulative total from the 1970s to 1994 was US$450 million.

In the U.S.A., of all the new energy development efforts, wind power generation development is deemed the most important. The development of wind power generation has been jointly promoted by the government and the private sector under the leadership of the DOE. As seen in Table 4.5.3, as of 1994, the installed capacity of wind power generation was 1,630 MW. The power generated during 1995 was 3,500 million kWh, equivalent to the residential power consumption of San Francisco and New Orleans. Figure 4.5.1 shows a year-by-year change in the unit cost of wind power generation. Starting at a level of 10 ¢/kWh in the latter 1980s, the generation unit cost is now 5 ¢/kWh or even lower.

Table 4.5.3 SITUATION OF WIND POWER IN USA

Period	1975–1990	1995	2000
Installed Capacity		1,630MW(1994) 2,330MW(1996)	
Generation	2,100GWh(1989)	3,600GWh(1995)	
Unit Capacity	less than 20kW(1975)	200–500kW	300–1,000kW
Construction Cost	US$2,000/kW(1980)	less than US$1,000/kW	
Generation Cost	50 ¢ –US$1/kWh(1975) 25–30 ¢ /kWh(1980)	6–9 ¢ /kWh	3.5–5 ¢ /kWh
O&M Cost	3.5 ¢ /kWh(1980)	1–1.5 ¢ /kWh	
Service Life	1–5years(1975)	20years	30years
Plant Factor	10%	20–25%	30%

Other types of development are: 17 MW of photovoltaic power generation facilities were operational as of 1988, 2,980 MW of geothermal power generation facilities were operational as of 1992, and 70 waste power plants totaling 1,400 MW were operational as of 1989.

(3) Germany

The total renewable energy power generation of Germany 17.2 billion kWh in 1990, 85 % was hydroelectric power and only 15 % was derived from new energy. Germany is considering increasing this ratio to 43 % by 2015.

To promote new energy utilization, there is a law requiring power utility companies to purchase power generated by renewable energy with the purchase price for power generated by solar energy and wind power specified at 90 % of the selling price.

As of 1990, the photovoltaic power generation capacity was 1MW, with the number of generators having increased six times from 1988. Aiming at the installation of 2,250 units, a system of providing a 50% subsidy was started in 1990. The generation cost is presently Pf.200 to 300/kWh. As of 1996, the wind power generation capacity was 150 MW. In 1991, aiming at increasing the capacity to 250 MW, a subsidy system providing DM 0.6/kWh for the maximum term of 10 years was initiated. At present, the generation cost is Pf 20 to 30/kWh. Waste power generation represents the largest share with a

capacity of 589 MW, generating 2.5 billion kWh, during 1990.

(4) The United Kingdom

The UK Government plans to introduce a renewable energy of 1,000 MW by 2000. For the related R&D it appropriated 160 million £ for the 10 years up to 1990. The emphasis is placed on wind power and biomass power.

Under the Non-fossil Fuel Purchase Obligation (NFFO), the government required power distribution companies to purchase electric power generated by the use of renewable energy. The purchase price is p6.55/kWh for waste power generation, p11/kWh for wind power generation, p6/kWh for hydroelectric power, p5.7/kWh for waste dump gas power, and p5.9/kWh for sewage gas power. These prices are much higher than the market electricity prices, and the power distribution companies receive subsidies derived from the fund which is based upon power price.

Under this system, power generation facilities which 100 MW were authorized in Fiscal 1990, and 470 MW were authorized in Fiscal 1991.

As of the end of 1992, there were 156 wind power generation facilities representing an approximate capacity of 51 MW. As of 1987, there was a waste power generation capacity of 7 MW, and as of 1991, there was a photovoltaic power generation capacity of 70 kW.

4.5.3 Action plan of development of new energy

Described on 1.1.2, the development of three types of new energy consist of solar energy(solar thermal utilization and pohotovoltaic power generation), wind power generation and waste power generation should be promoted. Here, action plan of development of new energy is described.

As of May 1996, 18,000 units (diffusion of residential use was 8,260 in 1994) were estimated to be in operation with 10 to 15 times this number considered to be in potential demand. As described, these units are mainly employed during the peak power demand

time in the daily load curve around 19:00 hrs. for bathing and other domestic requirements. With the further increased number of units they are expected to be able to control the peak power demand.

On the other hand, after 2000, the economical performance of photovoltaic power generation is expected to improve as solar cell costs become substantially lower. (Figure 4.5.2 shows the forecast of cost of solar cells in Japan)

From above, by 2010 diffusion of solar thermal water heater should be promoted to control the peak power demand and after 2010 the photovoltaic power generation should be introduced. (Figure 4.5.3 shows an outline of a reverse power flow system, and Figure 4.5.4 and 4.5.5 shows a photovoltaic power generation system that forms a reverse power flow system)

In the case of wind power generation, by 2010 regulation and requirement should be improved so that developer can generate the power by wind easily.

Finally, expected power output by waste power generations calculated as follows.

Power output is decided by calorific value of waste and in this calculation normal waste is adopted. And considering the quantity of waste, 500 tons which is disposed daily in Mauritius is selected, power output is estimated at 7,500 kW. It is very difficult to forecast the quantity of waste in 2025 and very rough estimation is expected three times present quantity. From this estimation, power output in 2025 is expected 22,500 kW.

General flowchart to form a plan of waste power generation is indicated as Figure 4.5.6.

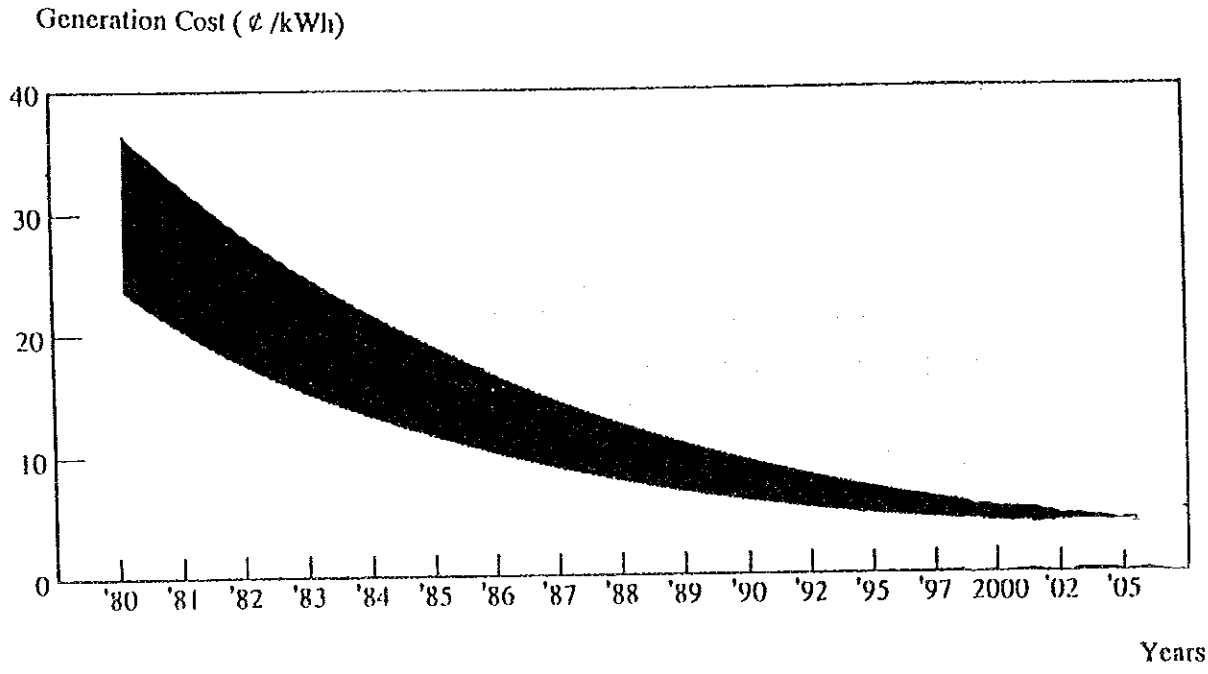


Figure 4.5.1 TREND OF GENERATION COST OF WIND POWER

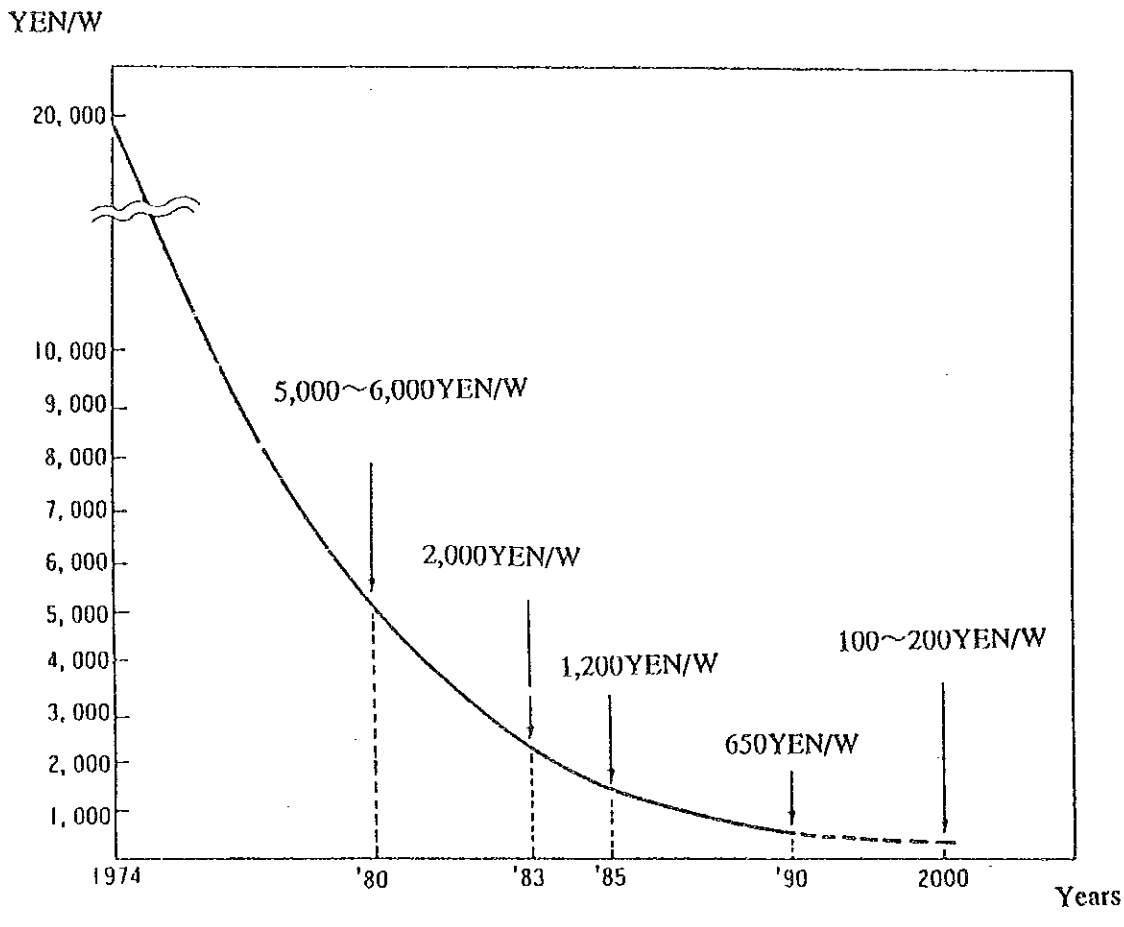
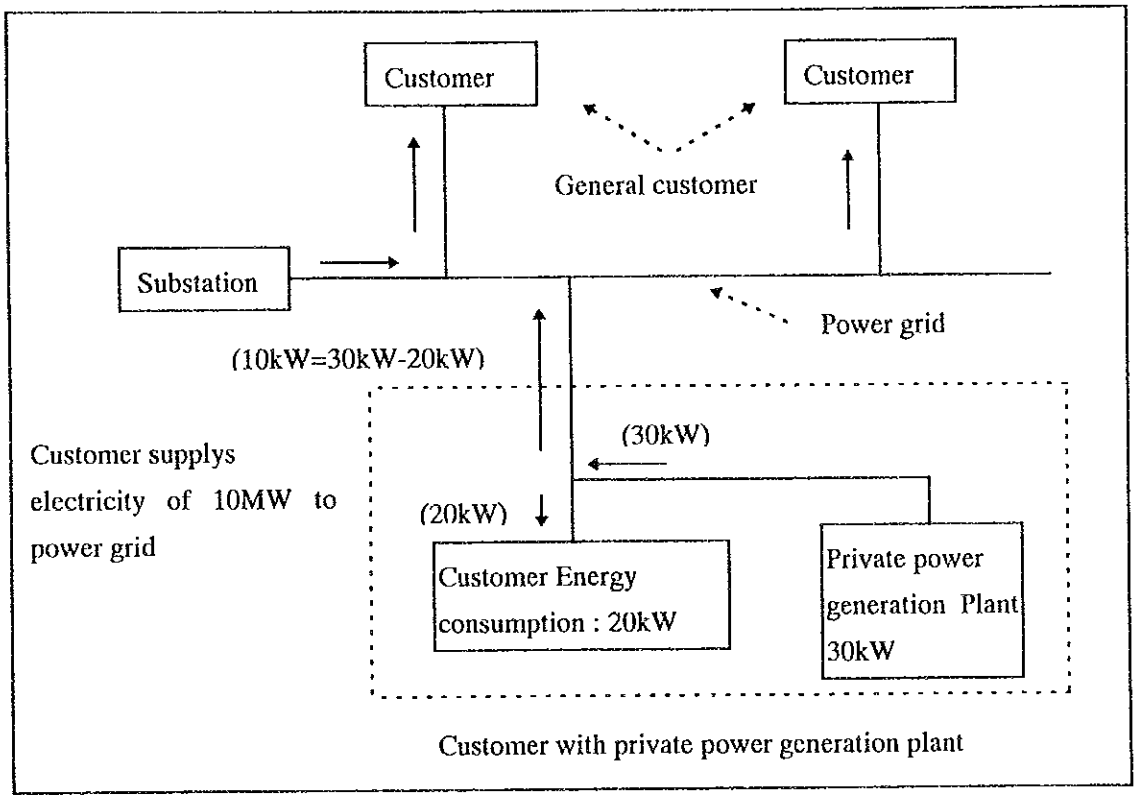


Figure 4.5.2 TREND OF GENERATION COST OF PHOTOVOLTAIC CELL

(a) Reverse Flow



(b) Not reverse flow

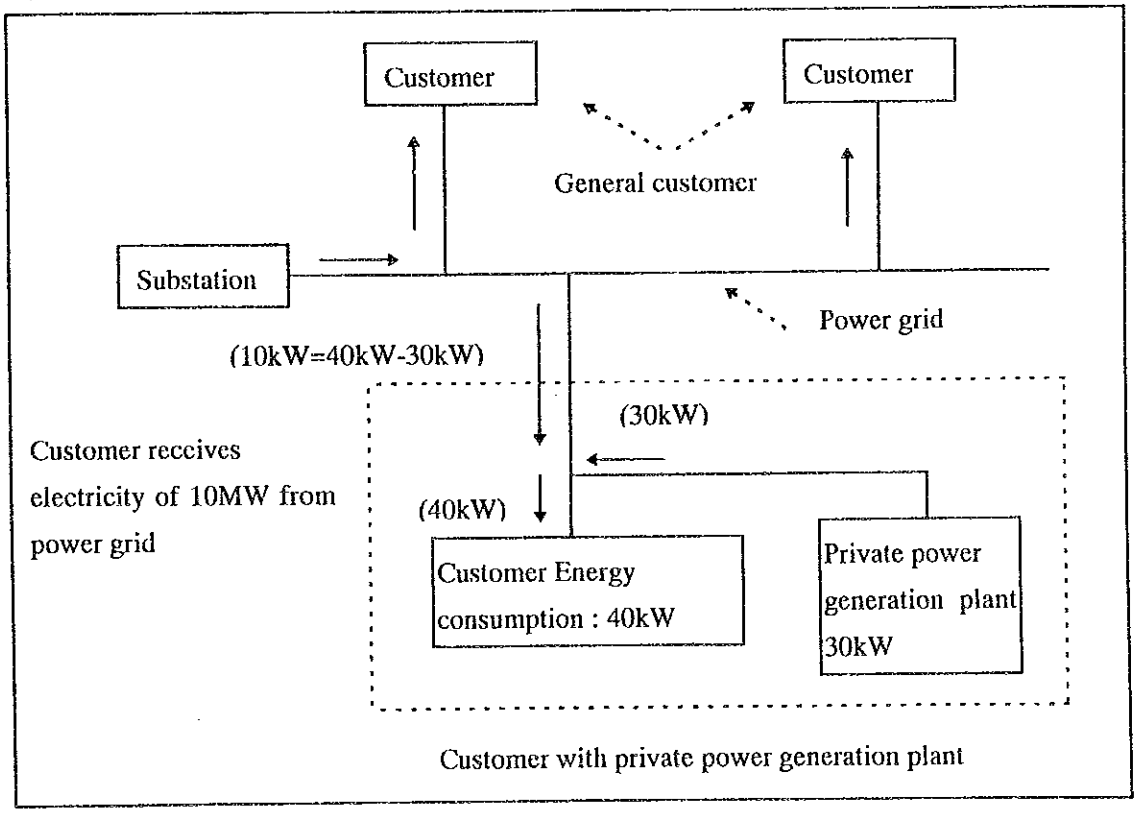


Figure 4.5.3 REVERSE FLOW SYSTEM

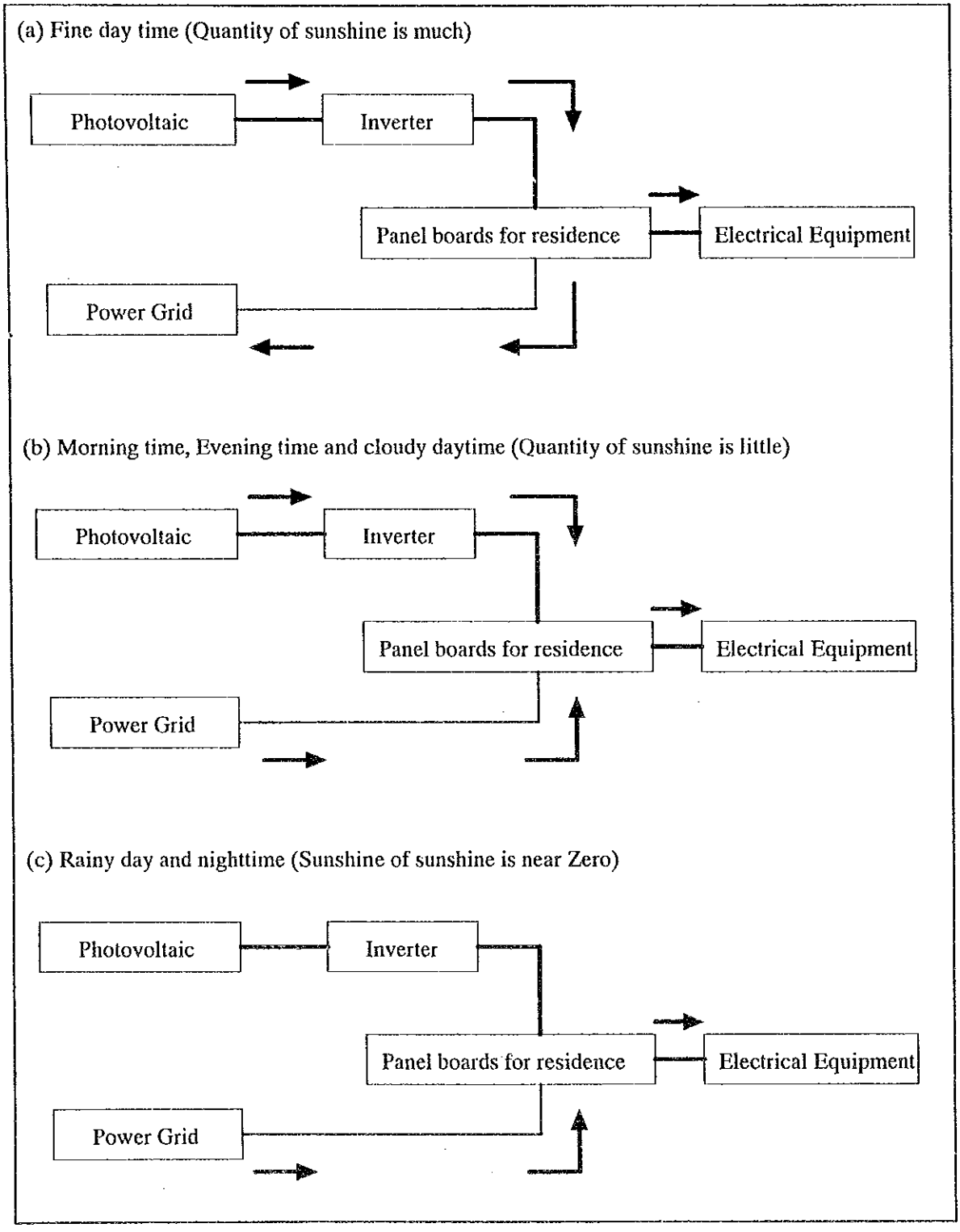


Figure 4.5.4 PHOTOVOLTAIC POWER GENERATION SYSTEM (a)

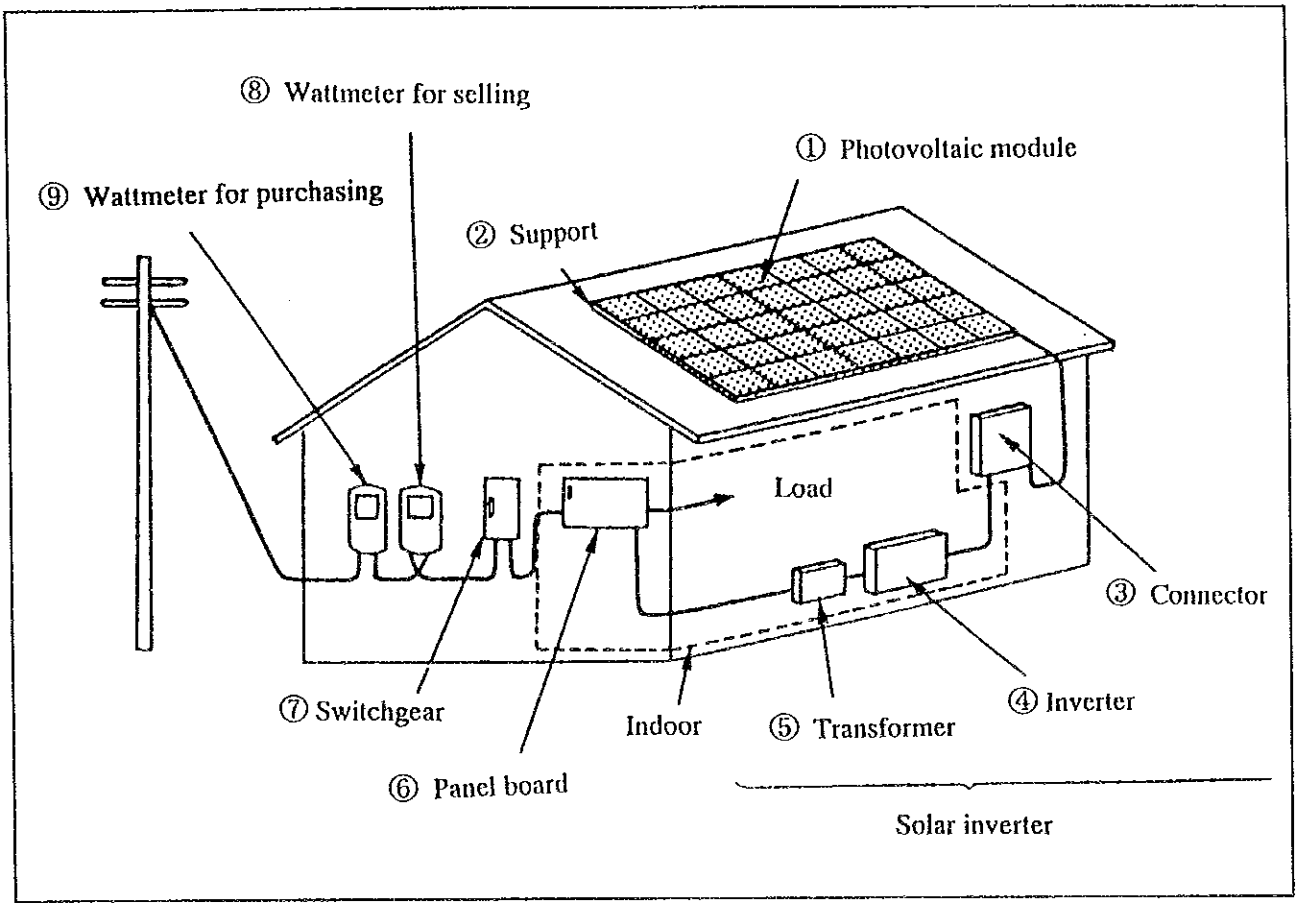


Figure 4.5.5 PHOTOVOLTAIC POWER GENERATION SYSTEM (b)

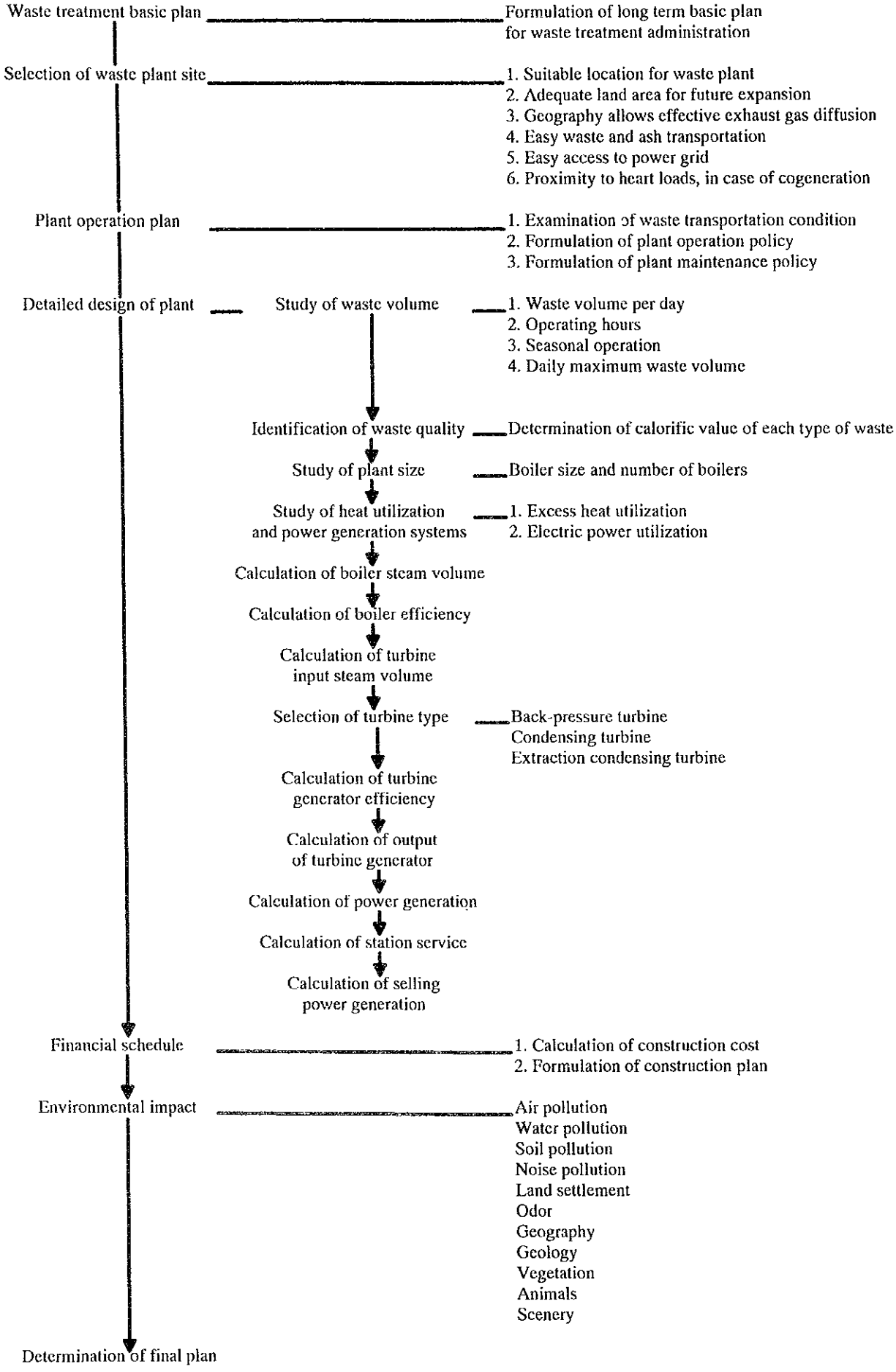


Figure 4.5.6 FLOW CHART OF PLANNING OF WASTE POWER GENERATION PLANT