

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)  
MINISTRY OF LOCAL GOVERNMENT AND PUBLIC UTILITIES  
THE REPUBLIC OF MAURITIUS

**A STUDY  
ON  
LONG TERM  
NATIONAL ENERGY PLAN  
IN  
THE REPUBLIC OF MAURITIUS**

**FINAL REPORT  
(SUMMARY)**

**JUNE 1997**

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**UNICO INTERNATIONAL CORPORATION  
ELECTRIC POWER DEVELOPMENT CO., LTD.**

TOKYO, JAPAN

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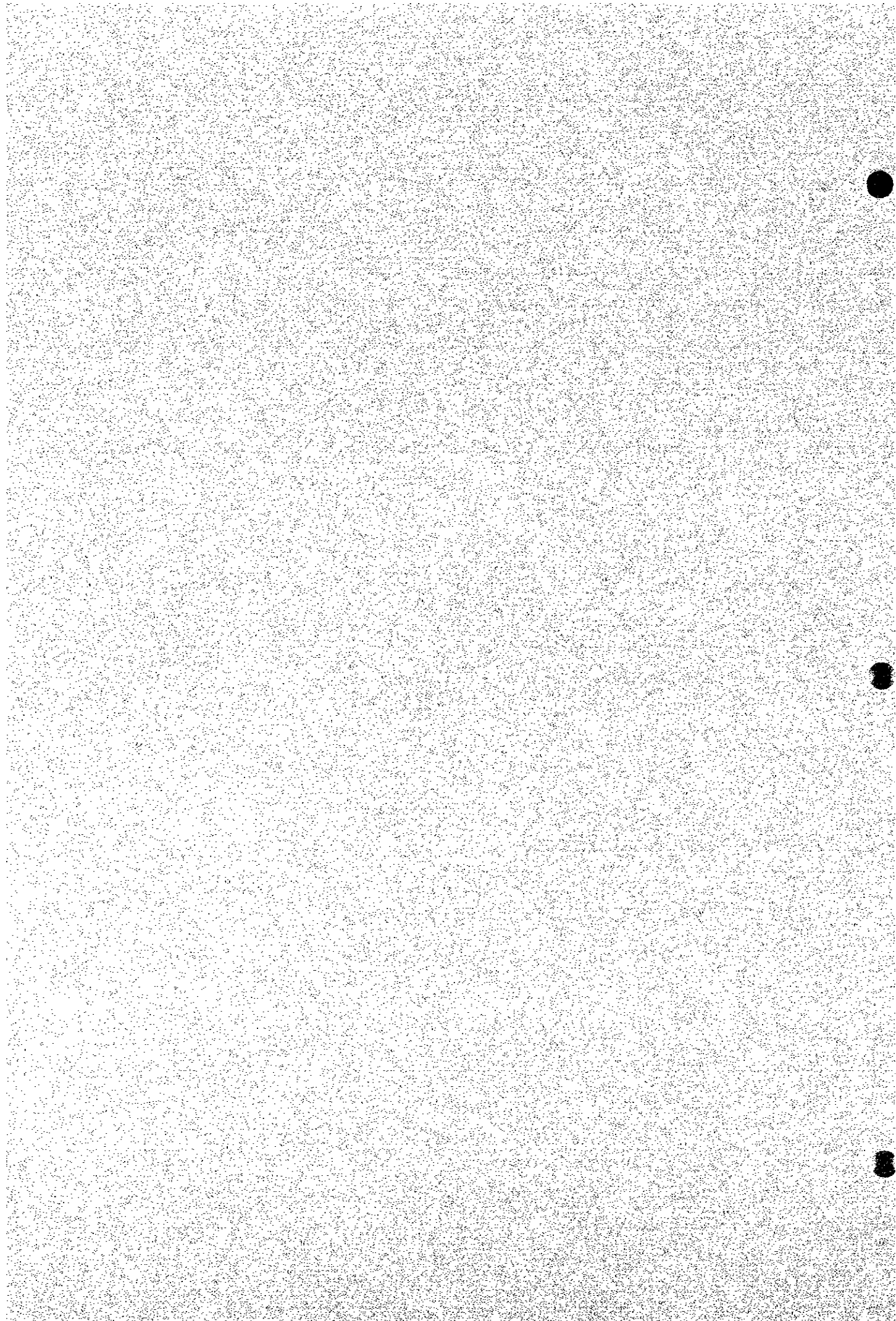
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**PART I INTRODUCTION**





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## **Introduction**

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This is a summary of the Final Report for the Study on Long Term National Energy Plan in the Republic of Mauritius.

The Study was commenced in March 1996, on the basis of the Scope of the Study and the Minutes of Meeting signed between the Ministry of Energy, Water Resources, Postal Services, Scientific Research and Technology (MEWPSRT, the present MLGPU) and Japan International Cooperation Agency (JICA) on December 7, 1995. The Final Report is presented as the main result of four local surveys and home-office analysis work.

### **1. Background of the Study**

The Economy of Mauritius has undergone rapid growth during the past decade as a result of the government's industrial policy, that seeks to change the economic structure from a mono-culture dependent upon sugar cane production to be a more diverse one. This rapid economic development, however, has created a new theme for Mauritius, which does not have much indigenous energy resources, i.e., how should the energy sector be developed to ensure economic development in the future.

At present, the Ministry of Local Government and Public Utilities (MLGPU), being responsible for comprehensive energy policy making, is now working on a new long-term energy development plan that sets forth the security of future stable energy supply as a major policy objective. For this purpose, MLGPU intends to introduce long-term demand forecast techniques that reflect market principles and other relevant factors, for the purpose of evaluating the long term energy planning made in the past and to establish a new plan.

On October 10, 1994, the Government of Mauritius requested the Government of Japan to conduct a study on long-term national energy planning as part of the above efforts. In response, JICA sent to Mauritius a study team discussed with representatives of the MEWPSRT (the present MLGPU) and other government agencies. On December 7, 1995, JICA and the MEWPSRT signed the Scope of Work and the Minutes of Meeting on the proposed study.

## **2. Objective of the Study**

The objectives of the Study are to establish a scientific basis for national energy planning with proposals for the energy sector investment program over the period 1996-2025, and to enhance the technical capabilities of Mauritius counterparts in energy planning and policy analysis.

## **3. Scope of the Study**

The Study was conducted in three phases in accordance with the Scope of Work. It was agreed thus the following four issues, and their related tasks would be emphasized in the Study.

### **(1) Energy Demand Analysis**

- To carry out an analysis of 1984-1994 trends in energy demand, and supply, and investments in the electricity, solid and liquid fuels sub-sectors.
- To establish an energy data base including annual energy balance tables.
- To develop an energy demand forecast model.
- To make projections of energy demand for the periods 1996-2000, 2001-2010 and inductively for the period 2011-2025 based on econometric tools and realistic and consistent scenarios of macroeconomics and sectoral growth, population trends and energy conservation.

### **(2) Energy Supply Studies and Investment Requirements**

- To identify the least-cost investment programme that meets the energy requirements under each economic growth and policy scenario.
- To make an assessment of the costs, benefits, finance and risks of the proposed energy investment program and fuel supply system.
- To establish a priority ranking of investment and policy measures consistent with (a) least-cost expansion of energy supplies and (b) optimal reliability of supplies.

### **(3) Energy Policy, Operations and Pricing**

- To review the policy measures and institutional framework.

- To review the current energy sector legislation and to make appropriate recommendations to keep pace with development in the sector.
- To study the potential and measures for energy conservation.
- To assess the impact of environmental management on the energy plan.

(4) Technology Transfer

- To train the Mauritian counterparts in energy planning and policy analysis and in the application of the analytical tools developed in the Study.
- To assist the Mauritian counterparts in developing monitoring techniques for the implementation of policy measures and projects.





## **PART II CONCLUSION & RECOMMENDATION**



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## **Chapter 1 Summary & Recommendation**

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### **1.1 Structural Reforms of Energy Sector**

#### **1.1.1 Establishment of National Coordination Body for Energy Sectors**

##### ***Energy Policy Making and its Implementation***

As a national economy develops, energy related issues become increasingly complex and more closely interrelated to the many elements of social and natural environments of the country, as well reflected in the current international consensus on the importance of “sustainable development”.

The need for harmonization of appropriate environment preservation with desirable economic development is considered as the foundation of the concept. Energy issues are always closely related to economic development of any country, where an increase in energy consumption in the transportation sector, industries and other sectors are inseparably associated with economic growth and development. At the same time, the increase in energy consumption resulting from economic development has the high potential to cause deterioration of the natural and social environments.

In order to achieve the desired economic development without a negative impact on the national environment, the establishment of a national level coordination body for making and implementation of policy related to energy, economic development and environmental management is an essential step to optimize the future development of Mauritius.

Energy experts are well aware that there is no way to separate energy issues from a broad range of economic policy issues, and energy related issues always involves to both domestic and foreign concerns. In addition energy policy needs to be harmonized with other national politics, some of which may have serious conflict with it. A typical example of this is seen when in the electricity tariff is raised, which always create financial conflict between the electricity sector and the industries and households.

It is observed by the study team that the MLGPU has the responsibility for formulating and implementing national energy policy, but at present there is the lack of linkage with other executing bodies which have primarily control over important elements of energy policy such as energy pricing, fuel management of the transportation sector, etc., preventing effective national coordination.

One weakness in the current energy policy making and its implementation in the country is the absence of a single executive body that can lead energy sector management.

As the first step of national energy policy coordination ,the strengthening of the energy group of MLGPU is recommended to ensure that it can take leadership in relation to the following activities;

- 1) Assessment of the current institutional framework of the government in relation to energy policy making and implementation with a view to preparing a comprehensive plan for establishing a high level executive agency, similar to the Department of Energy of the United States;
- 2) Continuous updating of the long term national energy sector development plan, which includes the existing energy sector and new energy development ; and
- 3) Build-up of expertise required to improve the ability to formulate and implement a comprehensive long term national energy plan.

### **1.1.2 Structural Reinforcement of the MLGPU**

It is recommended in paragraph 1.1.1 that a core organization be established for policy making and administration at the national level for long term energy planning and administration, by integrating of the activities of all related ministries and government agencies.

In addition, the strengthening of the MLGPU is strongly desirable in relation to energy information gathering and data processing for continuous updating of the long term energy demand and supply forecast and promotion of nationwide energy conservation activities.



Presently, energy related information such as on fuel imports, fuel consumption by each sector, electricity generation and consumption, are collected by CSO/MLGPU, but the current way of data collection from diverse sources is not adequate for accurate assessment of the energy use efficiency, to evaluate interchanability of energy types, to estimate the current and future of energy use and to use as the basis of energy policy formulation. In order to facilitate the collection of reliable data relating to the activities of multiple ministries/corporations for planning of the national energy policy, procedures for data collection compilation from different sources must be reviewed by the core organization of MLGPU. In addition, the MLGPU once collected basic data for long term planning of energy conservation by means of energy audit of a few sectors, which has not been continued in subsequent years. Clearly consistent energy auditing of every sector is very important to improve the accuracy of the long term forecast model prepared by MLGPU and the JICA team this time.

Consistent data collection and long term supply and demand forecast by MLGPU, as the basis of national energy policy making and its administration, will be very helpful not only for the national plan but also the planning and administration of energy related activities under individual ministries/corporations. It is expected that effective cooperation between the energy data/information center of MLGPU and the senior staff of every ministry and corporation will reduce work load of the senior staff in data collection and assessment of the effect of policies.

Personnel with the ability to organize the energy data gathering system and to assess data collection for policy making should be assigned as the core team of the MLGPU energy development department to realize the above functions.

### **1.1.3 Major Issues Related to Existing Laws and Regulations in Restructuring Energy Sector**

#### **(1) Major issues in present laws and regulations**

As seen in many countries including Japan, the electricity business in Mauritius originated in private initiatives to supply electricity to large cities and industrial areas on a pure commercial basis. In the process, the government was required to devise appropriate

measures to maintain public safety, such as the prevention of public hazards peculiar to the electricity business and the control of negative impacts of electrical installations on communication facilities. Various laws and regulations were effectuated with the primary purpose of ensuring safety control related to the electricity business by the government. This intention is clearly seen in the Electricity Business Act (AD1939). In the next stage, as the use of electricity was proliferated into the entire country, it was widely recognized that electricity was essential in improving national standards of living as well as industrial development. The electricity business, previously considered on a pure commercial basis, was required to serve public interest. For the commercial business, it is not viable to supply high quality electricity to an area with low population density and lagged industrial development, and at a low cost. During this stage of development, competition exerts full force and multiple electricity suppliers strive to serve an area with large demand where the price is kept at a reasonably low level by the competition. At the same time, duplication of investment occurs in transmission and distribution facilities for urban area. Naturally oversupply and excessive competition had took place.

The situation calls for the emphasis on public aspects of electricity (electricity supply to remote areas) and public control on the business to prevent undue competition. As the public increasingly demand stable electricity supply at low cost, the government grants a selected enterprise exclusive rights to supply electricity to a certain area while obliging it to extend the same service to an area for which supply is not commercially feasible. Then, as electricity charge is considered to be a financial burden on low-income households and the electricity cost is viewed as a key factor in determining the industry's international competitiveness in the country, electricity sales price falls below electricity reproduction cost to deprive the business of commercial viability, and the government takes over to manage it as a state-owned monopoly.

This was the time when Mauritius enacted the CEB Act, which laid the groundwork for the monopolistic electricity business which also prevails in many countries and is managed by a public organization or a special entity which is authorized by law to have monopolistic control of the business.

In recent years, privatization of public utilities including electricity is promoted in the U.K.,

the U.S., and EU countries. The move has been driven by public consensus that electricity price can be lowered by introducing competition into the industry that leads to cost reduction, together with the world political trend toward the small government. It should be noted here that the reduction in electricity supply cost is sometimes realized by transfer of infrastructure, which is not bring profit directly, constructed by low cost public money to the privatized entity at a very low cost. This implies that, when a new energy source, which is not profitable in short term, is to be developed at a cost of the private sector, special policy consideration is required to ensure recovery of the cost. In this connection, it is important to recognize the differences between middle-income countries and industrialized countries (especially the U.S. and U.K.) in the situation surrounding privatization of electricity business. This means, most of middle-income countries have investment requirements for public infrastructure including electricity to meet fast growing demand, which exceed each country's ability to meet financial requirements.

Under the current world economic conditions, the World Bank recommends the countries to privatize electricity and other public utilities in an attempt to encourage free flow of investment funds worldwide, so that they can build infrastructure required for adequate economic development while keeping (direct) financial obligation of each government at a controllable level.

In this context, it is important to realize that modernization of electricity business related laws, which MLGPU is mandated by the Mauritius government, intends to pave the way for infrastructure development in that direction. More precisely, the current Electricity Business Act and the CEB Act need to be entirely amended so as not to prevent private enterprises (both domestic and foreign) from entering the electricity business in the country by using their own funds, or a new law must be enacted to promote privatization of electricity business. One of impediments to privatization is found in the current laws that authorize CEB to monopolize the electricity business, which can effectively be used as a legal ground for blocking the entry of private enterprises as competitors (see Articles 4, 5, 6, 10 of the Electricity Business Act, and Article 3 of the CEB Act).

(2) Recommended amendments of the Electricity Business Act and the CEB Act in Mauritius

Introduction

Legal reforms for the electricity sector required for the country should start from the recognition that existing laws and regulations related to the electricity business primarily aims at ensuring stable, safe and low-cost provision of public utilities to every person and industrial sector, while leaving profitability of the business as the secondary goal, thereby justifying monopolistic control of the business with explicit or implicit assumption of financial dependence on government subsidy. The reforms therefore should aim to depart from the generation-old legal structure and establish a new electricity business law that can serve as the foundation of the national energy policy addressing the current needs.

New electricity business act

To achieve the above objective, the new electricity business law should incorporate the following elements:

1) Declaration of Policies

- (a) to ensure reliability, security, and affordability of power supply
- (b) to promote competition and accountability of industry participants to achieve greater operational and economic efficiency
- (c) to enhance inflow of private capital and broader ownership base of power generator, subsectors, and minimize movement financial and risk exposure
- (d) to rationalize and make electricity price competitive and affordable, and when warranted to provide transparent subsidies to unviable areas to assure socially and environmentally compatible energy sources and infrastructure

2) Definition of the Organization of the Power

Define the organization, the transition from the present to desired competitive structure, and responsibility of the various agencies and private entities during and after the restructuring process.

Generation of electric power shall be market-based and shall include but will not be limited to the participants.

- (a) Independent Power Producers (IPPs)
- (b) Electric Utilities (New CEB) Owing Generation Plants
- (c) Other state owned national generating authority for multi-purpose hydro etc.

The planning, construction and centralized operation of high-voltage transmission system not acquired by electric utilities shall be the responsibility of New CEB. New CEB shall assist Department of Electricity (Energy) in integrating expansion plans of generation and electric utilities, and shall provide access to the transmission system by all power producers and users through fair and transparent wheeling operations.

### 3) Tariff Setting

Tariff shall be cost reflective and set a level which allows companies to cover all reasonable costs including a reasonable return on their investment with the aim of achieving safe and reliable electricity supply and development of the system over the long term.

New CEB shall purchase that power needed to serve its anticipated demand (including reasonable reserve requirement) at rates that shall not be more than their "Avoided Cost".

"Avoided Cost" as herein defined shall mean incremental cost that an national electric utility (New CEB Generation) would incur toward meeting its anticipated power demand, if such utility does not buy power from a IPP.

Rate for purchase shall be just and reasonable to the customer of New CEB and in the public interest.

Be in accordance with guidelines set by the regulatory body, under Energy Ministry, on this matter where full and/or excess energy production shall be sold to the system of concerned parties.

An acceptable competitive scheme (e.g.bidding) is one means of setting avoided cost as well as reasonable purchase rates.

The regulatory body in consultation with related parties shall formulate and adopt a standard methodology for calculation of New CEB and other utilities avoided cost.

Criteria for competitive procurement scheme (e.g. bidding) shall also be formulated to define acceptable means of solicitation that can also provide the basis for determining an national electric utility's avoided costs and reasonable purchase rates.

- 4) The regulatory body, under Energy Ministry/D.O.E.
  - (a) Enforce technical performance standards for all generation facilities.
  - (b) Enforce performance standards for the transmission company (New CEB) including financial management, system losses, and reliability standards, including a system of incentives, fines and penalties to be consolidated by the regulatory body in a transmission code.

5) Restructuring

The existing CEB shall be restructured to separate its generation and transmission function and other allied undertaking. CEB shall reorganize and divest itself of its generation assets to ensure competition, supply reliability and efficiency. New CEB will retain control and responsibility over transmission functions.

6) Privatization

Privatization may be pursued through any or combination of the following.

- (a) Sales of share of stocks to institutional or investors in domestic, and, if warranted in the international market
- (b) A strategic partner
- (c) Employee stock option plan
- (d) Others

- 7) In addition to the above new elements, it is important to maintain safety management elements which are contained in the current law and continued to be imperative (e.g., Articles 19, 20, 21, 22, 46, and 47), and portions of the new CEB Act to specify CEB's responsibility and authority as a public utility need to be incorporated.

**Establishment of the new basic energy act**

It should be noted that the new law represents minimum required amendments of the present law to promote early privatization of the power generation business. In

addition, the study team believes that a law governing the entire energy sector should be enacted to enable the establishment of Department of Energy in order to ensure formulation of national energy policy and effective coordination and management of policy implementation.

As discussed in the beginning of this report, the basic law hereby proposed should contain laws and regulations which clearly define the purpose of establishing DOE and functions required for it (see Appendix 5 No.7638 Republic Act of Philippines). Furthermore, the development of a comprehensive law is imperative as part of modernization of the electricity business law, consisting of laws and regulations required for implementation of policy related to the entire energy sector, particularly fossil fuels, implementation of energy conservation projects including the development of new energy sources, a framework for public administration related to the entire energy sector and the environment, and implementation of pricing policy for public utilities including electricity and fuels.

#### **1.1.4 Deregulation**

##### **(1) Concept of Deregulation**

While the restructuring of CEB and private investment are urgent tasks for the power industry, the deregulation issue should be approached from a long term viewpoint. Since the revision of the relationship between the CEB will be dealt with first, the discussion on deregulation should be addressed second.

The general concept of deregulation is classified into the following eight elements;

- 1) Entry regulation
- 2) Operation and maintenance management
- 3) Diversification regulation (e.g., new business activities)
- 4) Investment planning (e.g., for new projects)
- 5) Work force management (e.g., appointments, promotions, salaries, etc.)
- 6) Financial management (e.g., procurement of funds)
- 7) Price regulation
- 8) Ownership

In the power industry, the first priority to be achieved among should be given entry regulation. Because of the CEB's capital constraints and fast growth of electricity demand, induced private investment is one of the most promising answers as it allows "off-balance (sheet)" transactions.

Further deregulation should be discussed thoroughly among the government, private sector and academic institutions. Empirically a drastic structural change is not always the best solution. For instance, the price charged by the privatized power industry in the Philippines is widely complained by consumers. Also environmental issues are easily neglected especially in the developing countries.

## (2) Action plans for forming a competitive market

The time schedule and major targets to be achieved during the specific periods are discussed in this section.

The schedule can be divided into two phases: short term (next five or six years) and long term.

### **Phase I : 1997-2002**

(Short term tasks)

- Improvement of CEB operations
- Further promotion of private sector participation, and legal reforms for the relevant licensing system
- Establishment of a committee for deregulation planning

### **Phase II : 2003-**

(Long term prospects)

- Preparation for the transition process
- Deregulation of the electric power industry
- Privatization



CEB restructuring and private investment promotion are central issues in Phase I. Deregulation cannot be achieved without regaining management efficiency and profitability of the CEB. Revenue growth, especially by adjusting the electricity tariff, is one of the most important issues. Phase I also serves as preparatory period for deregulation, and a committee to plan deregulation should be established.

Phase II, the deregulation period, will follow confirmation of management efficiency of the CEB and the maturity of the power industry. The profitable nature of CEB will have been enhanced through the partial deregulation such as promoted competition with other independent power producers and the restructuring. This way, the CEB will be able to seek and face further deregulation. Again, the transition period may be required, during which such measures as favorable tax treatment and access to government loans are provided.

### (3) Private Sector Investment

#### Concept of private sector investment

There are basically two objectives in inducing private investment. One is to bring in foreign direct investment. The other is to stimulate competition in the power industry. The reduction of the government intervention is also an indirect objective.

The encouragement of private investment for the industry will require the following preparations in the legal system.

- Licensing system for private investment
- Energy pricing system
  - Avoided cost
  - Bidding system
  - Negotiation system
- Obligation of producers (e.g. quantity, quality, etc.)
- Obligation of purchaser
  - Purchasing conditions
  - Open access to the transmission system

- Exemption from existing energy laws and regulations
- Favorable status for independent power producers, if any

Investors seek to minimize risks involved in their investments including foreign exchange, political, contract, and financial. For this reason, the government may be required to provide a transparent system for purchasing electricity.

### **1.1.5 Independent Power Producer Scheme**

Independent power producers have been increasing in number as well as importance in both developed and developing countries. This section makes recommendations on nurturing of independence power producers based on the concept for deregulation of the Mauritius power sector.

#### **(1) Action plans**

Private sector investment in the power generation industry in Mauritius is to be promoted through the following action plans.

#### **Step I : Preparatory Works**

- Revision of laws such as Investment Act, Electricity Act and CEB Act
- Drafting of technical performance standards
- Establishment of power development plan for the new producers

#### **Step II : Invitation/Selection of Investors**

- Preparation/issuance of request for proposals for power purchases
- Pre-qualification of bidders, if necessary
- Evaluation of proposals
- Award of contract

#### **Step III : Power Purchase Agreement**

The power purchase agreement would include the following stipulations.

- Required facilities
- Connection condition

- Payment
- Quality of supply
- Minimum take
- Fuel purchase agreement
- Duration of agreement
- Contract milestones
- Default and termination
- Security and liquidated damages
- Force majeure
- Dispute resolution
- Limitation of liability
- Confidentiality
- Miscellaneous provisions

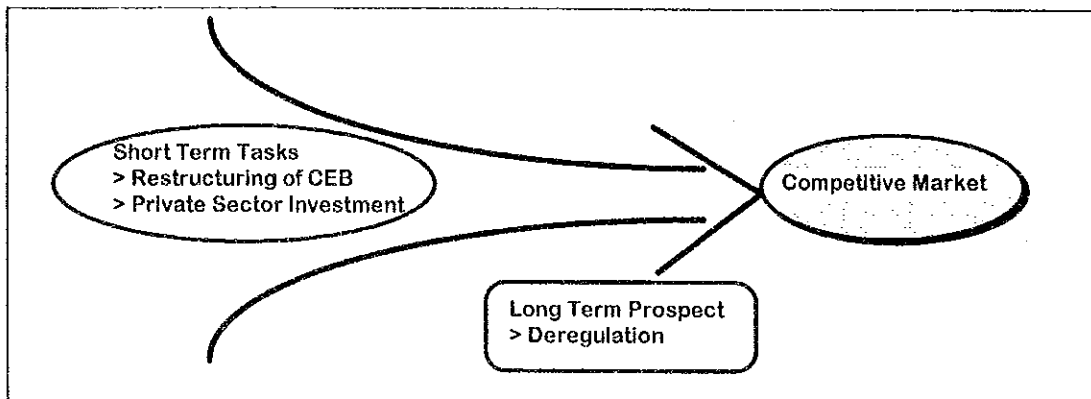
(2) Role of CEB

*Frameworks for Restructuring CEB and the Electric Power Industry*

The fundamental purpose of restructuring the CEB and the power industry is to spur the competitiveness and hence economic efficiency through deregulation. The underlying concept is to shift towards a competitive market in the industry and efficient regulation of the monopoly system, thereby providing consumers with more efficient services. Additionally, the concept enables CEB to mobilize alternative sources to finance future projects and to enhance the motivation of employees to improve their performance. The competitive market allows each party of the industry to achieve the following:

- Efficient regulation of the monopoly system
- Maximization of efficiency of public services for consumers
- Effective operation of the CEB

The basic concept for achieving this is illustrated as follows.



The three vehicles, namely 1) restructuring of CEB, 2) private sector investment, 3) deregulation, are discussed in the subsequent sections.

The CEB needs to enhance its organizational strength through the improvement of managerial, operational, and financial efficiencies.

(a) Improvement of management/organization efficiency

Senior managers should play the key roles in establishing long term strategy for the CEB and reconstructing organizational efficiency. In the process, CEB may face the following challenges.

- Need to establish clear, long term corporate strategy, especially development and financial planning
- Increase in managerial autonomy of the CEB
- Empowerment of management officers, especially financial managers

(b) Improvement of operational efficiency

While the CEB is committed to the continuous improvement of operational efficiency, it may be worthwhile again to reengineer each place of work and to review each procedure of tasks in order to eliminate redundancy and to rationalize operations. CEB might be able to look at the following items.

- Increase of employee productivity
- Efficiency in fuel procurement
- Review of staff allocation and outsourcing
- Decommissioning of outmoded power plant facilities, and standardization of operation and facilities

### (3) Privatization of the CEB

The efficient supply of electricity can be achieved through a competitive market. While the CEB has been a parastatal body, the restructuring of its organization will be required to shift it towards a competitive company and hence one that can meet the needs of consumers. Therefore, it is recommended to reform the CEB from the current organization to a corporation whose shares are primarily owned by the government initially and separated into two bodies, one in charge of power production and the other for transmission and distribution. The electricity production industry will be privatized and participation of independent producers will be encouraged. The power generation sector of the old CEB will continue to maintain existing power plants and participate in the bidding for power development if its financial condition so allows. On the other hand, the transmission and distribution company will remain a largely-state-owned monopoly because of the small size of the system and the need for secure supply of electricity. Additionally, the further privatization of the two corporations might be sought by public offering of its shares. However, before the privatization is implemented, a more in-depth study should be carried out to evaluate the validity of the privatization issue.

The role of the government after privatization will be to ensure stable and efficient supply of electricity from the viewpoint of public utility rather than that of market regulation. The government also should encourage continuing private investment and oversee electricity pricing. Preparation and enforcement of technical performance standards for independent producers will remain one of the most important roles of the government.

### (4) Improvement of the Financial Position of the CEB

The CEB is currently facing financial difficulties. CEB should consider the following possibilities.

- Revenue growth/revision of energy tariff
- Diversification of revenue sources
- Debt control

(a) Revenue growth/revision of energy tariff

Since supply of electricity is practically the sole business activity of the CEB, the electricity tariff plays a crucial role in the financial base. While the current tariff system is based on the prime cost principle and has been applied for a long period of time there are various elements to be re-assessed and reviewed as follows;

- Establishment of clear and transparent procedures for price revision
- The revision of electricity tariff should reflect the fluctuation of prime cost such as fuel cost, personnel expenses, and indirect costs. For example, the tariff could be revised every year, reflecting the actual variation of fuel price. The process of price revision must be clear and transparent.
- Determination of appropriate profit for CEB from a long term perspective
- Elimination of the discriminatory tariff system for some end users
- The discriminatory aspect in the electricity tariff system should be eliminated.
- Consideration to low income users
- Reasonable allocation of costs to the pricing system <Demand and running charge for each level and category of consumer>
- Introduction of time-of-day rate (discriminatory pricing)

(b) Diversification

Diversification of revenue centers for CEB would help improve its financial position as well as create new job opportunities. The examples of potential diversification may be sought in the following areas;

- Development of a new communication system
- Production and/or marketing of electrical appliances
- Industrial area development and real estate development

- Cable TV
- Management of power plant operation at a sugar mill
- Consultancy services

(c) Debt problem

Given the current accumulated debt level for the CEB, it is difficult to continue investing in new power plant development. Therefore, the CEB may want to seek an alternative financing scheme to cover the required cost for new projects. IPP can help solve this problem through introducing private funding necessary for new projects. We also recommend that the CEB establish a long-term repayment schedule for the accumulated debt along with the long-term development plan.

### 1.1.6 Financing

In the fund procurement plan for the energy development and supply project in Mauritius, it is important to consider how to secure the foreign currencies required for importing energy products while giving adequate consideration to the international balance of payments. As evident from the energy demand forecast in the present study, energy demand in Mauritius will continue to grow rapidly. Therefore, the securing of the required funds on a long-term basis, including the effective utilization of private capital in electric power projects, is a major challenge to the government.

The funds required for energy supply in Mauritius include those for securing the primary energy sources--foreign currencies for importing petroleum products, coal, etc. and domestic currency for purchasing bagasse; those for providing facilities for supplying energy (power generation and transmission facilities, energy product storage facilities, energy transportation facilities, new energy development facilities, etc.); those for investment in new energy development (foreign and domestic currencies); and those for providing various services relating to energy supply (operation and maintenance of facilities).

Of the above funds, those for securing the primary sources of energy and operating the

energy supply facilities are short term in nature, requiring a procurement plan based on the relationship between corporate finance and domestic financial institutions. On the other hand, the funds relating to the development of energy supply facilities are long term in nature, which, in view of the financial situation in Mauritius, need to be procured from foreign banking institutions, international cooperation agencies, etc.

The short-term funds, whether they are foreign or domestic currency, are procured on a routine basis, and the risk involved in procurement is relatively easy to predict. By contrast, the long-term funds for investment in energy supply facilities involve risks inherent in long-term funds. Concerning plant and equipment investment in power generation projects in Mauritius in the future, the following problems are pointed out and proper responses to them are called for.

- a) In order to meet the growing electricity demand for, it is necessary to implement plant and equipment investment on a continual basis. According to the plan for investment in power supply facilities shown in Chapter 9 of this report, financial demand is also expected to increase very rapidly.
- b) Because of the financial burden imposed by long term debt, the CEB lacks sufficient credit standing to implement the above plant and equipment investment on a continual basis.
- c) As the rupee-US dollar exchange rate indicates, the value of rupee in the international money market has declined continually. Thus, in terms of the exchange rate, both the CEB and private enterprises represent a high risk in introducing long-term foreign funds.
- d) The rate of inflation is markedly high and domestic interest rates are relatively high, and these conditions driving production costs high.
- e) Though privatization of the power generation business is expected, it is difficult to be realized since incentives for private investment (BOT, BOO, etc.) have not been sufficiently institutionalized by legislation.



- f) The industrial sector strongly resists a reasonable raise in power rates, making it difficult for the power generation business to be commercially viable.

## 1.2 National Energy Security

### 1.2.1 Energy Supply Security

Repeated regional conflicts in the Middle East, especially after the oil embargo to European countries in 1967, it have made countries recognize the importance of storage of petroleum for energy security. Prior to that, OECD issued a recommendation in 1962, to its member countries to have stockpiles of petroleum equivalent to 60 days consumption. Then, the first oil crisis occurred in 1973 and caused serious confusion and damage on the world economy. Responding to this experience, the IEA (International Energy Agency), which was organized as a subordinate of OECD, obliged its member countries to have oil stocks equivalent to 60 days' quantity of importation, which was raised to 90 days by 1980. IEA established detailed procedures to be followed in an emergency such as mutual accommodation of shortage and control of demand. And IEA decided to promote international cooperation in development of energy conservation technology and alternative energy for lowering dependency on petroleum. The second oil crisis, in 1978, caused Middle East crude oil prices to rise to 10 times the level of the early 1970s. It reconfirmed the importance of energy conservation, diversification of energy sources, purchasing from multiple sources and strategic stockpiling.

In response to the price increase of crude oil, developed countries endeavored to develop energy conservation technology and to increase recovery from existing oil fields. As a result of these efforts, although the growth rate of oil demand in developing countries was high, world consumption growth has been decelerated, due to slow down in developed countries. Regarding supply and demand of petroleum, the reserves to production rate (R/P) rose up to 40 years because of further growth of proven reserves (R) against production. The increase in proven reserves is the result of discovering new oil fields and increase in proved recoverable reserves. Recently, however, growth of proven reserves is increasing by enhancement of recovery rate while discovery of new oil reserve is decreasing.

Increased production in non-OPEC countries resulted in shrinkage of OPEC countries' production share to 30% (52% of world exports) in 1985, which went up again to the level of 42% at present. Due to the peaked production in big fields of non-OPEC countries and

increased oil demand in developing countries caused by motorization, increased dependency on OPEC countries is expected, especially on Middle East producers which have huge oil reserves but face uncertain geopolitical conditions. Crude oil produced in the Middle East accounted for 38% of the world total, and 54% (87% of export ) of OPEC countries at 1st oil crisis.

Under these circumstances, and as consumption of petroleum products in Mauritius accounts for 85% of total primary energy, it is clear that an interruption or drastic cut in oil supply will cause serious damage to the economy and population. For stable continuation of economic development, which has been supported by investment from foreign countries, secure and stable supply of energy is one of the essential conditions, and accordingly national energy security must be maintained.

Strategic stockpiling is the most common measures of assuring stable energy supply, but a tremendous amount is needed to secure energy supply for a long period of time. Accordingly, efforts to reduce dependency on petroleum, in view of its uncertainty of stable supply, must be made in parallel to a stockpiling program. The government is required to promote the following measures by providing incentives and taking account the benefit of lowering both the probable risk of supply shortage and the cost burden of strategic stockpiling.

(a) Utilization of Indigenous Energy (refer to Sections 4.5 and 5)

Hydropower, bagasse, and new energies such as wind, solar heat and photovoltaics are available or have commercial potential. Among them hydropower has been developed with no additional development being expected. There is considerable potential remaining for bagasse and it is required to utilize it for public energy with higher efficiency all the year round. As for new energy sources, Mauritius has recognized importance of their utilization and has introduced a semi-commercial scale wind power plant for testing. The solar water heater is also introduced in these years in effort to reduce energy imports. As a result of technological development, the economic viability of these new sources against traditional ones are being improved. Therefore the development of those energy sources as well as bagasse should be accelerated from now on as

one of measures for national energy security.

(b) Energy Conservation (refer to Para. 8.4)

Improvement of energy efficiency decreases dependency on imported energy and serves as a safeguard for the national economy against supply interruption. In addition, energy conservation gives favorable economical effects on the country and the company. Conservation should be promoted also from the viewpoint of global and national environment preservation. See to Para. 8.4 Energy Conservation and the Development of Related Technology for detailed discussion.

(c) Diversification from Petroleum to Alternative Fuels

At present, Mauritius imports most of primary energy in the form of petroleum products. This means that the national economy and people life can be disturbed directly by worldwide supply shortages or a significant price hike. To minimize such risk, dependency on imported petroleum energy needs to be reduced by means of diversification from petroleum. The basic requirements for alternative energy sources are presence of large reserves, wide distribution in the world, and low prices, major candidates include coal, natural gas, and oil sand. In Mauritius, natural gas and nuclear power are excluded from consideration because of relatively small energy demand and large investment required.

Coal reserves are huge and distributed world wide, and therefore its supply is assured. Coal is expected to become more important as oil-alternative. Considerations may be required in promotion of coal utilization in industries, e.g., the provision of a low-cost handling and transportation system, effective pollution control measures, and dispersal or utilization of ash.

(d) Establishment of Cooperative Relationship with Oil Suppliers

Oil companies working in Mauritius have attained stable oil supply capability by utilizing their international network from field production through refining. The establishment of a long term supply contract with such oil companies could

be of benefit for both parties. At present suppliers of petroleum products, except for CEB use, are selected through international bidding every year. From the viewpoint of energy security, considerable portions of oil imports should be made through inter-government deals and major oil companies by establishing cooperative relationship under the long term contract with oil companies and oil producing countries in long term bases.

Agreements within neighboring countries is also be useful to meet emergency requirements by cooperation of member countries.

### **1.2.2 Recommendation on the Use of Bagasse Energy**

#### **(1) Long term planning of the "Bagasse Energy Development Project"**

The Bagasse Energy Development Project (BEDP) has been promoted as an effective program both for improvement of economic competitiveness of the sugar industry and the effective use of bagasse energy. It is our understanding that the modernization program of the sugar industry includes the integration of sugar mills by merging a few small mills is contemplated in the near future.

The current BEDP has already sizable capacity as a portion of the CEB power supply system by use of not only bagasse also a large amount of coal as its fuel. As the result, the impact of BEDP program on the whole electricity generation system of the country become significant, and therefore the implementation of future BEDP project must be taken into consideration the long term power generation plan for the whole country.

The future BEDP power plant must be maintained at the technological level of other power plants in Mauritius, which is required to be considered as the reliable supply capacity during the peak demand period. The additional investment to improve reliability of the plant and the necessary cost for mitigating pollution of air and water by the plant, will necessitate to construct a large (above 30MW) unit to enjoy economy of scale, and thereby to secure the financial viability of the project.

The prospect for future capacity expansion of sugar mills and the need for increasing the scale of the power generation plants for cost reduction indicate that the future Bagasse

power projects may adopt a project scheme which adopt the plant of 30MW or more, without consideration to the limitation of availability of Bagasse for the project. This will result the future large BEDP power generation projects heavily depending on coal burning.

At present, it is difficult to advocate that the power generation system of Mauritius, which is isolated from neighboring countries and has a comparatively small total generation capacity, should have a very large modern power plant, in the 200-300MW range, using liquefied natural gas or coal, even though it is considered as the most economical power generation scheme under current international conditions. For this reason, the large slow-speed diesel-engine power generation, 25-30MW per unit, consists the major part of the power generation system of Mauritius and the medium scale plants, 10-30MW hydro power plants, bagasse power plant, and gas turbine single cycle plants are supplementing the diesel plants.

Nevertheless, the continuation of economic development and the improvement of the living standards of the country will be accompanied by a rapid increase in electricity demand, and the conditions justifying a large modern power plant, which will help achieve stable supply of low cost electricity to support economic development and daily life, will be fulfilled within 15-25 years. The introduction of a large modern coal base power plant in around 2015-2020 is considered the most economical way to meet the additional electricity demand.

Until such a large modern coal base power generation plant is constructed, coal-based power generation by BEDP will be an adequate project as the necessary means to develop bagasse power projects which can save 200,000 TOE energy imports. In addition, the use of coal in a Bagasse cum Coal project in the near future is an effective way to diversify energy sources (see Chapter 5.6).

However, after a modern coal-burning power plant is constructed, coal consumption by the Bagasse cum Coal power plant should be reviewed in response to the new circumstances in consideration to the low energy efficiency of the latter, 50% more energy consumption per kWh than the modern plant, and possible reduction of the impact on the environment by the coal burning through the mitigation process applied in the modern coal power plant.

In order to realize such a desirable transition from the Bagasse cum Coal power plant to the exclusive use of coal in a new large scale modern coal-burning plant, a comprehensive long term plan, which includes the coordination of the future coal power plant construction and the operation of the Bagasse cum Coal power projects in the coming years must be prepared. Also the agreement between future BEDP and CEB must be made with consideration of such long term prospects. It is also necessary that the procedures for coordination among CEB, the current and future BEDP and IPP, including coordination regarding the possible development of new energy and solid waste power generation projects, must be established as part of the long term power generation plan.

## (2) Standardization of the Bagasse Power Plant

As discussed in Chapter 5, the design of bagasse-burning power generation plant is closely integrated with the sugar manufacturing plant, and the arrangement of coal related facilities including ash treatment and waste water treatment can have wide variations, and the concept of stand-by equipment installation in the power plant may be different among parties.

On the other hand, the purchase price of electricity from the Bagasse cum Coal plant will be determined by avoided cost of CEB. In such case, the party who builds a very low cost plant with low reliability of electricity supply during a peak demand period can have very high profit compared with the party who spends a larger sum of money to improve quality of the plant.

In order to avoid such a situation the CEB must impose on the future BEDP applicant the requirements to conform to minimum design standards for their power generation facilities.

When such standards are established as the basis of plant design, the purchase price of power from difference BEDP projects can be standardized in a fair manner.

At the same time, time and effort by the MLGPU and CEB for the contracting BEDP projects could be reduced very much.

Note that the design standards must be prepared separately for the base load plant, middle

load plant and peak load plant. It is expected that in the near future, the private sector will be invited to bidding for IPP contracts. A design standard similar to that of the BEDP projects will be required to ensure the equitable basis of cost estimation for all the bidders. Otherwise, the evaluation of bid prices for the power supply will be very complicated.

### (3) Development of New Technology for Efficient Use of Bagasse as Fuel

Research projects on the improvement of the quality, sugar content and fiber content of sugar cane by genetic technology, the improvement of storage/transportation properties of bagasse by balling, and other research work, is under way in Mauritius and other sugar producing countries.

The development of technology which enables the continuous supply of bagasse to power generation throughout the year is strongly needed to improve the economy of any bagasse power project.

#### \* Expanding the cropping season. (Long-range future target)

If the cropping season of sugar cane is extended by genetic engineering from the current five months to 9-10 months in a year, it will be possible to realize a bagasse power project without coal use, and the project will be a very environment-friendly project using the really renewable indigenous energy source. The capital cost and operating cost of the project will be significantly reduced by eliminating coal and coal ash related costs.

#### \* Research and development of technology for bagasse storing.

It is observed that the technology conceived and tested in the past for storing bagasse and use of the stored bagasse during the off-cropping season proved to be unsuitable for large scale commercial operation.

The study team awared that “the Bio-Coal Technology”, which use bagasse as a supplemental component of a coal base fuel for domestic use, is being developed internationally as the mitigation of air pollution for coal burning in small boilers/stoves. (Reference Appendix 4-C)



It is considered that if a low cost combustible materials such as coal pitch/petroleum pitch has an excellent compounding effect on bagasse, when it is added as an compounding agent, the bagasse-pitch mixture may have good storage properties including the improvement of handling properties,

However, extensive technology development will be required to establish economic and environment friendly technology for use of such fuel on a commercial scale.

#### (4) Technology for integration of bagasse and solid waste power project

As described in Chapter 4.5, incineration of solid urban and industrial waste disposal will be a important project in Mauritius. It is expected that the burning of bagasse together with high calorie solid wastes will be an economic scheme for waste heat recovery power generation because waste power generation facilities include much the same equipment as those of bagasse power. It is recommended that technology required for bagasse use and that for solid waste power generation should be developed together.

#### (5) Development of a high-efficiency boiler for bagasse burning

The present bagasse cum coal power plant uses a very traditional stoker type boiler and the steam generation pressure is around 40-60 bar because the high-moisture, low-caloric value of bagasse make it difficult to use a more energy efficient system. The coal burning process during the off-cropping season of bagasse uses the same boiler to minimize investment, and the energy efficiency of coal remains around 22-23% (net). This low efficiency make it difficult to economically justify the burning of coal for power generation after a coal base modern energy efficient power plant comes on stream. However, if new technical innovation to improve energy efficiency of the Bagasse cum Coal power plant is realized, the future of such projects will be very bright.

For an example, the use of a fluidized bed combustor for low calorie solid waste burning or coal/bagasse gasification, which uses the technology to eliminate potassium migration problem, may have good potential to improve efficiency of bagasse energy use.

It is necessary that the MLGPU take leadership in urgent development of such important technology by obtaining the co-operation of the sugar industry and CEB.

### **1.2.3 Utilization of New Energy Sources**

Mauritius is a small island nation which has poor energy resources. 60% of the nation's energy is supplied by imported petroleum. Hydro-power and bagasse are the only available domestic energy resources.

Considering the issues related to the development of domestic energy resources, the needs for reducing dependency on imported petroleum and providing for the security of energy, the development of new energy, such as solar energy and wind power, are very important.

For the global environmental concerns, the development of new energy is indispensable for solving problems such as the earth greenhouse effect caused by CO<sub>2</sub> generated by fossil fuel combustion, acid rain and destruction of the ozone layer.

In Mauritius, the development of new energy was started in 1980 but presently, only solar thermal equipment for water heating, and wind power generation in Rodrigues are in practical use.

Considering the potential of new energy, Mauritius has rich sunshine and its location is ideal for solar energy utilization. With the presence of the southeastern trade winds Mauritius is ideally located for wind power generation. There is great potential in these energy resources.

On the other hand, the utilization of new energy in various countries is seen to concentrate on photovoltaic power generation, while wind power generation and waste power generation and the use of other new energy resources are still in the R&D stage.

Furthermore, demand for solar thermal water heaters is expected to increase. The economic performance of photovoltaic power generation is expected to improve as solar cell costs become substantially lower. Moreover, the basic research on the potential of

the usable winds was already conducted. Regarding waste power generation, although there is no experience with this in Mauritius, it should be positively promoted for the purposes of waste disposal and energy supply.

From these reasons, as in various other countries, the development of three types of new energy, namely solar energy (solar thermal utilization and photovoltaic power generation), wind power generation, and waste power generation, should be promoted. However, in view of the present meager use of new energy, action plans for new energy development promotion and the formulation and introduction of legal incentives by the government are indispensable. In particular the following plans are conceivable:

- 1) The establishment of a supply target for development of new energy in future;
- 2) The introduction of a compulsory system for the purchase, either by power companies or the government, of power generated by new energy sources (this system under purchase cost is higher than the avoided cost);
- 3) The provision of the government subsidy system for those introducing residential photovoltaic power generation systems;
- 4) The possible introduction of the so-called reverse power flow systems wherein photovoltaic power generators sell their generated power to power companies during the daytime, and buy power from power companies during the night time;
- 5) The introduction of tax credits and low interest loan systems for wind power generation developers;
- 6) The introduction of waste power generation systems under governmental leadership;
- 7) Public education and advertisement to promote new energy;

#### **1.2.4 Diversification of Energy Sources**

This aims at reducing dependency on petroleum products which have a 85% share in primary energy, and at improving protection against risks related to supply cut and price hike as may be caused by an international dispute. Realistic alternative fuels to be introduced to Mauritius in the near future are coal and Orimulsion as explained below.

To promote diversification, the government is required to build infrastructure such as

storage and distribution facilities and to provide incentives to make it possible for users to have access to available supporting technology, with special consideration to applicable environmental standards.

First of all, the government is obliged to establish a concrete program for promoting diversification including technical and financial support.

Widely adopted substitutes for petroleum fuel are coal, natural gas, nuclear and oilsand. Among those, natural gas and nuclear power are not relevant for Mauritius because of the small scale of energy demand and high initial investment required for facilities. In the future, however, it will be possible to utilize LNG if a cooperation program with neighboring countries can be established.

Coal reserves are huge and distributed widely all over the world, and supply security is expected to be very high. The major advantage of coal is its price and a future coal-fired power plant in this country will be located on the seacoast to receive coal directly from ocean-going ships. In connection with small industrial users located inland, a major concern in promotion of diversification is the establishment of an economical distribution system. In addition, small users require governmental support to comply with environmental regulations, including disposal of ash.

Oil sand is commercially available as Orimulsion which is water emulsified oil bitumen, produced in Venezuela. Orimulsion was developed to utilize natural bitumen as liquid fuel. The scale of recoverable reserves of natural bitumen in the Orinoco Belt is comparable to coal in South Africa and crude oil in Saudi Arabia. This fuel is outside OPEC production quotas due to its specification and is being utilized at commercial power plants in Japan, Europe and North America. According to the supplying company, the price of this fuel was set so as to be competitive against coal in general: however the price to Mauritius may be slightly more expensive than South African coal because of a longer distance of shipment and rather small demand. However, Orimulsion has such advantages as the ease in handling and transportation and less ash content. Therefore this fuel will be convenient for small industrial boilers.

### **1.2.5 Strategic Stockpiling**

The IEA requirement for strategic stockpiling by OECD members is equivalent to minimum 90 days of consumption. This figure includes the running stock and excludes the amount for imported petroleum reexportation. Generally, the running stock is 45 days and storage facilities of oil companies in Mauritius have 45-55 days storage capacities at present. The 90 days stock is based on the perceived need to control internal consumption according to the level of supply cut down.

CEB has changed its standard on storage capacity and has already increased storage capacity from 28 days to 90 days. Considering the fact that economic development in the country is dependent on foreign investment and international tourism, the security of stable energy supply is an essential requirement for further development. Accordingly, the 90 days storage, which is the same capacity as CEB already decided, will be the minimum requirement for both public and industrial sectors. This means an additional 45 days stock is required as strategic stockpiling. For electric power generation, IPP shall adopt the same standard as CEB for their fuel oil storage.

Laws to control internal supply smoothly in an emergency situation are required to support effective utilization of the stockpiling. This may need to cover such items as detailed procedure for control of demand according to the shortage of supply and expected duration of the shortage, when and how to release the emergency stock, and procedures to control electric power supply.

#### **(1) Strategic Stockpiling Facilities**

The petroleum products requiring strategic stockpiling are gasoline, diesel and heavy fuel oil. Bunker oil and jet fuel are excluded because of reexport. Kerosene consumption other than electric power generation is only 15% of airplane use, and diversion of airplane use will be possible to eliminate an additional storage. The supply sources of LPG are widely dispersed and less risk in supply cut-down is expected.

Costs relating to strategic stockpiling, such as investment cost for storage facilities and inventory cost of petroleum product, and maintenance cost, should be born by entire

population as a cost for national energy security. Considering that this storage is non-commercial use and needs a large investment, the government is required to provide sufficient financial measures.

There are two ways to build storage facilities.

- (a) The government builds the facilities independent of oil companies' normal operation.
- (b) The government requests oil companies to build and maintain the facilities with the 90-day capacity based on last year's sales quantity. Additional cost for expanded facilities and oil will be borne by the government and oil companies will be responsible to maintain stock of 45 days quantity.

(a) will be recommended from the viewpoint of possible efficient utilization of limited land and due to small domestic demand. (a) has the additional advantage of easy control of supply (where and how much) according to the government policy.

Based on the demand forecast, the following storage tanks are required to achieve the above mentioned strategic stockpiling capacity.

<u>Year</u>	<u>Gasoline</u>	<u>Diesel Oil</u>	<u>Fuel Oil</u>
2000	7000 kl x 3	7000 kl x 3	7000 kl x 2
2005	7000 kl x 1	7000 kl x 1	-----
2010	7000 kl x 1	-----	7000 kl x 1
2015	7000 kl x 1	-----	7000 kl x 1
2020	7000 kl x 1	7000 kl x 1	7000 kl x 1
2025	7000 kl x 1	7000 kl x 1	7000 kl x 3

The location for storage facilities will be an area allocated for new oil facilities in Mer Rouge of Port Louis port. This area is convenient for the following reasons.

- (a) Existing infrastructure can be utilized.
- (b) Adjoining oil companies' facilities saves construction cost (connections for receiving and releasing of oil, etc.)
- (c) Maintenance will be contracted to oil company to minimize cost.

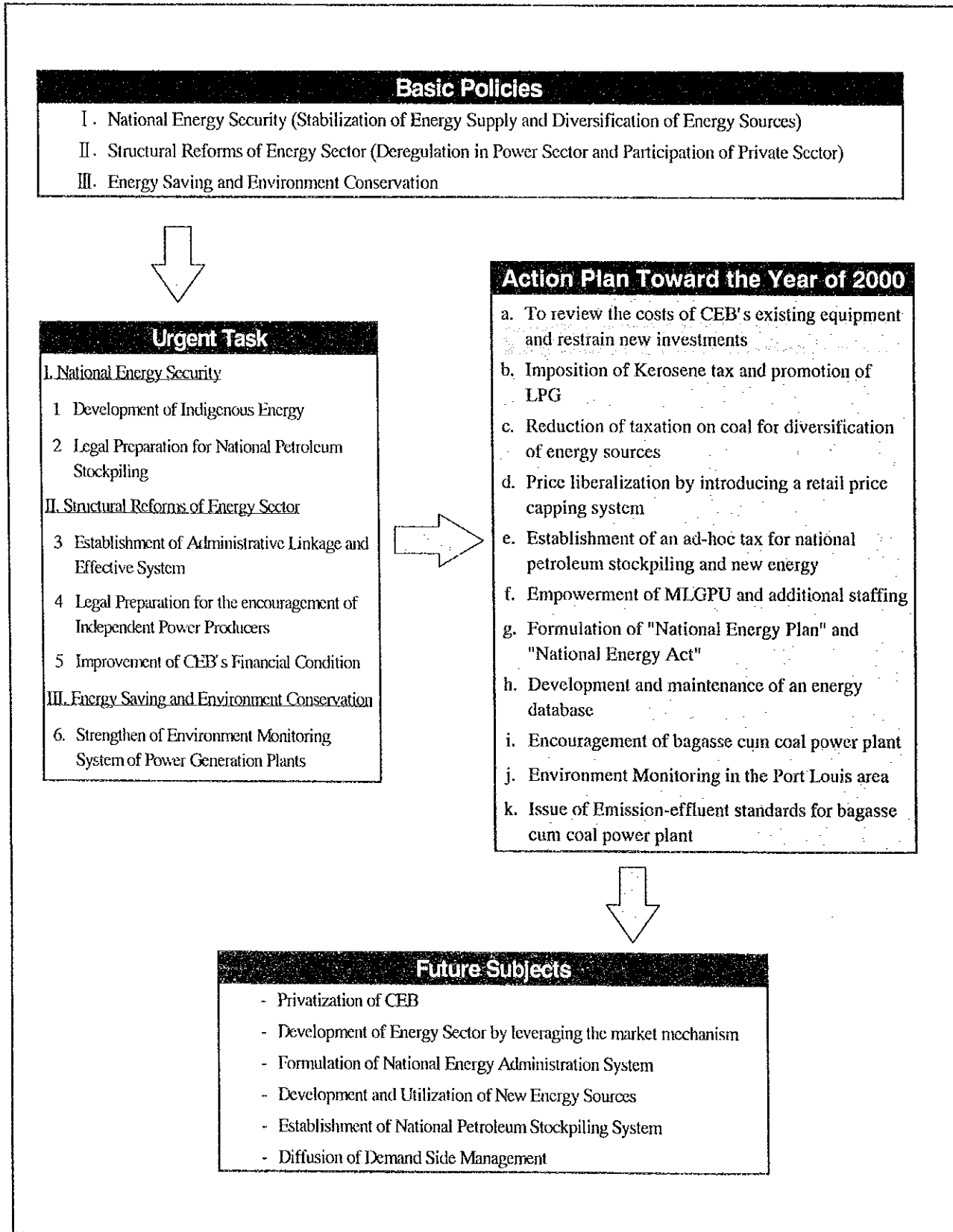
According to MMA, an additional area can be developed by reclamation to the west of the preset allocated area, to allow for future expansion. However, concentration of a large

quantity of oil at the entrance of the sole international port of Mauritius presents a major risk to the nation. To avoid it, future strategic stockpiling should preferably be built in the energy center in Mmahebourg area as proposed in Sec. 4.3 and 8.2.

(2) Maintenance of Storage Facilities

Even though the facilities are simple, adequate maintenance is the key to safety. In practice, the work should be contracted to oil companies who are doing the same activity. The work will include distribution of released oil to consumers through their facilities in an emergency situation.

**Table 1.1 SUMMARY OF ACTION PLAN FOR FURTHER ENERGY DEVELOPMENT**





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

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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 forecast 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 Indigenous 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.