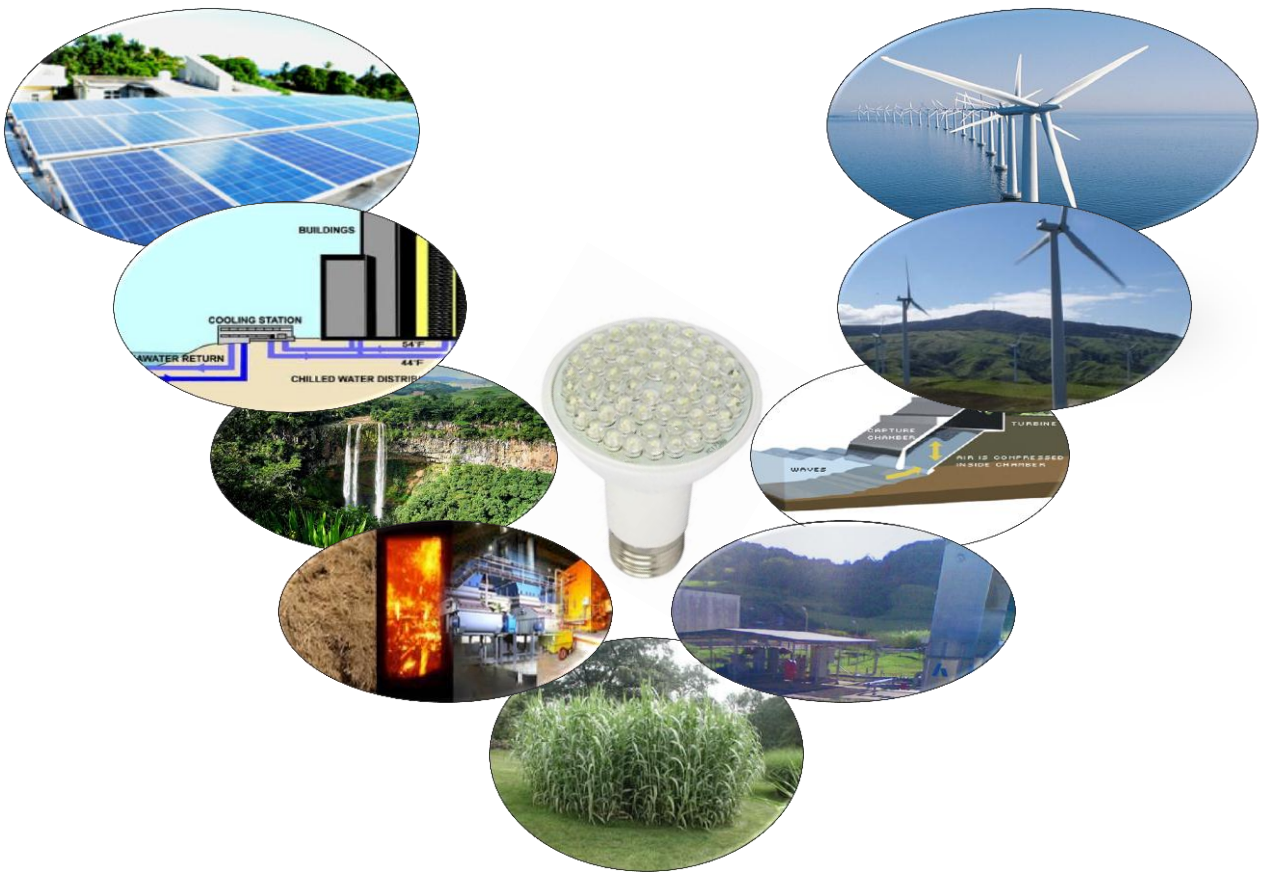
Report of the National Energy Commission

MAKING THE RIGHT CHOICE FOR A SUSTAINABLE ENERGY FUTURE:

THE EMERGENCE OF A "GREEN ECONOMY"



October 2013

"Nous ne pouvons pas élaborer des politiques, prendre des décisions en ignorant le défi du réchauffement climatique, la crise énergétique et la protection de l'environnement. Nous ne pouvons pas détruire les conditions mêmes de notre survie."

(Inauguration of Ferney Valley Nature Reserve, Extract from the Speech of Dr the Hon. NavinchandraRamgoolam, GCSK, FRCP, Prime Minister, Minister of Defence, Home Affairs and External Communications, Minister for Rodrigues, 2 August 2008)

DISCLAIMER

The National Energy Commission's (NEC) mandate is to review the national energy requirements, advise Government and other authorities concerned in the planning and execution of major projects in the energy sector to fully meet medium and long term needs, and to oversee the operation of the 'Maurice Ile Durable' (MID) Fund. This report has been prepared in good faith on the basis of information available at the date of publication. Every effort has been made by the NEC to assure the accuracy and reliability of the data and information contained in this report. However the NEC makes no representation, warranty or guarantee in connection with this report and hereby expressly disclaims any liability or responsibility for loss, damage, cost or expense incurred or arising by reason of any person using or relying on information in this report.

ACKNOWLEDGEMENTS

The National Energy Commission (NEC) was set up following a decision by Dr the Hon. NavinchandraRamgoolam, GCSK, FRCP, Prime Minister, Minister of Defence, Home Affairs and External Communications, Minister for Rodrigues, in the wake of the civil society efforts, notably the action of citizen Jeff Lingaya, for a sustainable energy future.

The NEC wishes to express its deep appreciation for the enthusiasm and willingness of all the organisations, experts and members of the public who have come forward to submit their views on the options available for the country's energy future. This has guided the preparation of the NEC's report.

The NEC also thanks Dr the Hon. Ahmed Rashid Beebeejaun, GCSK, FRCP, Deputy Prime Minister, Minister of Energy and Public Utilities for the support provided to the Commission.

The Secretariat is also commended for its assistance throughout the process.

GLOSSARY

AFD	Agence Française de Développement
AMM	Association of Mauritian Manufacturers
BEDP	Bagasse Energy Development Programme
BREDP	Biomass and Renewable Energy Development Programme
CEB	Central Electricity Board
CEL	Consolidated Energy Limited
CFL	Compact Fluorescent Lamps
CNG	Compressed natural gas
CO_2	Carbon Dioxide
DSM	Demand-Side Management
EE	Energy Efficiency
EEA	European Environmental Agency
EEMO	Energy Efficiency Management Office
GHG	Greenhouse Gas
GW	Gigawatt
GWh	Gigawatt hour
HFO	Heavy Fuel Oil
HSHFO	High-Sulphur Heavy Fuel Oil
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IEP	Integrated Electricity Plan
IPPs	Independent Power Producers
IRENA	International Renewable Energy Agency
ISED	Indicators for Sustainable Energy Development
JEC	Joint Economic Council
kW	Kilowatt
kWh	Kilowatt hour

LDC	Load Duration Curve
LCOE	Levellised Cost of Electricity
LNG	Liquefied Natural Gas
LSHFO	Low-Sulphur Heavy Fuel Oil
LTES	Long-Term Energy Strategy 2009-2025
MEA	Multi-Environmental Agreements
MEPU	Ministry of Energy and Public Utilities
MRE	Marine Renewable Energy
MID	Maurice Ile Durable
MID PSAP	Maurice Ile Durable Policy, Strategy and Action Plan
MSW	Municipal Solid Waste
MW	Megawatt
MWh	Megawatt hour
NAMA	Nationally Appropriate Mitigation Action *(against climate change)*
NaS	Sodium-Sulphur
NEC	National Energy Commission
NOX	Nitrogen Oxides
NREL	National Renewable Energy Laboratory, Department of Energy of the United States of America
OFSED	Office of Sustainable Energy Development
PMO	Prime Minister's Office
PPA	Power Purchase Agreement
PV	Photovoltaic
RE	Renewable Energy
R&D	Research and Development
RFP	Request for Proposal
SEIDF	Sustainable Energy Innovation and Development Fund
SIMPACTS	Simplified Approach for Estimating Impacts of Electricity Generation

SME	Small and Medium Scale Enterprises
SO_2	Sulphur Dioxide
SWH	Solar-Water Heater
SWAC	Sea-Water Air-Conditioning
TC	Technical Committee
UN-DESA	United Nations Department of Economic and Social Affairs
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
URA	Utility Regulatory Authority
USD	United States of America Dollars
WASP	Wien Automatic System Planning Package
WTE	Waste To Energy

EXECUTIVE SUMMARY

Making the Right Choice for a Sustainable Energy Future:

The emergence of a "Green Economy".

Cabinet, in January 2013, agreed to the setting up of a National Energy Commission (NEC) under the chairmanship of Mr D.D. Manraj and comprising members from Government and its agencies, the private sector, academia and representatives of the civil society.

The mandate assigned to the NEC by Government was to review the national energy requirements; advise Government and other authorities concerned in the planning and execution of major projects in the energy sector to fully meet medium and long term needs; and oversee the operation of the 'Maurice Ile Durable' (MID) Fund.

At the very start, the NEC decided to **focus on the electricity component** of the energy sector and leave the transport part for a subsequent study.Also, the third task assigned to the NEC, namely "oversee the operation of the 'Maurice Ile Durable' (MID) Fund", in the field of energy, will be dealt with in the next report of the NEC.This will also include a special focus on Rodrigues and the Outer Islands.

The NEC set out to fulfil its mandate in an **inclusive and participatory manner** and in this regard, adopted a twin-approach in its interaction with stakeholders and the public, namely, through hearing of parties having expressed their intent to do so and the rigorous analysis of submissions. As a consequence, two sub-committees were set up to facilitate and expedite the work of the Commission.

In this endeavour, the NEC had difficulties obtaining data from certain quarters and had to devise ways and means, obviously more time-consuming, to obtain information. Nonetheless, the willingness of stakeholders and the public to provide as much input as possible, research work undertaken and availability of documents from the public domain enabled the NEC to progress in its tasks.

The NEC first set itself to examine the Integrated Electricity Plan (IEP) 2013-2022 prepared by the Central Electricity Board (CEB). After an in-depth analysis thereof, the NEC considered that, notwithstanding the likely significant work undertaken by the CEB to prepare the IEP, this document **could not fullyadhere to the MID Policy, Strategy and Action Plan which was only approved in June 2013, in particular the 35% renewable energy (RE) target in 2025.**

There is a variety of tools for energy system planning that can be sourced from various international bodies. The CEB cites the WASP tool of the International Atomic Energy Agency (IAEA). The IAEA is one source of expertise, but there are many others such as the International Energy Agency (IEA) andother United Nations bodies. The IAEA itself offers several analytical tools that support energy analysis and planning in Member States. For instance, the Indicators for Sustainable Energy Development (ISED) and the Simplified Approach for Estimating Impacts of Electricity Generation (SIMPACTS) are two IAEA tools designed to ensure that energy planning is aligned with sustainable development.

As required by its mandate, the NEC examined the short to medium term supply/demand situation, i.e. for years 2014 to 2016. On a number of issues, the NEC could not agree with the assumptions used in the IEP document. Additionally, the NEC has focused on demand reduction which has the capability to ease off the pressure on supply sources.

The adjustments made by the NEC show a different picture from that of the IEP. Taking into consideration the possible forthcoming commissioning of 4x15 MW medium-speed diesel engines and the decommissioning of some old engines, the NEC considers that this net addition coupled with the timely implementation of the **measures it recommends would significantly reduce the risk of any power deficit between 2014 and 2016**. The long term perspective should, according to the NEC, scrupulously follow the contours of the MID policy.

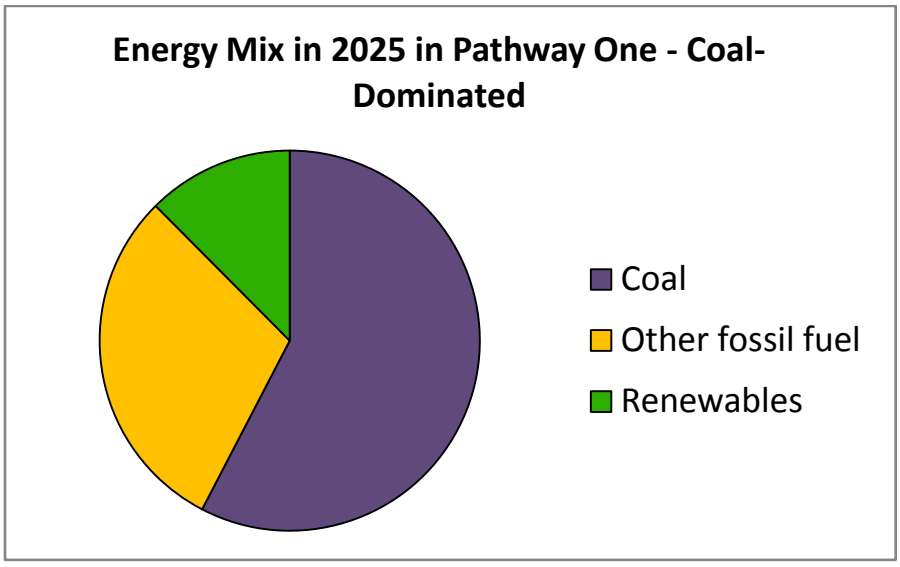
The NEC undertook a number of comparative analyses to assess two Energy Pathways. The First Pathway (**Pathway One**) is essentially **coal-dominant**. It factors in the IEP proposals, the 4x15 MW diesel plants and additional demand from 2022 to 2025. The Second Pathway (**Pathway Two**) makes increased use of **renewable sources** of energy, and integrates **Energy Efficiency/Demand Side Management**.

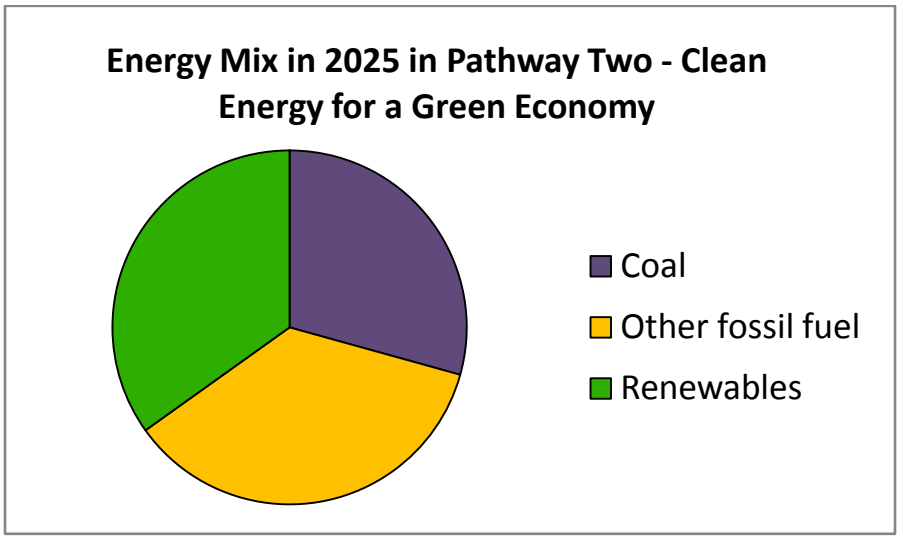
The feasibility of the two Pathways was studied using a multi-criteria analysis. Seven sets of criteria were listed, namely: Economic/financial, Energy security, Environmental, Social, Health, Water usage and Land issues. **Pathway Two** stands out clearly in respect **of lowest financial/economic costs**, coal usage and additional CO_2 emissions.

Pathway One which has a much higher percentage of fossil fuels, is more liable to cost increases resulting from escalating commodity prices and the Rupees/USD exchange rate. The higher percentage of local resources significantly improves **the energy security** in case of major supply disruptions under Pathway Two. Coal ash production and disposal are linked to the quantum of coal used; Pathway Two with the **lowest coal usage** is the best as this means lesser ash landfills and ash ponds, and thus less property value depreciation and inconveniences to communities living in the vicinity.

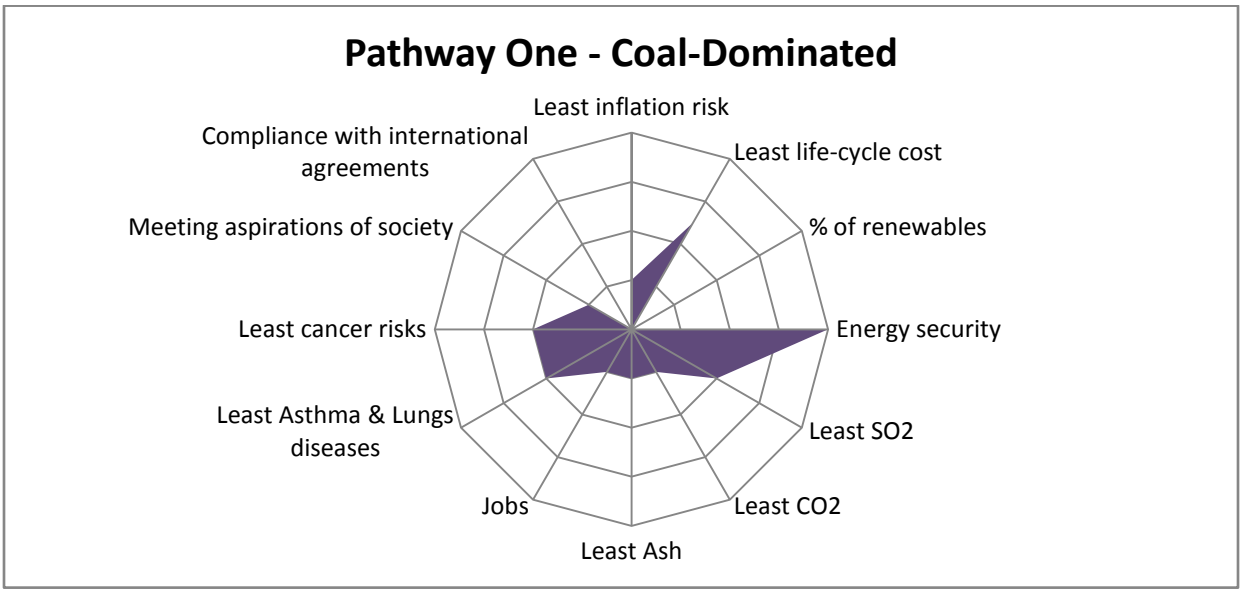
Employment opportunities, in Pathway One, would concern only the power plants, whereas in Pathway Two, cane/biomass and solar/wind activities would offer more job opportunities, especially at local and SME level. The promotion of local skills would be enhanced. Furthermore, the greater **fulfilment of Energy Efficiency/ Demand-Side Management** programmes in Pathway Two will contribute to job creation and the development of skills. Employment multiplier effects thus play in favour of Pathway Two.

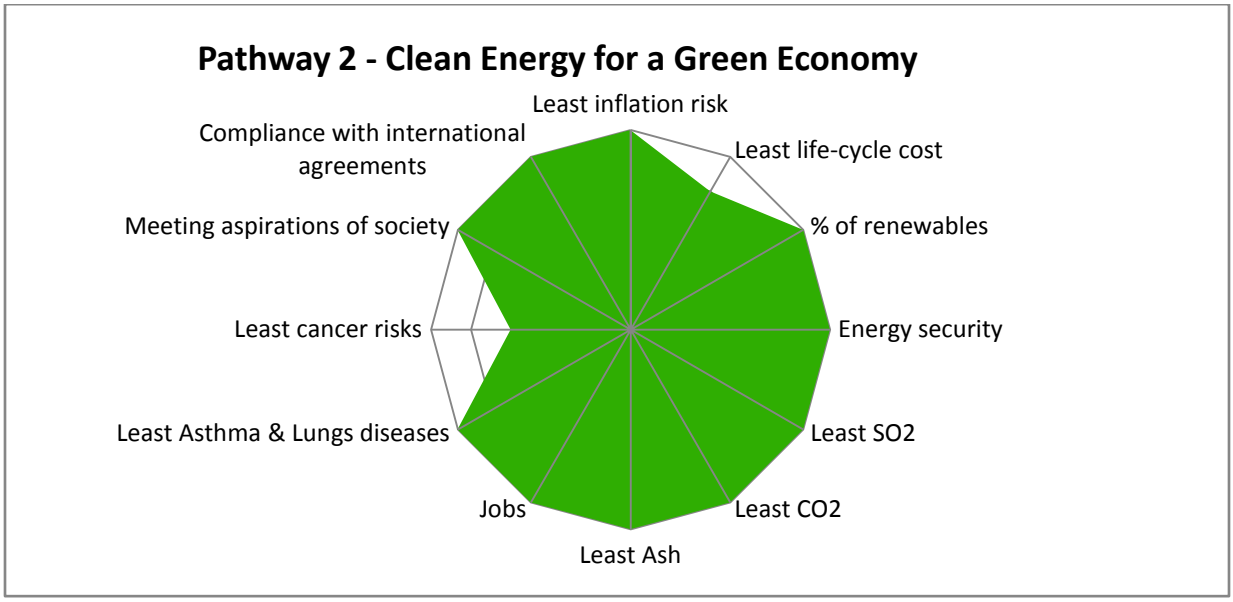
Pathway Two is supported by new pricing structures for **bio-energy as it would displace fossil fuels**and by the **increase of the price of bagasse for small and medium planters**through consultations between the concerned parties.This Pathway is **relevant for the sustainable development of the whole Republic of Mauritius**, including Rodrigues, Agalega and the Outer Islands whilst Pathway One is limited to the case of Mauritius by its very dependency on coal.





The **MID objectives are best served by Pathway Two**. Pathway One uses **six** times more coal, emits **four** times more additional CO_2 and **eight** times more SO_2 than Pathway Two. Additionally, Pathway One in terms of life cycle costs is some **40 % more expensive** than Pathway Two. Regarding the MID target of 35% renewables in total electricity export to the grid in 2025, Pathway One brings the current level of about 20% renewables to 12.5%, whereas **Pathway Two attains the 35% target.** Furthermore, over and above cost, environmental and health aspects, Pathway Two enables the country to fully comply with its **commitments under Multi-Environmental Agreements (MEAs)**.





Pathway Two through its numerous benefitsis expected to lay the foundations of a '**Green Economy'**which has as main features sustainability, inclusiveness and democratisation.In addition the **'Green Economy'** will enhance the position of Mauritius as a regional player in this emerging sector, and will also intertwine with the current 'Ocean Economy' which the Government is embarking upon. Both the **'Green Economy'** and the 'Ocean Economy'complement each other towards a prosperous sustainable future for the country as land-based power requirements symbiotically embrace clean oceanic developments, giving a new boost to the democratisation of the economy.

In the light of the above and given that Pathway Two is also a dynamic process which can accommodate proposed **national developments in industrial, commercial, mass transport, waste management, ocean economy and other sectors**, there is a **need to update the IEP**. The charting out process of the new IEP, including economic modelling, should be based on international best practices taking into account the three scenarios:

a) High Growth Scenario;

b) Base case Scenario; and

c) Low Growth Scenario.

The above exercise will thus lead to a new power forecast for the period of 2014 – 2025. Based on these new findings and the recommendations contained in this report, an updated IEP for the Republic of Mauritius will emerge defining the sustainable energy mix, together with a National Electricity Supply and Procurement Plan (NESPP) forperiod 2014 -2025.

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SUMMARY OF NEC RECOMMENDATIONS

- **RECOMMENDATIONS 1 TO 8: AVOIDING ANY POWER DEFICIT**
- **RECOMMENDATIONS 9 TO 21: FOSTERING A SUSTAINABLE ENERGY FUTURE: MOVING TOWARDS A "GREEN ECONOMY"**

NEC 1 URGENT ACTION: Accelerate the following immediate supply options

1.1. Undertake a consultative process to **assess further optimisation of the maintenance schedule** with a view to minimising maintenance in the months of February and Marchparticularly, to be completed by end 2013 (MEPU, CEB, IPPs).

1.2. Initiate discussions to optimise power generationof IPPs,**for a gradual transition to and maximisationof biomass,with participation of small planters** (MEPU, CEB, IPPs).

1.3. Accelerate the implementation of Renewable Energy (RE) projects(60MW) already in the pipeline and the Sea-Water Air-Conditioning (SWAC) under the Deep Ocean Water Application project (PMO, MEPU, CEB).

1.4. Commission medium-speed diesel engines (2x15 MW in 2015 and 2x15 MW in 2016), that will use low-sulphur HFO and can later be used with natural gas or biodiesel,**to reinforce RE backups and to be viewed as anticipated investment to cater for future semi-peak/peak demand**(MEPU, CEB).

1.5. Commission by early 2014 an engineer's report on the operating capacity of the whole power system of Mauritius (CEB and IPP plants)(MEPU,CEB).

1.6. Amend legislation to allow small/medium-scale green electricity producers to sell to their in-house customers by end of 2013 (MEPU).

NEC 2 URGENT ACTION: Implement the following Energy Efficiency and Demand-Side Management (EE/DSM) projects for the next 3 years with a potential cumulative saving of at least 30 MW at peak hours(MEPU, EEMO, Private sector, CEB):-

2.1 **New low-energy lighting project (CFL)**

2.2 **Replacement of old refrigerators project**

2.3 **Time-of-use (ToU) tariff in industries project**

2.4 **Solar-water heater (SWH) project**

2.5 **Air-conditioning peak power demand reduction project**

2.6 **Variable speed drives in industry**

2.7 **Street-lighting project**

2.8 **Sensitization on peak demand reduction**

NEC 3 Launch a National Energy Efficiency Action Plan for the Republic of Mauritius and execute Demand-Side Management, with adequate staffing and resources provided to the Energy Efficiency Management Office (EEMO) by December 2013 (MEPU, EEMO, Private sector, CEB).

NEC 4 Set up unloading agreements and special interruptible rates.

NEC 5 **Link concessionary electricity tariffs to industry with Energy Efficiency targets to be determined**.

NEC 6 **Urgently review environmental norms and recommendations for the establishment of norms for the Republic of Mauritius applicable to electricity power plants (emissions and ash disposal).**

NEC 7 **Complete as soon as possible the feasibility study being undertaken on Liquefied Natural Gas (LNG) and conduct another study on Compressed Natural Gas (CNG).**

NEC 8 **Accelerate the dissemination of solar power plants (photovoltaic (PV) or other technologies)in the Republic of Mauritius** through the following by 2014:

8.1 Conduct small scale PV electricity generation tests in all micro-climate regions of the Republic of Mauritius, so as to assess with precision the total PV potential in the country.

8.2 Launch a new Request for Proposal (RFP) for a series of 2-5 MW PV utility plants, with battery, with a strong focus on small planter cooperatives, Small and Medium Enterprises (SMEs) and citizens' cooperatives. To also include a strong focus on rooftop and parking installations.

8.3 Allow industries, hotels, office buildings and commercial malls to set up their own 500 KW – 2 MW plants, with battery, for their own use and for their tenants. Include also a strong focus on rooftop and parking installations.

8.4 Bring public buildings to generate a given level of their electricity needs from RE, with battery.

8.5 Allow home-owners to install PV plants on their homes.

8.6 Amend legislation and regulations as needed for implementation of the above.

NEC 9 **The NEC has identified 2 possible future energy pathways for the Republic of Mauritius. On the basis of economic, environmental and social criteria, the NEC is recommending Pathway Two,** which comprises a combination of bagasse/biomass development for coal substitution, with possible natural gas/biodiesel development, along with the integration of solar, wind and other RE, with electricity storage. Energy Efficiency and Demand Side Management (EE/DSM) are vital components of Pathway Two. The Pathway will lead to **the emergence of a new economic sector: the "Clean Energy" sector, and will lay the foundations of a "Green Economy".** In-depth studies, including the development of master plans for Energy Efficiency/ Demand-Side Management and Renewable Energy, need to be conducted to ascertain the exact

additional power capacity needed under the MID paradigm. **The energy future of Mauritius is to be worked out with precision, in line with the MID Policy and Energy Pathway Two, through appropriate modelling exercises and detailed feasibility studies.**

NEC 10 Operationalise the Utility Regulatory Authority (URA) before the end of 2013 (MEPU).

NEC 11 Set up an Office of Sustainable Energy Development (OFSED) by mid-2014, with members drawn from all key stakeholders, including civil society to, *inter alia*:

a) advise in the formulation of policy and strategies to achieve **sustainability** in the energy sector in line with the MIDPolicy;

b) promote the effective implementation of the renewable energy programmes;

c) ensure that the interests of consumers, public health, the environment and future generations are safeguarded in the field of energy; and

d) assess and advise on the **sustainability** of project proposals in the energy sector.

NEC 12 Restructure the MID Fund so as to create a Sustainable Energy Innovation and Development Fund (SEIDF), **and devise for its funding a new mechanism to charge a levy on coal used for electricity generation that:**

a) is applied strictly according to the "polluter pays principle";

b) is not passed on to the consumers; and,

c) is used strictly to fund RE and EE/DSM projects to facilitate the transition to a sustainable energy future.

NEC 13 Develop a Long-Term Energy Efficiency/ Demand-Side Management Master Plan for the Republic of Mauritius, complementary with the Renewable Energy Master Plan.

NEC 14 Develop a Renewable Energy Master Plan for the Republic of Mauritius by 2014 and initiate the large-scale grid integration of variable RE through the following:

14.1. **Define a methodology for the management of large scale grid integration of variable RE, with focus on Smart Grid deployment**.

14.2. **Define the precise capacity credit to be assigned to variable RE**.

14.3. **Based on international best practices, use the existing hydropower, medium-speed diesel engines and gas turbines as backup capacity for variable RE, and**

give variable RE plants first priority in generation scheduling and dispatching under normal power system operating conditions.

NEC 15 **As part of the RE Master Plan, implement large-scale electricity storage for variable RE to become firm power.**

NEC 16 **Set up a Biomass and Renewable Energy Development Programme (BREDP) to devise a package of measures for the promotion of bagasse/biomass, biogas, solar and wind, by mid-2014.** The task of setting up the BREDP could be left to the proposed OFSED.

NEC 17 **Enable CEB to build and operate RE plants**, so as not to limit RE projects only to private promoters, and **define a target share for CEB in MID's objective of 35% of electricity generated from RE**.

NEC 18 **Encourage small planters, SMEs and cooperatives to transition into renewable energy production (e.g. solar parks and wind farms), with the possibility of VAT refund on equipmentto be consideredas part of a full support package**, **so as to enable the democratisation of private energy production**, **by mid-2014**.

NEC 19 **Review the price of bagasse for small and medium planters so that it encourages bagasse production**, through consultations between the concerned parties.

NEC 20 **Devise a price mechanism for bio-energy (biogas, biomass, biodiesel) that will encourage the development of bio-energy**.

NEC 21 **The IEP needs to be updated by early 2014 to implement Pathway 2**, **in line with all the above, in an inclusive, participatory manner, and by using planning tools and methods that align energy planning with sustainable development**.Concurrently steps could be taken:

21.1. To launch RFPs for new power plants

21.2. For new power plants to be in operation by 2015/2016

21.3 For the new Renewable Energy Procurement Framework to be implemented by 2014

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PART ONE

ANALYSIS, FINDINGS AND RECOMMENDATIONS

INTRODUCTION

The first Technical Committee (TC1) was set up by the NEC with the following terms of reference: "**tosubmit a report on the demand situation and supply options of electricity related to the short and medium term, and the urgency of the CT Power project."**

At the 11th Meeting of the NEC, the above terms of reference were further clarified to highlight that:

(i) the NEC would, in the first instance, focus on the current and short-to-medium term situation in view of assessing POWER demand and supply options including the proposal of solutions based on economic feasibility whilst integrating environmental and social considerations; and

(ii) the NEC would, in the second instance, elaborate medium-to-long term recommendations, including financial engineering aspects related to the use of the MID Fund as well as that of other identified sources. NON-POWER sector would also be considered.

The current report addresses the objective set out in sub-paragraph (i) above. It has been finalised after more than 20 technical meetings. Inputs were also sought from various stakeholders and experts. Proposals from the public have been duly considered in the final elaboration of the recommendations. Feedback from NEC's plenary meetings has also been included.

Reference in the report is made to the Republic of Mauritius as a whole unless otherwise stated, or warranted for by the obvious context of the related analysis.

It is to be noted **with concern** that, in spite of several reminders from the NEC, theCEB did not provide information and clarifications requested by the NEC. The NEC has worked from data available in CEB's IEP as well as the CEB's presentation to NEC and from alternative reliable sources.

1. POLICY AND REGULATORY FRAMEWORK: A SITUATIONAL ANALYSIS

The policy, institutional and regulatory framework for the power sector is regulated by legislation dating back to 1939 and 1963:

- Electricity Act 1939 (EA)
- Central Electricity Board Act 1963 (CEB Act)

Under the CEB Act, the Central Electricity Board (CEB) has been given the mandate to **"prepare and carry out development schemes with the general object of promoting, coordinating and improving the generation, transmission, distribution and sale of electricity… in Mauritius"**.

The Utility Regulatory Authority (URA) Act was passed in 2004 and the Utility Regulatory (Amendment) Act in 2008, and both Acts were proclaimed in 2008. However the URA has not been set up and is not yet operational. The Electricity Act of 2005 has been passed but not yet proclaimed. The Long-Term Energy Strategy (2009-2025) of the Government was approved in 2009. An Action Plan was finalised in 2011. Among the targets set is the objective of achieving a 35% share of Renewable Energy in electricity generation by 2025.

The Energy Efficiency Act of 2011 which sets up the Energy Efficiency Management Office (EEMO) has yet to establish guidelines regarding demand-side management of electricity.

The Public Procurement Act 2006 sets out in the Schedule the prescribed amount for the type of contract for the CEB. The Public Procurement Regulations 2008 as amended, in the first schedule sets out that the CEB is an exempt organisation in so far as *the 'goods purchased for resale, including services incidental to the purchase or distribution of such goods.'* are concerned.

The 'Maurice Ile Durable' Policy, Strategy and Action Plan (MID PSAP) approved by Government in June 2013 reconfirms the target of 35% share of Renewable Energy entering the grid by 2025 and sets a target of 10% reduction in energy consumption in non-residential and public sector buildings by 2020. The MID Action Plan caters for a Compliance, with accompanying Monitoring & Evaluation Mechanism, which is being developed.

According to representations received, some of the drawbacks highlighted may be set out as follows:-

a) inadequate national parameters guiding the preparation of an Integrated Electricity Plan (IEP);
b) lack of a transparent investment environment;
c) sub-optimisation of renewable energy resources for electricity at competitive prices; and
d) lack of a framework to foster energy efficiency and demand-side management.

The whole question of guiding principles related to the preparation of an "Integrated Electricity Plan" is fully explained in this section and in **Appendix 2** of this report.

In this context, the CEB:

(i) acting under the CEB Act of 1963; and

(ii) being exempted to follow the provisions of the Public Procurement Act of 2006 in relation to the *'goods purchased for resale, including services incidental to the purchase or distribution of such goods'* as per the Public Procurement Regulations 2008 as amended by G.N. 68 of 2009,

has produced an Integrated Electricity Plan(IEP) that may not have taken fully into account the following key parameters:-

- the target of producing 35 % of electricity from renewable energy;
- energy efficiency and demand-side management potential; and
- the consultative process with stakeholders which an IEP warrants;

The policy, institutional and regulatory issues have to be fully addressed.

2. REVIEW OF THE CEB INTEGRATED ELECTRICITY PLAN2013-2022

2.1 Best Practices for the Development of an Electricity Plan

The figure below shows the various elements involved in integrated electricity planning as well as the major linkages amongst the various steps (*Source: USAID-Best Practices Guide: Integrated Resource Planning for Electricity*).

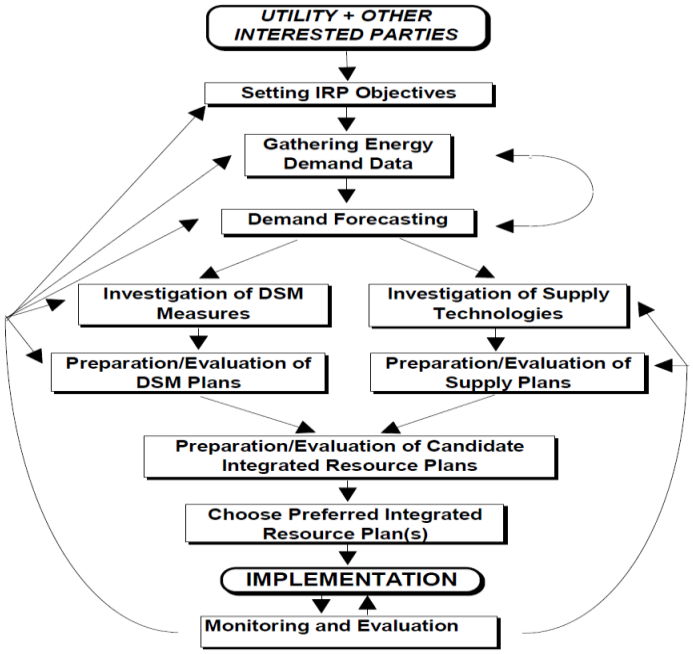


Figure 1 - The Integrated Electricity Planning Process

The NEC has researched best practices regarding the planning process for an IEP and has found the USAID's *Best Practices Guide: Integrated Resource Planning for Electricity* to be the most valid reference document. The NEC recommends the main requirements put forward by this guide. See the excerpt in Box1 hereafter, with full details in Appendix 2.

Integrated Electricity Planning is a process of planning that satisfies multiple objectives for resource use. Broad objectives can include:

- Conform to national development objectives
- Ensure that all households and businesses have access to electricity services
- Maintain reliability of supply
- Minimize the short term or long term economic cost of delivering electricity services
- Minimize the environmental impacts of electricity supply and use
- Enhance energy security by minimizing the use of external resources
- Use of local resources
- Provide local economic benefits
- Minimize foreign exchange costs
- Diversify supply
- Increase efficiency
- Provide local employment
- Retain flexibility Developing plans that are flexible enough to be modified when costs, political situations, economic outlook, or other conditions change

The objectives set by the utility guide the planning. Such objectives as the ones listed above may conflict with one another to varying degrees. Therefore, preparing, deciding upon and implementing a preferred plan requires both a series of objective *analyses* and the use of *processes* by which the values and judgments of stakeholders are applied in developing the plan. C*riteria* by which the achievement of each objective may be measured must also be established.

Integrated Electricity Planning approaches to *vertically integrated* power systems should govern the selection of power plants as well as investment in other aspects of electricity supply and in demand-side efficiency measures as well.

Integrated Electricity Planning is built on principles of comprehensive and holistic analysis. An IEP should consider a full range of feasible supply-side and demand-side options and assesses them against a common set of planning objectives and criteria. Integrated Electricity Planning is also a transparent and participatory planning process. It contrasts with traditional planning that is typically top-down, with public consultation occurring only as a last step, when plans are virtually complete. Integrated Electricity Planning can make planning more open to relevant governmental agencies, consumer groups, and others, thus considering the needs and ideas of all parties with a stake in the future of the electric system.

Investigation of Demand-Side Options:IEPs are a mix of supply-side and demand-side resources. While the supply-side resources generally dominate, DSM resources can significantly reduce required supply-side additions over a planning period. Demand-side management, or DSM, refers to programs or projects undertaken to manage the demand for electricity: reducing electric energy use, changing the timing of electricity use (and thereby the profile of peak power demand), or both. By reducing the demand for electric energy and power, DSM options can reduce the use of existing electric supply facilities (or, equivalently, serve more users with given facilities), and defer the addition of new capacity. Review of DSM options begins with identification of all applicable options and their cost and performance characteristics. The more promising DSM options are selected for further study and incorporation in draft DSM programs and plans. It is necessary to collect data on DSM options so that they can be compared with each other and with supply-side options.

Box 1 - Planning process for an Integrated Electricity Plan

Source: USAID-Best Practices Guide: Integrated Resource Planning for Electricity

2.2 Energy System Planning

There is a variety of tools for energy system planning available from international bodies. The CEB cites the WASP tool of the International Atomic Energy Agency (IAEA). However, the IAEA is one source of expertise, among many others such as the International Energy Agency (IEA) and other United Nations bodies. The IAEA itself offers several analytical tools that support energy analysis and planning in Member States: MAED, MESSAGE, WASP, FINPLAN, SIMPACTS and ISED (see Box 2 hereafter for selected details).

The IAEA released in August 2009 a very useful compendium, entitled "*IAEA Tools and Methodologies for Energy System Planning and Nuclear Energy System Assessments*". **The IAEA links closely energy planning and sustainable development** (highlights added):

> *Energy planning aims at ensuring that decisions on energy demand and supply infrastructures **involve all stakeholders**, consider all possible energy supply and demand options, and are consistent with overall goals for **national sustainable development**. The concept of sustainable development encompasses **three interdependent and mutually reinforcing pillars**: **social** development, **economic** development and **environmental** protection, linked by effective government institutions.*

Wien Automatic System Planning Package (WASP)– cited by the CEB

WASP is the IAEA's long-standing model for analysing expansion plans for electricity generation. Initially developed in the 1970s, it has been enhanced and upgraded over time to match emerging needs and allow analysis of contemporary issues such as environmental regulations and market restructuring, among others.

WASP is an effective tool for power planning in developing countries. It permits the user to find an optimal expansion plan for power generation over a long period of time and within the constraints identified by local analysts. This may include limited fuel availability, emission restrictions, system reliability requirements, etc. Each possible sequence of power plants that could be added to an energy system, for example an expansion plan or policy, and which meets selected constraints, is evaluated by a cost function of capital investment costs, fuel costs, operation and maintenance costs, fuel inventory costs, salvage value of investments and cost of energy demand not served.

WASP requires that the technical, economic and environmental characteristics of all existing power plants in a country's electricity generation system be defined. These characteristics include plant capacities, minimum and maximum operating levels, heat rates, maintenance requirements, outage rates, fuel and operation costs, emission rates, etc. For a given yearly future demand for electricity, the model explores all possible sequences of capacity additions that will match this demand, and at the same time overcome all constraints, for example a certain level of system reliability, availability of certain fuels, build-up of various technologies, or environmental emissions.

Indicators for Sustainable Energy Development (ISED)

The ISED framework provides a flexible tool for analysts and decision makers to better understand their national energy situations and trends, and the impacts of policies and policy changes on the energy system. The indicators reflect the interaction of energy with the economic, social and environmental aspects of sustainable development over time. The ISED can also be used to monitor progress of policies and strategies for sustainable energy development.

The IAEA developed the framework for ISED in cooperation with the International Energy Agency (IEA), the European Environmental Agency (EEA), the European Commission's EUROSTAT and the United Nations Department of Economic and Social Affairs (UN-DESA) to:

- *Complement the efforts of the UN Commission on Sustainable Development (CSD) on Indicators for Sustainable Development (ISD), by providing a higher resolution to energy issues with a consistent set of energy indicators, and*

- *Assist Member States in capacity building necessary for elaborating sustainable energy strategies.*

Each of the indicators is relevant to the economic, social, environmental and institutional dimensions of sustainable development.Indicators in the *social dimension* measure the impact that available energy services may have on social well-being. Social ISED describe issues related to accessibility, affordability and disparity in energy supply and demand. Indicators in the *economic dimension* measure the impact of energy supply and demand and the quality of energy services on the progress in economic development. Economic ISED include energy use, production and supply, energy supply efficiency and end-use energy intensity, energy pricing, taxation and subsidies, energy security, and energy diversity.

Simplified Approach for Estimating Impacts of Electricity Generation (SIMPACTS)

SIMPACTS estimates and quantifies the health and environmental damage costs of different electricity generation technologies. It consists of separate modules for estimating the impacts on human health, agricultural crops and buildings resulting from routine atmospheric emissions of pollutants from energy facilities. It can be used for comparative analysis of fossil, nuclear and renewable electricity generation, siting of new power plants or cost effectiveness of environmental mitigation policies. **It estimates physical damages and external costs.** A decision aiding module permits comparison of the relative advantages of different technologies. **The most significant aspect of SIMPACTS is its simplicity — it is designed for use on a PC with a minimum of input data.**

For airborne pollution, whether from fossil or nuclear plants, the model follows **the impact pathway approach**. The emission source is characterized, and an inventory of airborne releases is prepared. The changes in ambient concentrations of various pollutants are estimated using atmospheric dispersion and deposition models. Then, exposure response functions are used to relate the change in pollutant concentration to a physical impact on the relevant receptors.

The model allows a user to make a **range of external cost estimates ranging from crude to accurate, depending on available data.** An approximate estimate can be obtained with input on average population, plant characteristics and emissions. Given the high uncertainties involved in any estimation of external costs, SIMPACTS produces results well within the range of more complex models.The key stages for **these pathways** are: releases, transport, contamination, human exposure and health effects.

Box 2 – Some energy planning tools and methodologies from the IAEA

Source: IAEA Tools and Methodologies for Energy System Planning and Nuclear Energy System Assessments, August 2009

2.3 Observations and comments on the CEB IEP 2013-2022

The CEB is to be commended as a utility for having formulated a 10-year integrated plan and for having integrated a strong focus on the specificities of Rodrigues. It provides relevant information, although there are a number of issues which require clarifications.

The NEC considers that the methodology used in the IEP is fundamentally relying on a conventional approach of power-sector planning. Whilst this might have been pertinent in the past, the current context calls on the following which would have enhanced the value of the IEP report:

- key Performance Indicators (KPIs) by which the achievement of each objective specified in the IEP will be measured, such as affordability, environmental impact, Energy Efficiency / Demand-Side Management (DSM), renewable energy targets and others.
- a comprehensive and detailed Energy Efficiency/Demand-Side-Management plan.
- a participatory process in the elaboration of the report. No workshop has been organised by CEB to discuss the IEP with stakeholders. There is a need for greater involvement of stakeholders in the planning process. A permanent governance arrangement for the IEP should be instituted with a larger participation from relevant government organisations, civil society, business, academia and trade unions.
- full range of feasible supply-side and demand-side options, and the assessment of alternatives.

integration of environmental and social dimensions, as well as a comparative sustainability assessment using a multi-criteria analysis of alternative scenarios. A clear policy and regulatory framework is needed regarding the methodology of an IEP in order to assist planners in selecting the desirable options.

- the demand forecast could include price elasticity of demand.
- the decreasing cost of maturing technologies in the planning methodology should be included, i.e. how the price of new technologies (e.g. renewable energy, batteries) is decreasing due to their global diffusion.
- the costs used in the modelling should cover externalities, such as environmental and social, associated with specific technologies.
- the capacity credit of the various Renewable Energy (RE) for projects in the pipeline should be included in the supply/demand matrix. For instance, variable renewables such as planned wind and solar farms projects should be included, especially as hydro, in spite of its variability, is already well included.
- the goals and objectives of the planning process should not be restrictive (see Box 1).
- some key assumptions regarding system parameters made in the supply/demand matrix are aggregated over seasons as well as on an annual basis. These assumptions can be misleading in assessing whether there is a deficit in a specific period of the year. In a disaggregated form, a better model would have emerged (see section 2).

- the methodology as described in the IEP could have been updated by using the latest Load Duration Curve (LDC) of 2012. Over the past few years, there has been a more pronounced increase in peak and semi-peak load than base-load. This could have considerable implications on investment choices.

- an independent scrutiny of the costs screening curves for installation and operation of power plants, which are used to determine investment choices, could have been undertaken. Moreover several options could have been included(e.g. biomass, biofuel, biogas, co-generation options, natural gas, waste-to-energy and also other forms of renewable energy).

- the possibility of gradually substituting coal with biomass should have been considered.

- the opportunity of a scheme for the wider democratisation of the energy sector could have been considered, such as encouraging small planters to transition into renewable energy production.

- peak-demand forecast values should be clarified, as it appears that forecast values have been calculated using actual network losses. The IEP claims an accuracy of within 0.48% in terms of peak demand forecast over the period 1999-2011 to validate the methodology used (see Peak Demand Forecast Accuracy**–Appendix 3**).Moreover, it has also been noted that previous forecasts in other official documents were over-predicted (see **Appendices 4 and 5**).Furthermore, the forecasting in the IEP, on top of making econometric peak demand forecasts for the commercial sector also adds innew project developments in the short term and their power needs. There is thus a risk of double counting and over- capacity in the forecasting as some of the projects in the short term may not materialise. All of the above calls for an independent review of the forecasting methodology. See Box 3 on demand forecasting methods. Wider field data collection (e.g. with the help of Statistics Mauritius) would help, as it would enable end-use forecasting models in the future.

- the actual forecasting model, which is based on GDP driving demand, does not take into account the emergence of less energy-intensive sectors of the economy, demand-side management or climate change impacts such as temperature and humidity patterns.

- the precise modalities for the revision of the IEP should have been defined.

- there appears to be some inconsistencies in the definition and reporting of effective capacity figures, which need to be clarified.

Demand Forecasting Method: Inaccurate forecasts could lead to either a shortage situation (too few power plants built) or surplus situation (too many power plants built). Overcapacity is expensive and under-capacity is an economic disaster. Methods used to forecast demand include trending, econometric analysis, end-use simulation, and combinations thereof. CEB has used mainly an econometric modeling approach. Econometric forecasting assumes that past relationships between electricity use or peak demand and various economic or demographic variables continue to hold into the future. End-use forecasting differs from trending and econometric forecasting in that it builds up estimates of electricity needs starting with an analysis of what electricity is used for. An end-use model of household electricity use might include separate estimates of electricity used for lighting, water heating, space heating, air conditioning, fans, cooking, entertainment, and other appliances. End-use approaches have several advantages. They can be quite detailed, providing more accurate information for planners. They can provide integrated forecasts of both energy and peak power demands. The assumptions used in forecasting are usually easy to follow, check, and revise as new data become available. End-use forecasts provide an excellent framework for estimating the impacts of energy-efficiency options and demand-side management by making changes to parameters used in the baseline forecast. In the example used above, for instance, the analyst can change the assumed energy intensity of air conditioners to reflect introduction of more efficient units. On the other hand, end-use forecasts are data-intensive. Surveys of different types of buildings are usually needed to collect good data on energy end-uses.

Box 3 - Demand Forecasting Methods

2.4 Suggestions for a future IEP

As stated by the CEB, the IEP should be a dynamic plan,and be periodically revised and updated, as necessitated by changing circumstances. In particular, with the recent finalisation of the Maurice Ile Durable (MID) Policy, Strategy and Action Plan on 14th June 2013, the IEP should be updated, using a participatory process and taking also into account the above observations and comments.

For the purpose of this report, the NEC has used figures available from the IEP and the CEB's presentation to NEC. For the short term, particularly with respect to the current context, the NEC has used the CEB's forecast and methodology in spite of the limitations described above. The error involved

in forecasting demand and evaluating supply over the short term is less significant than when a longer scope is analysed.

3. ASSESSMENT AS TO WHETHER THERE WILL BE A POWER DEFICIT OVER THE 2014-2016 PERIOD

This section answers the question of whether there will be any power deficit over the 2014-2016 periods. In particular, the supply/demand situation in critical periods in years 2014, 2015 and 2016 are examined. The analysis is based on data and information extracted from the IEP and in the presentations made by the CEB to the NEC. There are also important seasonal variations that should be factored in as these heavily impact the demand and supply of electricity, and hence on the reliability of the power system.

3.1 Seasonal variations

Historical CEB data shows three major system parameters, as given below, that exhibit significant variations over the calendar year in the demand and the supply:

- scheduled maintenance of power plants
- hydropower generation
- summer and winter peak demand

3.1.1 Scheduled maintenance of power plants

It can be seen from the Figure 2 below, which is taken from the IEP that there is significant variation in the maintenance of power plants over the months, for the past years. In the IEP demand and supply matrix it is assumed that scheduled maintenance is constant (60MW) all year round. The present analysis will include the seasonal variation of the scheduled maintenance.

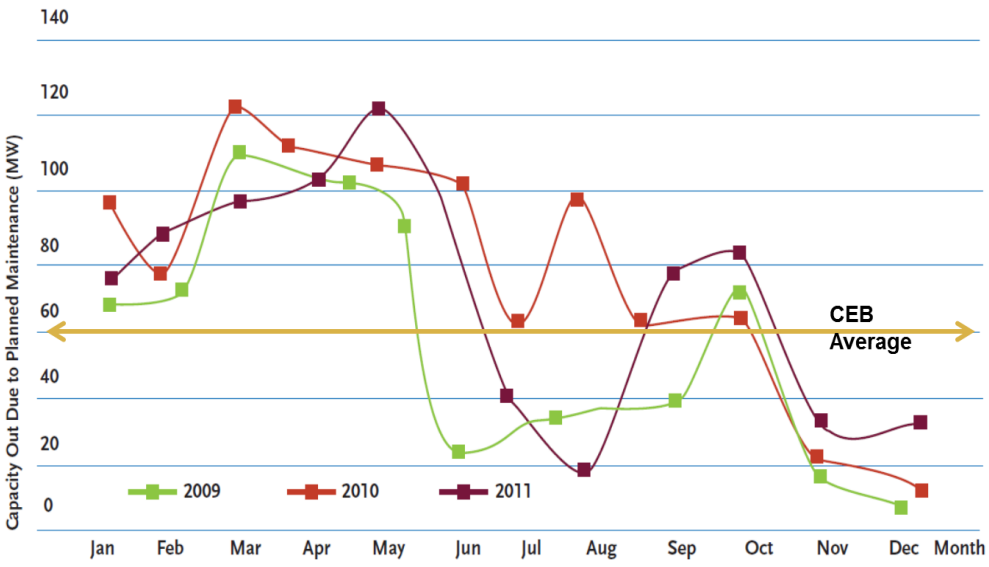


Figure 2 - Schedule maintenance of power plants 2009-2011

3.1.2 Hydropower generation

Historical climate data shows that there are significant variations in the rainfall pattern of Mauritius. Consequently, the amount of hydropower generated throughout the year should reflect this seasonal variation. However, the IEP model assumes a constant availability of 25 MW all year round. The present analysis will take into account the seasonal variation, as shown in Figure 3 below.

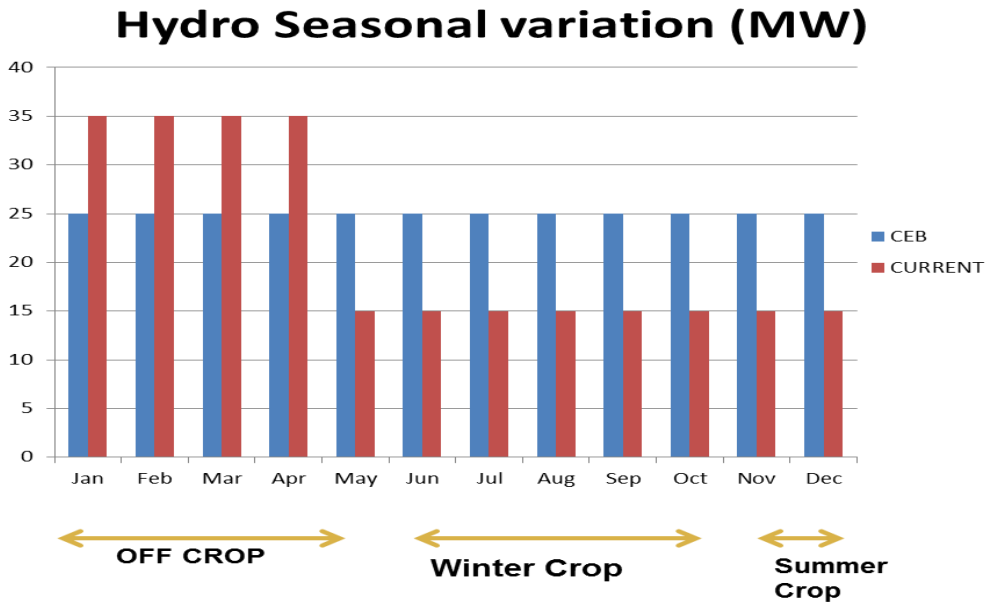


Figure 3 - Average seasonal variations of hydropower in MW

3.1.3 Summer and winter peak demand

Historical CEB data also exhibit differences between summer and winter peak demands. This difference has become more pronounced in recent years because of the increase in domestic, commercial and industrial use of air conditioning as shown in the figure below. The present analysis will take into account the winter and summer peak differences, as shown in Figure 4 below.

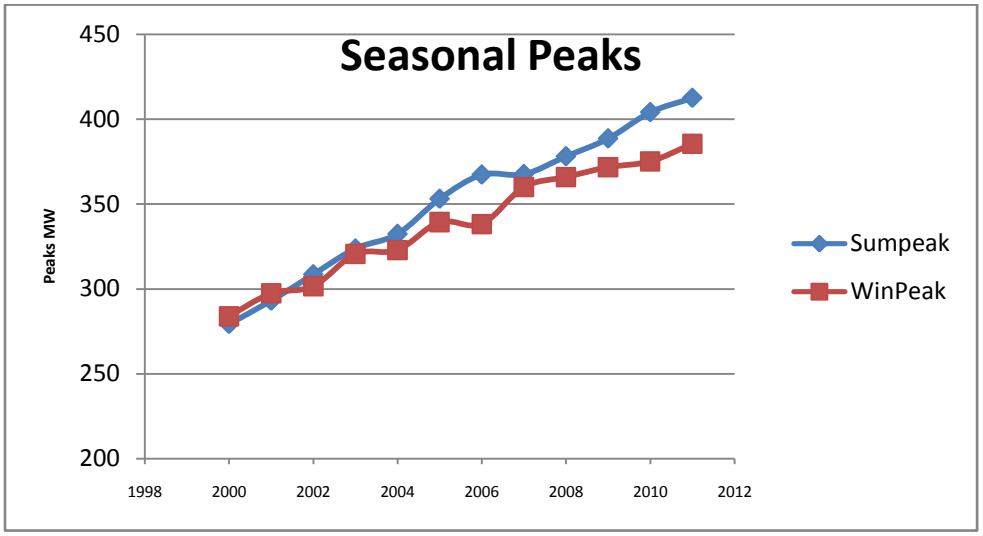


Figure 4 - Difference between summer and winter regarding peak electricity demand

Whilst the evening peak is attained earlier in the day in winter, the summer peak is higher and the ratio winter/summer is 89%. The same ratio in respect of morning and day peaks is 82%. **For purposes of this exercise, the higher seasonal peak ratio of 90% will be taken.**

3.2 Comparative analysis of the main assumptions in the demand-supply matrix

The table below summarises the set of assumptions which are inbuilt in the IEP model as compared to that proposed by the NEC. It is noted that in addition to the above three seasonal parameters (maintenance, hydropower, summer-winter peak), there are also differences in two other key system parameters, notably:

a) "The largest unit out" factor, which is used to take into account unpredictable plant breakdowns.

b) Consolidated Energy Limited (CEL) available all year round instead of operating only during the off-crop period.

Table 1 - Comparative analysis of the main assumptions in the demand-supply matrix

Parameter	IEP assumption	NEC assumption
1. Season	• Crop (June to December) • Off-crop (January to May)	• Crop Winter (June to October) • Crop Summer (November-December) • Off-crop (January to May)
2.Scheduled maintenance of power plants	60 MW flat all year round, without taking seasonal variations into account	• Crop Winter: 50 MW average • Crop Summer: 15 MW average • Off-crop: 90 MW average
3. Largest power unit out	• 37 MW in crop season • 37 MW in off-crop season	• 33 MW in crop season (winter and summer) • 37 MW in off-crop season
4. Hydro	25 MW flat all year round	• 15 MW average in crop season (winter and summer) • 35 MW in off-crop season
5. Peak demand	No summer-winter variation	Winter peak = 90% of Summer peak
6. Maximising existing capacity (CEL)	22 MW only in off-crop	As power plant is already operational during off-crop, 22 MW can be available all year round.**This would then be part of the biomass development programme, with focus on participation of small planters.**

3.3 The criterion used to determine the need for new power capacity: the Reserve Capacity Margin (RCM)

In the IEP, the criterion that is used to determine whether additional power is required in the system is the reserve capacity margin.

If the RCM is less than the threshold value of -5 %, then more power capacity is needed. The RCM is calculated as follows:

$$\frac{\left(\sum_{i=1}^{n}\text{Effective Capacity}_i\right) - (\text{Capacity Out})_{Mtce} - (\text{Capacity Out})_{Bdown}}{(\text{Forecasted Peak Power} + 10\%\ \text{Spinning Reserve})} - 1$$

where,

- *n* is the total number of generating units connected to the grid;
- $(Capacity\ Out)_{Mtce}$ is the maximum capacity that is assumed to be unavailable due to maintenance;
- $(Capacity\ Out)_{Bdown}$ is the largest generating unit assumed to be unavailable due to breakdown.

Box 4 - Formula for the calculation of the Reserve Capacity Margin

Source: IEP, page 134.

3.4 RCM calculations for 2014-2016 comparing the IEP and NEC models

In this section, the supply and demand requirements for the years 2014-2016 are analysed over a calendar year, taking into account the above assumptions and broken into the following three periods:

- January to May – Off-crop period during summer only
- June to October - Crop period during winterseason
- November-December - Crop period during summerseason

3.4.1 Period January to May – Off-crop period during summer only

This period is the most critical period in terms of matching demand with supply as it corresponds to the period where most of the scheduled maintenance is carried out, while the demand is at its peak due to the summer season. It should also be noted that in the NEC model, no new power is included and it will later be shown that a rescheduling of the maintenance will significantly improve the power reliability for this period. Moreover, there are other aspects

such as EE/DSM and the firm capacity credit for wind farms, which are absent from the IEP model, that will be developed later and which will further improve system reliability.

The main system features for this period are:

- Scheduled maintenance of power plants: average of 90 MW rather than 60 MW of the IEP model
- Hydropower: 35 MW rather than 25 MW

Table 2 - RCMs over 2014-2016 / January to May Period

Item	2014 (MW)	2015 (MW)	2016 (MW)
Effective available capacity as per CEB Matrix, but no new 100 MW capacity over 2015 and 2016	**603**	**603**	**578 ***
Add to IEP average of 25 MW Hydroelectricity to adjust for season	**10**	**10**	**10**
New coal or biomass/coal plant	**0**	**0**	**0**
Largest unit out	**37**	**37**	**37**
Scheduled maintenance (off-crop historical average)	**90**	**90**	**90**
Effective available capacity	**486**	**486**	**461**
Peak power forecast (IEP)	**461**	**475**	**492**
Peak power plus 10%	**507**	**523**	**541**
Reserve Capacity Margin	**-4.1**	**-7.1**	**-14.8**
Comparison with IEP RCM	**0**	**4 (with 50MW from CT Power)**	**5 (with 100MW from CT Power)**

** Pielstick engines decommissioned in 2016 as per CEB matrix*

The last two rows of the above table compare the RCM of the two approaches. It is noted that for this particular period the NEC model shows no power deficit for 2014. However, for both 2015 and 2016, the RCM for the NEC model is below the threshold of -5 %. In the IEP model, it should be noted a new 50 MW power plant has been factored in 2015, and this is increased to 100 MW in 2016. In contrast, in the NEC model, no new power plants are included. The deficit shown in the NEC model will be addressed by different means which will be presented in subsequent sections, so that there will be no power deficit for these years.

3.4.2 Period June to October – Crop period during winterseason

This period corresponds to the Crop period and also to the winter season. To that effect, the assumptions are:

- Scheduled maintenance of power plants: average of 50 MW rather than 60 MW of the IEP model
- Hydropower: 15 MW rather than 25 MW
- Winter peak demand = 90% of summer peak demand
- CEL 22 MW throughout the year, as part of the biomass development programme, with focus on participation of small planters.

Table 3 - RCMs over 2014-2016 / June to October

Item	2014 (MW)	2015 (MW)	2016 (MW)
Effective available capacity as per CEB Matrix, but no new 100 MW capacity over 2015 and 2016	**553**	**553**	**528***
Add back CEL difference (biomass)	**22**	**22**	**22**
New coal or biomass/coal plant	**0**	**0**	**0**
Deductfrom IEP average of 25 MW Hydroelectricity to adjust for season	**10**	**10**	**10**
Largest unit out (MW)	**33**	**33**	**33**
Scheduled maintenance (crop average)	**50**	**50**	**50**
Effective available capacity	**482**	**482**	**457**
Peak forecast (IEP)	**461**	**475**	**492**

Peak as adjusted for winter factor of 0.90	**414.9**	**427.5**	**442.8**
Peak power plus 10% reserve	**456.4**	**470.3**	**487.1**
Reserve Capacity Margin (RCM) ,%	**5.6**	**2.5** **(no new power plant)**	**-6.2** **(no new power plant)**
Comparison with IEP RCM	**-8**	**-6** **(with 50MW from CT Power)**	**-4** **(with 100MW from CT Power)**

** Pielstick engines decommissioned in 2016 as per CEB matrix*

It is to be noted that for the years 2014 and 2015 the IEP model is showing significant deficit of power, despite an additional 50 MW of power in 2015. On the other hand, for the same 2 years, the NEC model shows no deficit in power, and so without any additional new power capacity.

For the year 2016, the IEP introduces a second unit of 50 MW, totalling 100 MW of new power, but the RCM improves only to -4%, which is just above the threshold value of -5%. In the NEC model, with no new additional power, the RCM is -6.2%, which is just below the threshold value. This would suggest that new power capacity is needed for 2016, although measures such as optimized scheduling of maintenance, implementation of renewable energy projects already in the pipeline and energy efficiency and demand side management will improve the reliability. This will be addressed in paragraph 2.4.4.

3.4.3 Period November to December – Crop period during summerseason

This period corresponds to the Crop period and also to the summer season. To that effect, the assumptions are:

- Scheduled maintenance of power plants: average of 15 MW rather than 60 MW of the IEP model
- Hydropower: 15 MW rather than 25 MW
- Winter peak demand = 90% of summer peak demand
- CEL 22 MW throughout the year, as part of the biomass development programme, with focus on participation of small planters.

Table 4 - RCMs over 2014-2016 / November to December Period

Item	**2014 (MW)**	**2015 (MW)**	**2016 (MW)**
Effective available capacity as per CEB Matrix, but no new 100 MW capacity over 2015 and 2016	553	553	528 *
Add back CEL difference (biomass)	22	22	22
New coal or biomass/coal plant	0	0	0
Deductfrom IEP average of 25 MW Hydroelectricity to adjust for season	**10**	**10**	**10**
Largest unit out	33	33	33
Scheduled maintenance (crop average)	**15**	**15**	**15**
Effective available capacity	517	517	492
Peak forecast (IEP)	461	475	492
Peak power plus 10% reserve	507.1	522.5	541.2
Reserve Capacity Margin,%	2	-1 (no new power plant)	-9 (no new power plant)
Comparison with IEP RCM	**-8**	**-6** **(with 50MW CT Power**	**-4** **(with 100 MW CT Power)**

** Pielstick engines decommissioned in 2016 as per CEB matrix*

From the above table, it can be deducted that the IEP model is predicting power deficit in 2014 which continues into 2015, despite the introduction of a 50 MW power plant in 2015. The further addition of a second 50 MW unit brings the IEP RCM just above the threshold value of -5 %.On the other hand, the NEC model only indicates a power deficit in 2016. This will be addressed in paragraph 2.4.4.

3.4.4 NEC recommendations to avoid any power deficit over the period 2014-2016

Based on the above analysis, the NEC makes the following recommendations with a view to avoiding any power deficit for the period 2014-2016.

NEC 1 URGENT ACTION: Accelerate the following immediate supply options

1.1. Undertake a consultative process to **assess further optimisation of the maintenance schedule** with a view to minimising maintenance in the months of February and Marchparticularly, to be completed by end 2013 (MEPU, CEB, IPPs).

1.2. Initiate discussions to optimise power generationof IPPs,**for a gradual transition to and maximisationof biomass,with participation of small planters** (MEPU, CEB, IPPs).

1.3. Accelerate the implementation of RE projects(60 MW) already in the pipeline and the Sea-Water Air-Conditioning (SWAC) under the Deep Ocean Water Application project (PMO, MEPU, CEB).

1.4. Commission medium-speed diesel engines (2x15 MW in 2015 and 2x15 MW in 2016), that will use low-sulphur HFO and can later be used with natural gas or biodiesel,**to reinforce RE backups and to be viewed as anticipated investment to cater for future semi-peak/peak demand**(MEPU, CEB).

1.5. Commission by early 2014 an engineer's report on the operating capacity of the whole power system of Mauritius (CEB and IPP plants) (MEPU, CEB).

1.6. Amend legislation to allow small/medium-scale green electricity producers to sell to their in-house customers by end of 2013 (MEPU).

NEC 2 URGENT ACTION: Implement the following Energy Efficiency and Demand-Side Management (EE/DSM) projects for the next 3 years with a potential cumulative saving of at least 30 MW at peak hours(MEPU, EEMO, Private sector, CEB).

2.1 **New low-energy lightingproject (CFL):** Replicate the 1 million CFL lamps project with a target of 10 MW peak reduction at an investment of Rs 50 million.

2.2 **Replacement of old refrigerators project:** Similar to a project developed in Reunion and elsewhere with the replacement of 20,000 low efficiency fridges giving a 2 MW peak reduction, at a cost of Rs 100 million. Other social and environmental benefits will accrue from this project (e.g. elimination of CFC and electrical/electronic waste).

2.3 **Time-of-use (ToU) tariff in industries project:** To replace the concessionary tariffs through the definition of specific ToU agreements with relevant clients to promote peak power reduction. Estimated potential is a 10 MW reduction.

2.4 **Solar-water heater (SWH) project:** Pursuit of SWH subsidy programme. Estimated peak load reduction is 2 MW. **Use of SWH for solar cooling** can be introduced under the SWH subsidy programme towards reducing peak demand in summer (day-time).

2.5 **Air-conditioning peak power demand reduction project:** urgent implementation of audits; minimum performance standards; regulations, including those related to buildings; energy efficiency labelling and differentiated duties already worked out by EEMO, accompanied by education and sensitization. 10 MW can be saved during peak hours.

2.6 **Variable speed drives in industry:** Under joint project by the AgenceFrançaise de Développement (AFD), the Joint Economic Council (JEC) and the Association of Mauritian Manufacturers (AMM), the introduction of variable speed drives on motors alone can lead to at least 20% reduction in power consumption including at peak hours. Potential will depend on scope of project. Pay-back is less than 1 year.

2.7 **Street-lighting project:** Already an estimated 2 MW peak saving noted in the past as a result of introduction of energy-efficient lighting. To replicate the project. Application of green procurement policy needed.

2.8 **Sensitization on peak demand reduction:**Already proposed by Energy Efficiency Committee of EEMO, this programme will support and help towards achievement of above targets through listed activities.

NEC 3 **Launch a National Energy Efficiency Action Plan for the Republic of Mauritius** and execute Demand-Side Management (DSM) by December 2013 (MEPU, EEMO, Private sector, CEB).

3.1 **Setting up of a Steering Committee** at the level of the MEPU with the participation of key stakeholders to oversee the implementation of the specific projects related to peak demand DSM.

3.2 **Setting up of a Technical Team** at the level of the EEMO with the collaboration of the CEB.

3.3 **Provision of seed-money** towards the definition of specific projects and initiation of same (through grants / zero-interest loans).

3.4 **Reporting and feedback** on the status of Peak Power DSM (Peak Watch) through the full empowerment of the *Observatoire de l'Energie* in terms of required resources (management and administrative, statistical support, ICT, technical support, etc.).

3.5 **Provide the EEMO with the minimum critical mass in terms of human resources** in order to deliver the above objectives.

3.6 **Set a mandatory annual demand reduction target for the CEB and EEMO to achieve.** Study the possibility of incentivising this by providing funding grants to CEB and EEMO for each additional MW / MWh saved beyond the annual mandatory target. Top priority is to be given to strong DSM programmes to boost energy efficiency.

NEC 4 **Set up unloading Agreements and special Interruptible Rates**: large electricity users may be offered price discounts in exchange for allowing the utility to disconnect all or a portion of their electrical equipment when the utility system is short of generating capacity. This is already being used in Réunion Island. **Stand by generators from large customers (e.g. airport terminal, the cyber tower, big hotels, port, etc.) could play a significant role in peak load management.** The total such capacity available in the country could be at least 20 MW. If there was a price incentive given to these customers, CEB could use these generators in emergency situations.

NEC 5 **Link concessionary electricity tariffs to industry with Energy Efficiency (EE) targets to be determined**. Define a concessionary threshold for each beneficiary abovefor which they would be charged the commercial rate (MEPU, CEB, JEC, Ministry of Industry, Commerce and Consumer Protection).

NEC 6 **Urgently review environmental norms and recommendations for the establishment of norms for the Republic of Mauritius applicable to electricity power plants**, provided that public safety and pollution aspects are adequately addressed (emissions and ash disposal).

NEC 7 **Complete as soon as possible the feasibility study being undertaken on Liquefied Natural Gas (LNG) and conduct another study on Compressed Natural Gas (CNG).** As natural gas plants are ideal backup capacity for renewable energy, are less polluting than coal, diesel and HFO, and will act also as anticipated investment for future semi-base and peak load needs. Furthermore natural gas can be of relevance for transport fuel needs.

NEC 8 Accelerate the dissemination of solar power plants (PV and other technologies) across the Republic of Mauritius through the following by 2014:

8.1 Conduct small scale PV electricity generation tests in all micro-climate regions of the Republic of Mauritius, so as to assess with precision the total PV potential of the country.

8.2 Launch a new Request for Proposal (RFP) for a series of 2-5 MW PV utility plants, with battery, with a strong focus on small planter cooperatives and on citizens' cooperatives. Include also a strong focus on rooftop and parking installations.

8.3 Allow industries, hotels, office buildings and commercial malls to set up their own 500 KW – 2 MW plants, with battery, for their own use and for their tenants. Include also a strong focus on rooftop and parking installations.

8.4 Bring public buildings to generate a given level of their electricity needs from RE, with battery.

8.5 Allow as many home-owners as possible to install PV plants on their homes.

8.6 Amend legislation and regulations as needed for implementation of the above.

3.4.5 Impact of the main NEC recommendations on the issue of power deficit

The main measures recommended by the NEC are:

1. Rescheduling of maintenance of power plants.
2. Commissioning of new medium speed diesel engines, which will operate on low-sulphur HFO or biodiesel, and that can be later retrofitted to LNG / CNG over the medium term. They will be anticipated investment for future peak/semi-peak demand also.
3. Strong implementation of Energy Efficiency / Demand-Side Management (EE/DSM)
4. Accelerating Renewable Energy development.

The most critical period over 2014-2016 is the Off-crop season from January to May. Table 5 below shows the impact of the NEC's recommendations for addressing any power deficit.

Table 5 - Impact of the main NEC recommendations on the issue of power deficit

Item	2014 (MW)	2015 (MW)	2016 (MW)
Effective available capacity as per CEB Matrix, **but no new 100 MW capacity over 2015 and 2016**	603	603	578
Add to 25 MW Hydroelectricity flat annual average to adjust for season	**10**	**10**	**10**
New coal or biomass/coal plant	0	0	0
Largest unit out	37	37	37
Scheduled maintenance (off-crop average) - reduced from 90 MW to 75 MW (that possibility was confirmed during the presentations of the IPPs before NEC)	**75**	**75**	**75**
New medium speed diesel engines, which will operate on low-sulphur HFO or biodiesel, and can later be retrofitted to LNG / CNG	**0**	**30**	**60**
Mare Chicose Biogas Plant	**3**	**3**	**3**
Effective available capacity	504	534	539
Peak power forecast (CEB)	461	475	492
Peak power plus 10%	507.1	522.5	541.2
Reserve Capacity Margin (%)	**-0.6**	**2.2**	**-0.4**
Comparison with CEB RCM (%)	**0**	**4 (with 50MW CT Power)**	**5 (with 100 MW CT Power)**

As can be seen from the last two rows of the above Table, the NEC recommendations significantly improve the reliability of the power system, thus ensuring no power deficit in the critical period of January to May for the years 2014, 2015 and 2016.

It should be highlighted that along with addressing the power deficit in 2016, the 60 MW (4x15) medium-speed diesel engines will be vital for the following:

- as a backup for the progressive integration of renewable energy on the grid;

- the introduction later of biodiesel and/or natural gas, cleaner fuels that can also be linked to mass transport; and
- the replacement, after 2016, of the old Pielstick engines.

In addition to the above, **the reliability of the system will be further enhanced with the measures recommended for Energy Efficiency / Demand-Side Management (EE/DSM) and for Renewable Energy (RE)**. The table below gives an indication of the immediate potential contribution available from RE and EE/DSM.

Table 6 - Potential of RE and EE/DSM over 2013-2016

Item	**2014 (MW)**	**2015 (MW)**	**2016 (MW)**
Renewable Energy (Capacity credit of 10% to wind energy projects, 40 MW pipeline)	**4**	**4**	**4**
Demand-Side Management	10	20	30

The above discussion clearly demonstrates that should the NEC recommendations be implemented, there will not be any power deficit in 2014, 2015 and 2016.The country has the breathing space – and the means – to set in motion the necessary measures needed to achieve the transition towards a sustainable energy future.

The remaining part of this Report deals with the post-2016 national energy requirements, and strategies in that regard.

4. FOSTERING A SUSTAINABLE ENERGY FUTURE: MOVING TOWARDS A "GREEN ECONOMY"

The previous section clearly demonstrates that any power deficit up to 2016 can be avoided. In this section, various pathways towards a sustainable energy future are explored.

4.1 Introduction

There has been a major development since the publication of the IEP. The Maurice Ile Durable (MID) Policy, and Strategy Action Planwas approvedby Government for implementation on 14thJune 2013. A specific goal has been set for Energy – to ensure that the Republic of Mauritius is an efficient user of energy, with its economy decoupled from fossil fuel.The MID Action Plan reconfirms the objectives set in the Long-Term Energy Strategy 2009-2025, which are to achieve 35% renewable energy by 2025 and to reduce energy consumption in non-residential and public sector buildings by 10% by 2020. Furthermore, one of the main recommendations in the MID action plan is the development of a mechanism for checking MID compliance of new policies, strategies or other plans.

It is crucial that the power demand and supply requirements of the country are aligned with the above objectives. A key principle that needs to come to the fore is the need to fight against energy inefficiency. There is no point in boosting renewable energy if energy is then wasted. The first principle of sustainable energy is to be energy efficient.

This section thus highlights the need to break-away from the business-as-usual approach in order to meet the MID objectives and achieve a sustainable energy future.

4.2 Vision and Goals

For a Small Island Developing State (SIDS) such as Mauritius, spending time debating on the relevance of sustainable development is a luxury that we cannot afford. We have to make the most of the scarce resources at our disposal. Increasingly costly fossil fuels are draining more and more of our hard-gained foreign exchange reserves away from our economy. Not only 80% of our energy needs depend on importing fossil fuels, but we spent 430% more in 2012 on these imports than in 2002, whereas in quantities (thousand tonnes of oil equivalent) the increase was simply 42%. In the overall imports bill of Mauritius, the share of fossil fuels imports now represents 21%, compared to 10% in 2002. The country spent Rs 33.4 billion last year compared to Rs 6.3 billion in 2002.

Furthermore, in a small island country with a very high population density, there is no space for polluting activities with high health risks. Also, tourism revenues that are a vital income for our nation and that are already facing difficult times will not be sustained if our country does not maintain a green paradise image. Basing our economy on fossil fuels is putting our long-term development under threat. Mauritius has no option but to move away from fossil fuels. The country can capitalise on the abundance of sun and marine energy that it has been blessed with. Finally, in terms of international credibility, Mauritius has taken the lead on a number of international agreements and movements for sustainable development and environment protection (SIDS, Earth Summit, etc.). Mauritius must be seen to implement its commitments. This will position the country favourably for access to international funding.

In this regard, the **NEC through this report fully endorses the relevancy of the vision statements expressed in the Long-Term Energy Strategy 2009-2025 and the 'Maurice Ile Durable' Policy, Strategy and Action Plan** (MID PSAP).

Energy helps to drive the global economy and has a significant impact on the quality of life and health of the population. Reliable and affordable energy has in the wake of the recent surge in prices of petroleum products, never been as important as it is to-day. It is now central to our economic development and will continue to be an indispensable vector on which the economic and environmental sustainability will depend.

The Government of Mauritius is focused on diversifying the country's energy supply, improving energy efficiency, addressing environmental and climate changes and modernizing our energy infrastructure in order to meet the challenges ahead. Besides security of supply and affordability we are further confronted with another challenge namely that of making a rapid shift to a low carbon, efficient and environmentally benign system of energy supply. What is needed is nothing short of a complete change in habits through decisive policy actions, but without losing sight of the affordability criteria. In this venture, the collaboration and participation of the private sector and other stakeholders is a sine qua non.

Figure 5 - Vision Statement in Long-Term Energy Strategy 2009 – 2025, Ministry of Renewable Energy & Public Utilities, October 2009

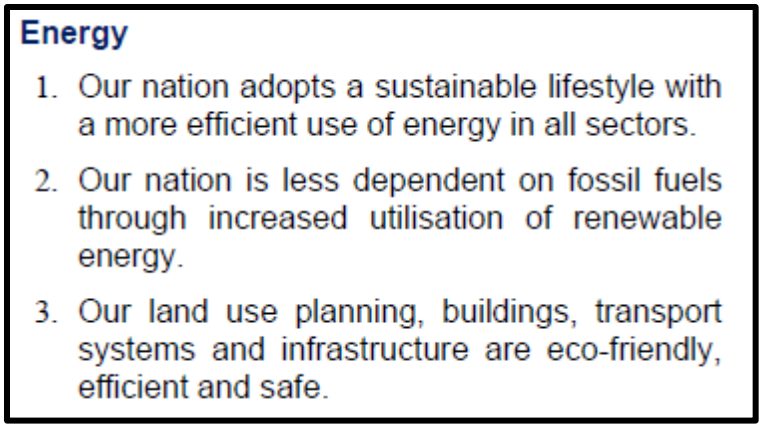


Figure 6 - Vision Statement on Energy in 'Maurice Ile Durable' Policy, Strategy and Action Plan (MID PSAP), July 2013

Consistent with the MID vision on Energy, the MID goals on Energy Efficiency, Renewable Energy and Power Sector Reform will be used as the guiding principles. Furthermore, the NEC believes that **achieving sustainability is not contrary to economic development, and is in fact a key driver of growth, especially for a Small Island Developing State (SIDS).** The United Nations Environment Programme (UNEP) points out that *'Rather than being seen as a passive receptor of wastes generated by economic activity or as one of many substitutable factors of production, the environment in a green economy is seen as a determining factor of economic production, value, stability, and long term prosperity – indeed, as a source of growth and a spur to innovation. In a green economy, the environment is an "enabler" of economic growth and human well-being.'*

Our environment – the sun, the wind, the sea – are opportunities that our economy must capitalise upon. UNEP defines the notion of 'Green Economy' *as 'one whose growth in income and employment is driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services'*. The move towards non-polluting and renewable forms of energy, internationally termed as 'Clean Energy' will thus help, in the context of climate change and acute global competitiveness, to strengthen our economy and position Mauritius strongly in the international arena.

4.3 Capitalising on the Potential of Renewable Energy and Energy Efficiency

However, while the world these last years has been moving towards more RE, Mauritius over the past decade has been moving in the opposite direction of the 'Maurice, Ile Durable' objective of achieving a 35% share of renewable energy in electricity generation. Total electricity generated in 2012 stood at 2,796.4 GWh, out of which renewable energy (hydro, wind, landfill gas, photovoltaic & bagasse) represented 551.9 GWh, i.e. a share of 20.7%, whereas in 2002, the share of renewable energy stood at 27.6%. The share of renewable energy is on a clear decline. U**nless a strong action plan is set and implemented rapidly, it seems that the MID target will not be met, despite the already approved 60 MW RE projects.** This would truly be a major missed opportunity, as, back in 2002, Mauritius was among leading countries in terms of electricity generated from renewable energy. **With the cost of fossil fuels set to continue to rise, the time is now ripe to embark on a new energy pathway.** See Appendix 6 for full details on cost estimates for electricity generation.

A master plan for the development of Renewable Energy in Mauritius has been in preparation under the Outline Energy Policy. It is critical that such a major policy document is completed if we are to achieve the transition towards a sustainable energy future. In addition, a complementary Master Plan on Energy Efficiency/Demand-Side Management is vital (see Recommendations as well as **Appendix 7**).

The United Nation's International Renewable Energy Agency (IRENA) has warned that deployment of RE continues to be hindered by **outdated perceptions** that renewable technologies are too expensive and difficult to implement: '*public debate around renewable energy, however, continues to suffer from an outdated perception that renewable energy is not competitive, forming a significant and unnecessary barrier to its deployment*' (IRENA Newsletter, Issue No. 5, January 2013). This could cost our country dearly.

4.3.1 Renewable Energy options and opportunities

Beyond bagasse, the renewable energy options available to our country are:

- Marine Renewable Energy (MRE) – very promising, considering our total oceanic surface, but the technology is still in development. A strong R&D programme is needed.
- Biomass – to be developed in parallel with the revitalisation of the bagasse sector.
- Biogas from municipal waste –projects are feasible that will enable a sustainable waste-to-energy programme.
- Geothermal – promising, considering Mauritius' volcanic origins. Current feasibility assessment efforts need to be sustained as geothermal is a mature technology providing effective cheap electricity supply in countries, such as Philippines and Indonesia.

According to the IRENA, the weighted average LCOE by region is between USD 0.05 and USD 0.09/kWh.

- Solar photovoltaic (PV) and wind – the technologies are mature, prices have dropped massively (70% in past 2 years for PV) and intermittency can be tackled via flexible backup (existing fleet of diesel and kerosene generators), and via electricity storage (batteries and pumped hydro).

Variable RE (solar and wind) offer considerable positive externalities:

1) Solar and wind do not involve imports in foreign exchange ;
2) They do not have combustible and foreign exchange escalation factors;
3) Solar and wind do not emit sulphur dioxide , a toxic gas responsible for asthma and bronchoconstriction; and
4) Solar and wind do not emit carbon dioxide.

Solar energy has the potential, even without storage facilities, to displace expensive HFO and gas turbine power in the morning and day peaks and bring about significant savings for the CEB. Wind energy will also be useful to displace high cost power at evening peak time. The recent solar PV 10 MW tender by the CEB has yielded kWh rates showing that utility solar PV plants are cost-competitive with CEB's thermal plants. The kWh price agreed upon after negotiations between the CEB and the lowest bidders is approximately Rs 6 kWh, or even lower, for the lifetime of the Power Purchase Agreement (PPA). These plants are expected to be on the grid in 2014.The potential cost savings to CEB through the implementation of the RE projects already in the pipeline(about 60 MW) is to be quantified. Purely in terms of fossil fuel import costs avoided, giving RE plants priority dispatch over diesel and kerosene units will enable savings of Rs 4.2 million per GWh (see Table 15 in **Appendix 6**).

These potential savings are set to improve further with the rapid pace of technological progress and price reduction underway in the field of RE technologies. Global PV module prices have dropped drastically, with the IRENA stating that '*a 60% reduction has been achieved over the last two years and more than a 40% reduction is likely to occur by 2020'.* IRENA even forecasts that '*the LCOE [Levellised Cost of Electricity] of utility-scale systems for both thin film and c-Si* [popular types of PV modules] *could decline to between USD 0.06 and USD 0.10/kWh by 2020*'. **This works out as Rs 1.86 per KWh and Rs 3.1 per KWh.**This gives an indication of the profit margin that private projects as mentioned above could be achieving and demonstrate thus the potential benefit of investing also in CEB-owned PV plants, as the population will benefit from cheap solar energy prices, once the initial investment costs have been recouped.

4.3.2 Managing the intermittency challenge of variable RE

Weather variability poses major challenges to the integration of wind and solar energy on the grid. However, a number of countries are already successfully integrating on their grid large shares of variable RE. Some are faced with the same constraint as Mauritius, i.e. a national grid that is isolated (e.g. Spain, where wind farms generate about 25% of total national electricity demand, reaching at times 55%). The process on how to effectively integrate large shares of variable RE has been well mapped out in various best practice guides available for policy-makers and utility companies from international organisations such as the International Energy Agency (IEA) and the IEC. See **Appendix 8** for full details.

Furthermore, large-scale battery storage for variable RE is on the brink of utility-scale deployment, which means that for instance electricity produced during the day by PV could be used for the evening peak. Variable RE becomes firm power. There is a global race underway for the commercial development of large-scale batteries for utilities, businesses and residences, driven by huge deployment of variable RE happening worldwide. The IRENA released in April 2012 a special '*Electricity Storage – Technology Brief*', which states:*'Energy storage technologies are quickly evolving since the share of renewable electricity is growing fast and there is an increasing need for storage capacity. Storing low-cost electricity (e.g. overnight) and selling it during peak-demand periods could soon become cost effective due to the increasing cost of peak electricity.'*

Data dating from September 2010 (three years ago) from the International Electrotechnical Commission (IEC) reveal thatthere were then already 223 battery storage sites operating across the world, for more than 450 MW in installed capacity. The IEC forecasts that by 2020, installed capacity will be in terms of GW. Sodium-Sulphur (NaS – used in Réunion by EDF) and Lithium-Ion batteries are among the most utilised. But other technologies, offering better safety and performances, are emerging.See **Appendix 9** for information on current technologies and costs for large-scale electricity storage, including another storage option, i.e. pumped hydro storage.

Wind and solar energy are now concrete options for bringing Mauritius to its vision of 35% electricity generated from RE by 2025.

4.4 Energy Pathways

In order to achieve the vision and goals of a sustainable energy future for Mauritius, NEC has adopted a participatory and multidisciplinary approach consisting of evidence-based analysis of energy sources and of mature and emerging technologies. The proposals from promoters and the public as well as from experts have been duly considered. The NEC has reviewed the social and environmental implications, on top of the economic affordability. This has led to the identification of a number of different options to meet our future energy needs. **A set of options can be mapped in a consistent manner to form an "Energy Pathway".** The aim is to find the one that will effectively lead us to a sustainable energy future.

4.4.1 Identifying a desirable energy future for the Republic of Mauritius

The energy future of Mauritius is facing two radically different pathways:

1. A coal-dominated pathway, with a 100 MW coal-only plant to be followed afterwards by additional coal power plants, based on a least financial cost approach only (**Pathway One**).

2. A MID-compliant pathway that would satisfy economic affordability, on top of environmental and social sustainability concerns (**Pathway Two**).

The present configuration of the electricity sector is poised in between these two energy pathways (see **Appendix 9** for current supply options). The right choice therefore needs to be made as to the energy future of the country.

The IEP considers that additional power capacity of 200 MW is to be added by 2022. But this is according to a business-as-usual scenario. This figure does not stand if Mauritius embarks on the paradigm shift of MID and moves towards a Green Economy. An extrapolation of the figures given in **Table 5** shows that up to 2022 in the critical off-crop period of January-May:

- using the IEP's demand forecast figures;
- integrating energy efficiency/demand-side management;and
- factoringcapacity credit of 10% for upcoming wind farms projects (solar farms left out as not being able to cover the evening peak);

the total additional capacity needed would be in fact much less than 200 MW.

In-depth blue-prints, including the development of master plans for Energy Efficiency/DSM andfor Renewable Energy, need therefore to be produced to ascertain the exact

additional capacity needed under the MID paradigm. National development projects in terms of sustainability criteria need to be identified clearly and included in the latter blue-prints.

In the meantime, to guide this process, the NEC has conducted a multi-criteria assessment of what both pathways would entail in terms of economic, environmental and social implications on the basis of existing proven and mature sources/technologies. Also, the NEC has considered strategic options that could further transform the Mauritian economy and bring it to a new development threshold. The aim here is to establish clear direction and boundaries within which the energy future of Mauritius is to be subsequently worked out with precision, through appropriate modelling exercises and detailed feasibility studies, by the Government, in participatory manner with the private sector and civil society.

4.4.2 Multi-criteria assessment of the Two Pathways

The purpose of this section is to estimate the least-cost option of both pathways – coal-dominated and MID-compliant –**from a holistic perspective, which includes the full economic, social and environmental impacts**, and not just from strictly the financial perspective. For instance, the competitiveness in our major export markets is not only due to "bottom-line" aspects but is also tributary to issues such as carbon footprint, environmental protection and social norms. Also, health considerations are at the very heart of the concerns of populations. Finally, international donor/lenders more and more require the 'greening' of projects before engaging in their financing.

4.4.2.1 Parameters for the analysis.

The NEC has used a 2014-to-2025 period to be consistent with the MID horizon and the LTES timeframe. Also, in the absence of precise information on LNG and in particular CNG at this stage for the specific Mauritian context, these two combustibles are not factored in this analysis.However, as natural gas but also biodiesel and marine renewable energy (MRE) will enable even greater sustainability, a proper feasibility study on LNG/CNG should be undertaken as soon as possible, as well as feasibility studies for biodiesel and marine renewable energy (MRE). The latter options can be integrated in **Pathway Two**.Pathway Two makes a maximum call on renewable sources of energy, considering that technological progress can graduate up intermittent solar/wind to firm power status and other biomass, wood chips and highly efficient photosynthetic graminae, could be produced and available in significant amounts.

4.4.2.2 Criteria selected

(a) **Economic/financial**: capital cost per MW installed in United States of America dollars (USD); border cost/kWh of imported combustible; concessionary funding from international donors/lenders
(b) **Energy security**: local resources, political risks of supplying areas, encumbered sea routes , combustible of last resort;
(c) **Environmental** : Sulphur Dioxide ($SO_{2)}$ and additional Carbon Dioxide ($CO_{2)}$ emissions per kWh, ash and its disposal, biodiversity;
(d) **Social** : employment, proximity to urbanised areas;
(e) **Healt**h: any known hazard and in particular asthma/broncho-constriction and cancer.
(f) **Water usage**;
(g) **Land issues**: availability, siting to optimise injection into the grid and minimisation of line losses.

For purposes of this exercise only the first five are taken into account.

4.4.2.3 The analysis

Pathway One –*Coal-dominated*:

(a) 190 MW coal plants;
(b) 60 MW net high-sulphur Heavy Fuel Oil (HSHFO) plants;
(c) As a consequence of the above, solar and wind are not needed for firm power purposes and remain '*below the line'* items as intermittent sources of electricity.

Pathway Two – *Clean Energy for a "Green Economy"*

(a) 60 MW net LSHFO plants;
(b) 50 MW bagasse & biomass/coal plants with a 50/50 mix i.e. 25 MW bagasse & biomass and coal 25MW ;
(c) 60 MW solar and wind, with 60 MW of batteries and working in complementarity with 60 MW LSHFO to ensure 24/7 supply of electricity,i.e.60 MW firm ;
(d) Reduction in demand due to effective measures and excellent results on the phasing out of concessionary tariffs of large establishments: 50 MW;
(e) Other biomass/ sustainable waste-to-energy : 30 MW;
(f) Coal-only plants: 0 MW.
(g) Note that LNG/CNG as well as biodiesel and Marine Renewable Energy not factored in, due to lack of data, but will become feasible options in the next years.

Table 7 - Energy mix comparisons

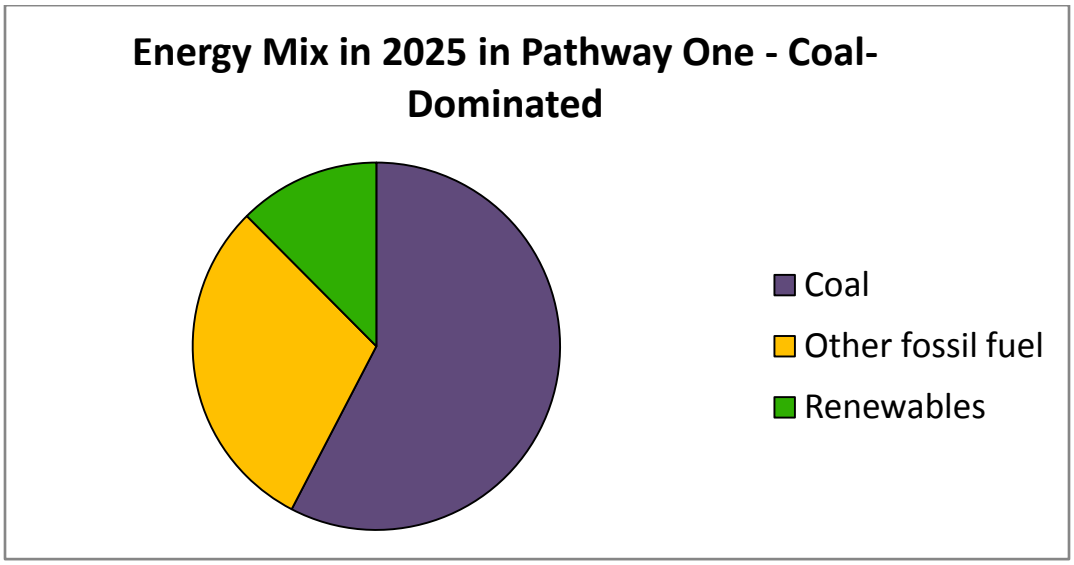
Attaining the MID Objective in GWh	Now	Pathway One in 2025 - Coal dominated	Pathway Two in 2025 - Clean Energy for a Green Economy
Coal	43.5%	58.0%	29.3%
Other fossil fuel	37.0%	30.1%	35.8%
Renewables	19.6%	12.5%	34.9%
Total GWh	2300	3780	3378

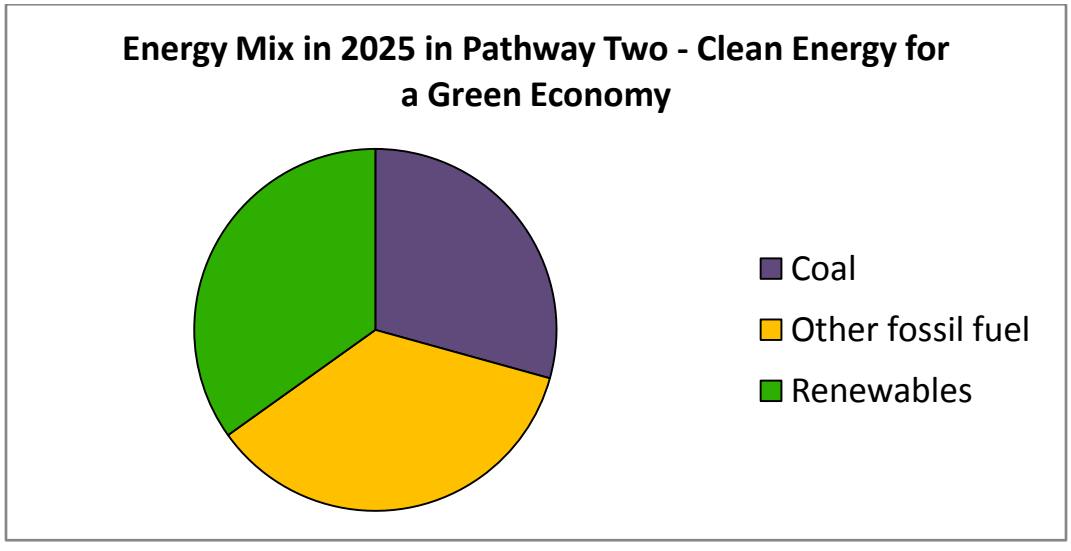
Table 8 - Pollution and Costs comparisons

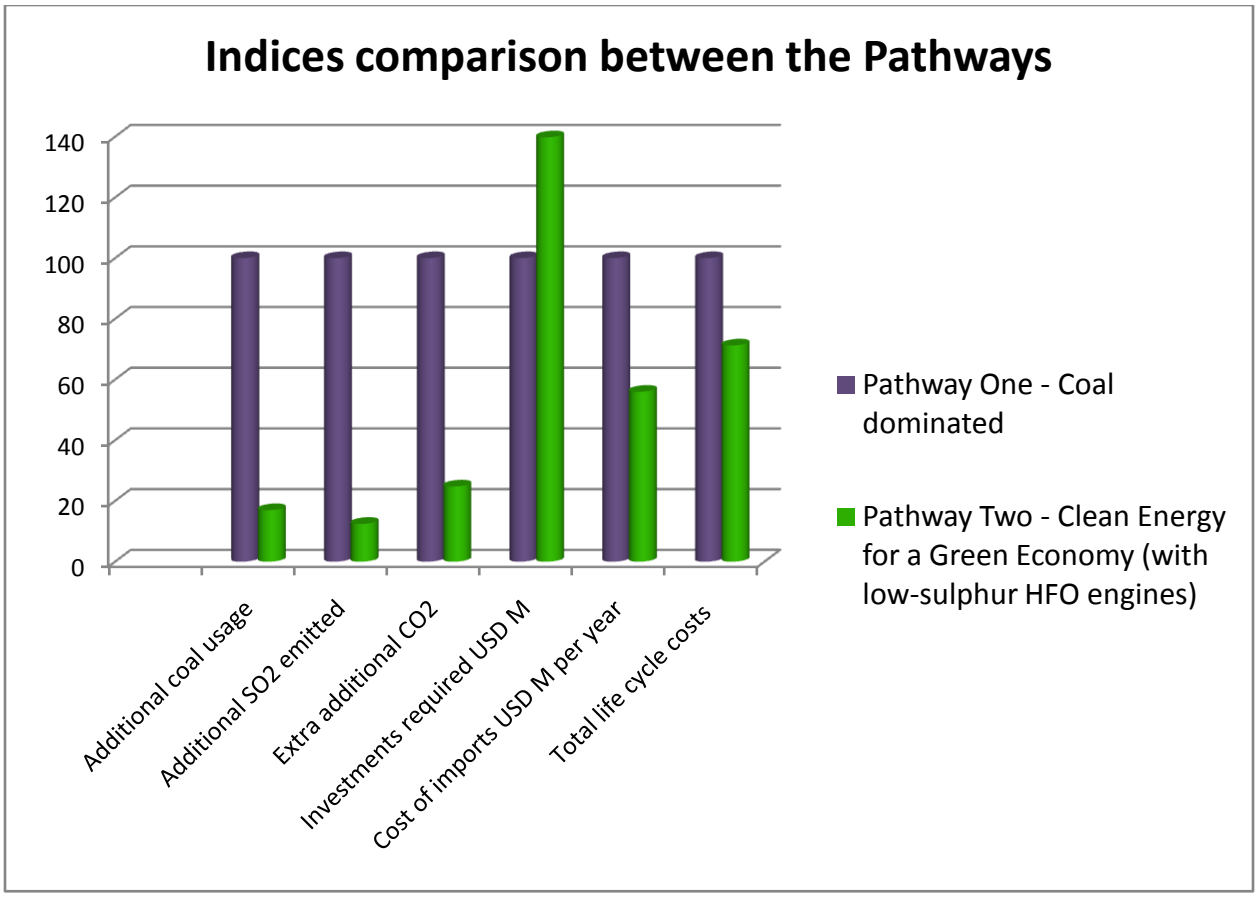
Indices	Pathway One - Coal dominated	Pathway Two - Clean Energy for a Green Economy
Additional coal usage	100	17
Additional SO2 emitted	100	12
Extra additional CO2	100	25
Investments required USD M	100	140
Cost of imports USD M per year	100	56
Total life cycle costs	100	71

Not only **Pathway Two** ensures that the MID target is met, but it stands out clearly in respect of financial/economic costs, in terms of savings stemming from demand reduction measures, which far outweigh the required investments. Pathway Two also ensures reduced CO_2 emissions. The situation on SO_2 is cause for concern. The most critical health hazards, asthma &broncho-constriction and cancer, are associated with the amount of SO_2 emitted. Equally, SO_2 emissions on account of the formation of acid rain impact negatively on human and animal life.However, the situation improves substantially if low-sulphur HFO is used. Hence,

NEC has selected for assessing Pathway Two, the low-sulphur HFO (LSHFO) option, which is more beneficial. LSHFO is more expensive than its high-sulphur HFO (HSHFO) counterpart. However the application of the 'polluter pays' principle is expected to bring the two at par. In addition, Pathway One which has a much higher percentage of fossil fuels, is more liable to cost increases due to this same principle. Here again Pathway Two comes out first. The higher percentage of local resources significantly improves the energy security in case of major supply disruptions.







On the issue of coal ash production and disposal which is linked to the quantum of coal used, Pathway Two again stands out, as this means lesser ash landfills and ash ponds, and thus less property value depreciation and inconveniences to communities living in the vicinity.

As for employment opportunities, in Pathway One, these would concern only the power plants, whereas in the Pathway Two, cane/biomass and solar/wind activities offer more job opportunities, especially at local and SME level. The promotion of local skills will be enhanced. Furthermore, the greater fulfilment of Energy Efficiency and Demand-Side Management programmes in Pathway Two will contribute to job creation and the development of skills. Employment multiplier effects thus play in favour of Pathway Two.

Furthermore, the concerns of all the islands of the Republic of Mauritius have been taken onboard without making any specific reference thereto. In some cases, notably Rodrigues, the environmental issue is far more acute than in Mauritius Island, and this will have to be taken care of in the implementation of the Pathway chosen. It is to be highlighted that Pathway One with its fossil fuel only approach is limited in its geographical scope only to

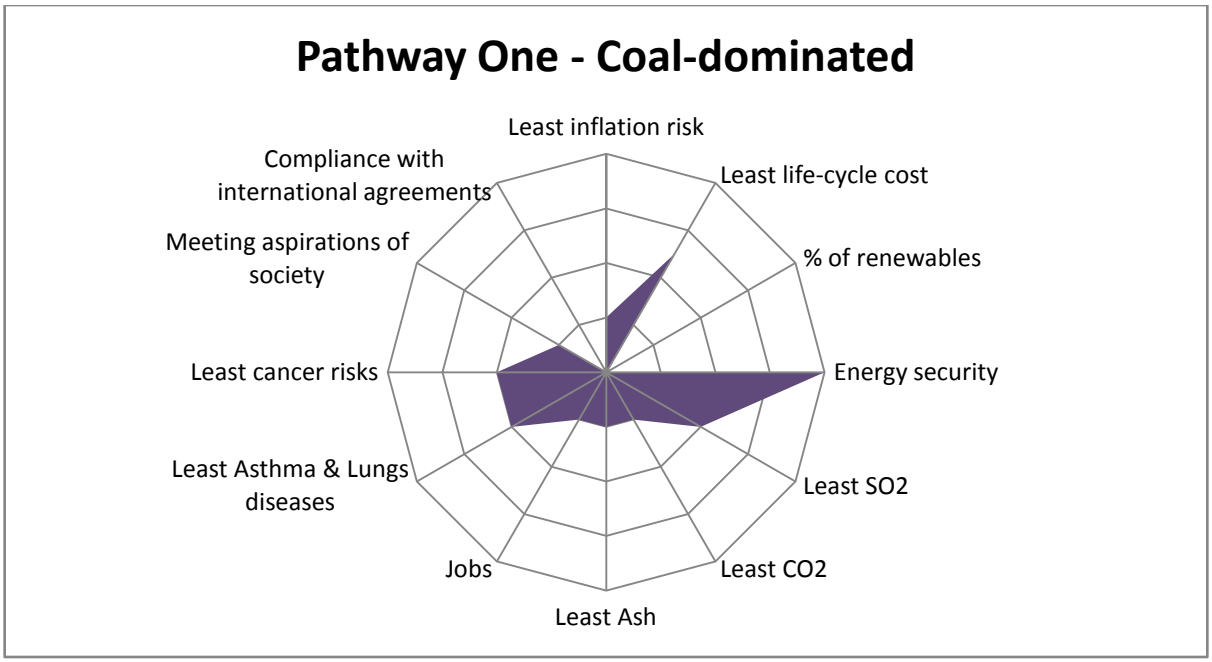
Mauritius Island whereas Pathway Two comprises a spectrum of projects that will accommodate the legitimate concerns of all the islands of the Republic of Mauritius.

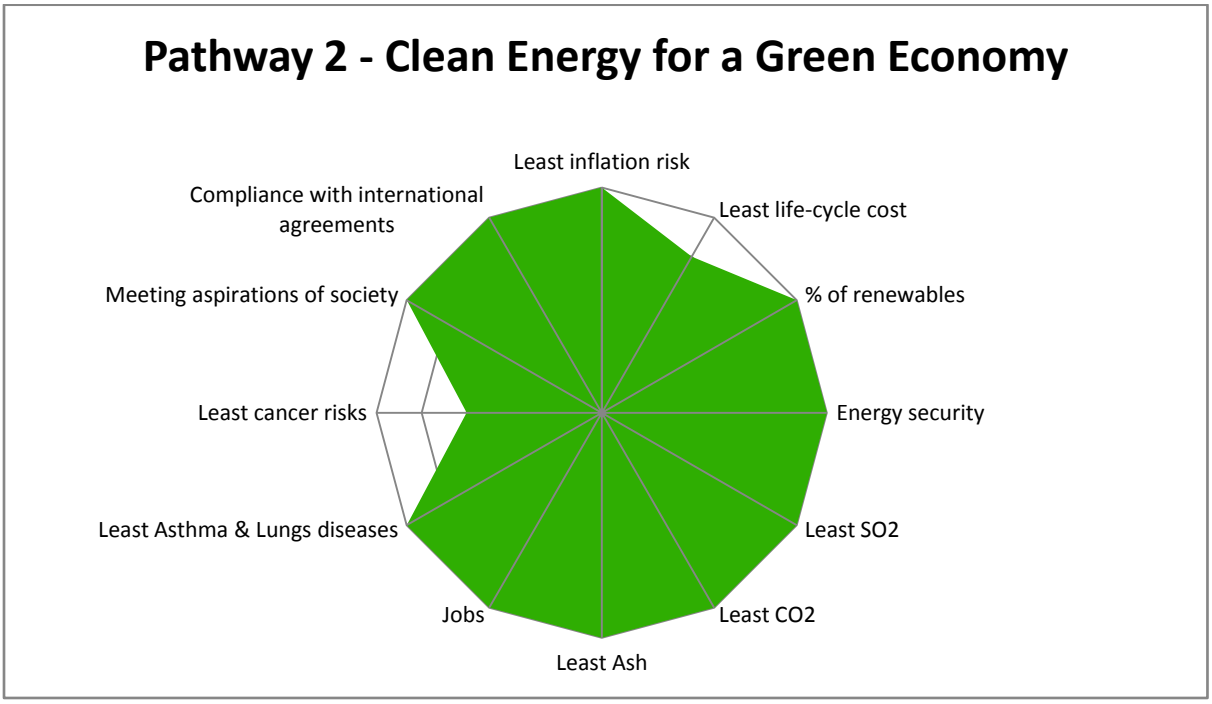
All the above considerations can be converted into a scaled approach where the lowest risk and the highest benefits score 5, and the highest risk and lowest benefits score 1, or even zero (e.g. cancer risks).

Table 9 - Scaled approach (0 is worse and 5 is best)

Item	**Pathway One** *Coal is dominant*	**Pathway Two** *Clean Energy for a "Green Economy"*
Least exposure to fossil fuel inflation	1	5
Cost over 20 years	2.5	4
Proportion of renewables	0	5
Energy security	4	5
Lowest emission of SO_2	2	5
Lowest emission of additional CO_2	1	5
Lowest ash production	1	5
Job opportunities	1	5
Asthma &Broncho-constriction	2	5
Cancer risks	2	3
Meeting aspirations of society	1	5
Compliance with international agreements	0	5

From the figures of the above table, web charts have been prepared as follows (Low-Sulphur HFO is considered in the charts shown for Pathway Two):





Pathway Two comes out first on each of the 5 criteria selected for the multi-criteria analysis:

a) Economic/financial;
b) Energy security;
c) Environmental;

d) Social / employment; and
e) Health.

4.4.3 Conclusion

To any reckoning **Pathway One** does not meet the objectives of MID and sustainability, while **Pathway Two delivers both on MID and on economic affordability**, with the LSHFO option having an edge over its HSHFO counterpart.

Pathway One uses **six**times more coal, emits **four** times more additional CO_2 and **eight** times more SO_2 than Pathway Two. Additionally Pathway One in terms of life cycle costs is some 40% more expensive than Pathway Two. Regarding the MID target of 35% Renewables in total electricity export to the grid in 2025, Pathway One brings the current level, which is at about 20% to 12.5%, whereas, Pathway Two attains the 35% target.

Also Pathway Two and its numerous benefits – renewables, national effort to reduce demand, role of small planters, SMEs and cooperatives – is expected to lay the foundations of a '**Green E**conomy' which has as main features inclusiveness and democratisation of the economy.

Pathway One (Coal-dominated scenario – starting now):

- **The country will be locking itself into an everlasting coal energy future.** Plants optimising bagasse and using new forms of biomass would be crowded out. The pressure to recoup investment on large centralised units in relatively short pay-backs will entail plants operating 24/7 as much as possible. Also, by their very nature, coal plants cannot do rapid start/stops to accommodate the integration of variable RE (wind, solar). A coal-dominant scenario makes the country's power system rigid and this will in effect seriously limit the opportunities for renewable energy, biomass cogeneration and energy efficiency / demand-side management. Investor interest in developing sustainable energy projects will be stifled. The target of 35% electricity generated from RE by 2025 willbe under serious threat. Environmental and social liabilities will also be highest.

- Neither state-of-the-art technology nor economies of scale are achievable with coal units below 300 MW capacity. There will also be less system flexibility overall, as the "largest unit out" factor will be high.

- Land utilisation, water use, ash disposal and transport requirements are largely hidden costs that are not factored in the least financial cost approach.

- The country's dependency on fossil fuel imports will be deepened, with greater exposure to higher import prices. There will be an impact on the country's attractiveness as a tourist destination and on its international environmental commitments.

- **The coal lock-in will close the door to all initiatives and emerging economic opportunities in the field of sustainable energy.**

Pathway Two: Clean Energy for a "Green Economy"

Pathway Two is the optimum energy mix, consistent with the MID objectives and based on the democratisation and decentralisation of power supply, through encouraging also small planters, cooperatives and SMEs to engage in renewable energy production, as well asthe CEB.

- It is based on a gradual reduction of the coal dominancy through the development of additional biomass (beyond bagasse) and thepossible introduction of natural gas plants (LNG or CNG) or biodiesel, which enables the large-scale integration on the grid of variable sources of RE (solar and wind). Existing HFO engines/ coal-fired boilers can be modified to take CNG/LNG supply to ensure base-load as well as variable RE backup.

- The acceleration of grid modernisation (deployment of Smart Grid) will be essential, so as to enable advanced demand-supply optimisation.

- Energy efficiency / DSM is central throughout this transition as it is pointless to add capacity without first looking at optimising the use of energy. CEB, together with EEMO, will drive energy efficiency programmes ("negawatts").

- Strong information, education and communication programmes will be critical to bring about effective behaviour change for EE/DSM.

- Existing resources and facilities/plants are optimised (bagasse, cane residues, biomass/coal-carbon burnout/sustainable waste to energy/existing RE)

- Development of large-scale electricity storage (batteries and pumped hydrostorage) to 'firm up' variable RE.

- Introduction of marine renewable energy, such as deep-sea water air-conditioning, offshore wind energy and wave energy.

- LNG/CNG development will capitalise on regional sources (Mozambique, Tanzania, etc.) and will be relevant also for transport fuel, including mass transit.

- Pathway Two will enable the 35% RE target in electricity generation to be met by 2025 (MID Action Plan).
- It is to be highlighted that with the level of rapid technology innovation taking place in the field of sustainable energy, new options will emerge over the next years which will have a major impact on the energy landscape. The flexibility of Pathway Two allows for this integration.
- Pathway Two also enables the country to meet its international commitments regarding environment protection and sustainable development agreements to which Mauritius is a contracting party. It also allows to be better positioned for international funding.

4.4.4 The preferred pathway: Moving towards a 'Green Economy'.

The NEC has undertaken qualitative and quantitative assessments of the two Pathways and, taking on board:

- the multi-criteria assessment;
- the substantive submissions and proposals received from the public and professionals of the industry (refer to Part 2 of the Report);
- international best practices; and
- MID PSAP and the Long-Term Energy Strategy 2009-2025.

the**NEC is recommending Pathway Two as the optimum energy mix, consistent with the MID objectives for the Republic of Mauritius.**Pathway Oneis not to be pursued as it will lock the country into a path that is not compatible with MID and will close the door to energy efficiency and opportunities in the emerging sustainable energy sector.

Furthermore, the NEC believes the energy mix as proposed in the Long-Term Energy Strategy for 2025 can be reviewed (see figure below), especially as it makes **no mention of electricity generation from natural gas, bioenergy or from marine renewable energy.** Consequently, there can be a significant reduction in the percentage shares assigned to coal and fuel oil in the total electricity generation, in favour of natural gas/bioenergy and variable RE in the projections of the Long-Term Energy Strategy for 2025. This is to be investigated fully through a multi-criteria sustainability assessment, supported by related feasibility studies, instead of just the least-cost approach excluding external costs. Similarly, waste-to-energy can be included if it is renewable i.e. biomass or bio-waste.

TABLE 5.2: Percentage Share of Energy Sources

Fuel source		PERCENTAGE OF TOTAL ELECTRICITY GENERATION			
		2010	2015	2020	2025
Renew-able	'Bagasse'	16%	13%	14%	17%
	Hydro	4%	3%	3%	2%
	Waste to Energy	0	5%	4%	4%
	Wind	0	2%	6%	8%
	Solar PV	0	1%	1%	2%
	Geother-mal	0	0%	0%	2%
	Sub-total	20%	24%	28%	35%
Non-Renew-able	Fuel Oil	37%	31%	28%	25%
	Coal	43%	45%	44%	40%
	Sub-total	80%	76%	72%	65%
	Total	100%	100%	100%	100%

Source: Long-Term Energy Strategy 2009-2025.

4.4.4.1 Clean Energy for a"Green Economy"

Contrary to the coal lock-in of Pathway One, Pathway Two will bring about a paradigm shift in the energy sector in Mauritius. The two pathways not only differ in terms of energy production units but more importantly in their philosophy. Pathway One solely addresses electricity production and makes no allowance for renewable energy. Pathways Two has as ultimate objective the optimal use of renewables. For instance, in Pathway One the 4x15 MW HFO engines have only a restricted scope, whereas these plants in Pathway Two are essential stepping stones to enable the graduating up to firm status of solar / wind energy. Furthermore, they represent 'anticipated investment' to provide for future peak and semi-peak demand, possibly from natural gas or biodiesel.

Pathway Two and its numerous benefits (renewables, national effort to reduce demand, role of small planters, SMEs and cooperatives) willdirectly unlock the full potential of a new economic cluster, that of Clean Energy, thus creating a new economic space in Mauritius. This will lay the foundations of a "**Green"** economywhich has as main features inclusiveness and democratisation of the economy. Over and above diversifying further the economy to become a new pillar at par with tourism, textile, ICT as foreign exchange earner, it will also harness all the competitive strengths of Mauritius (our human capital, our financial services, ICT, our solid legal and institution framework) to become a regional African player in this upcoming transversal field.

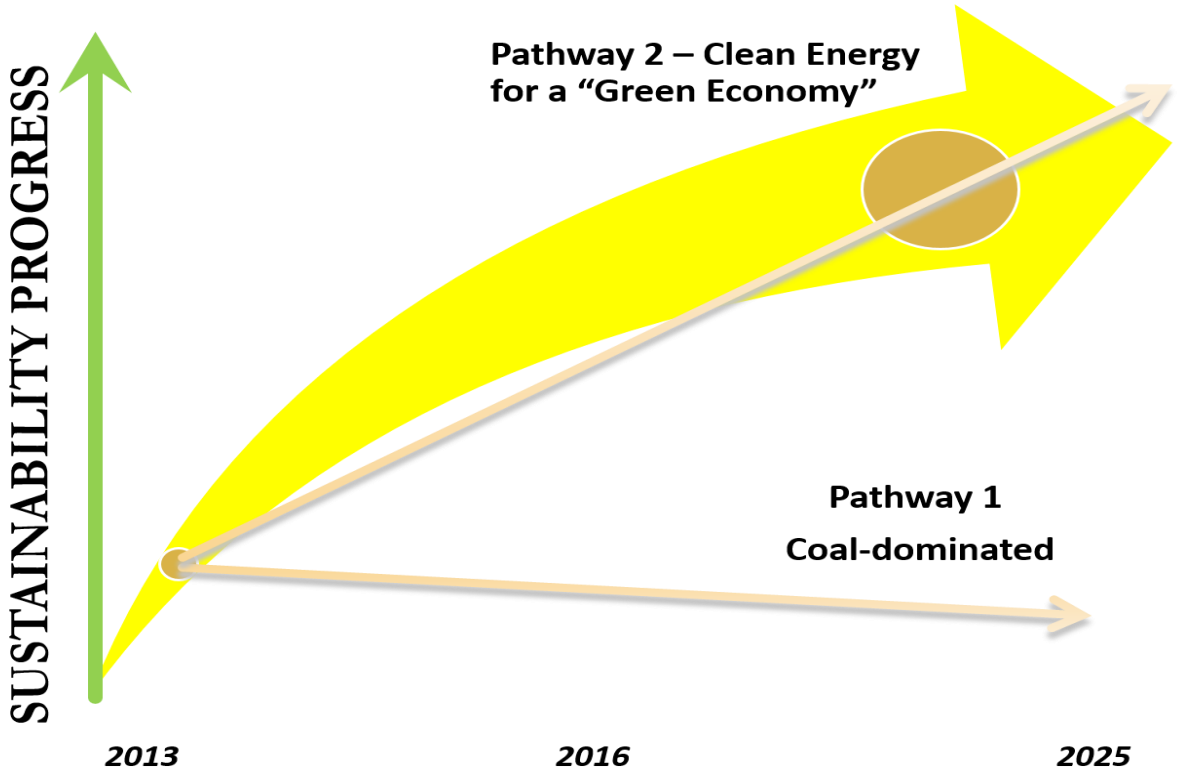


Figure 7The Two Energy Pathways

In view of the above, the NEC recommends the revisiting of the IEP to implement Pathway Two and its compliance with, and relevance to, the MID paradigm in an inclusive and participatory manner. This task would also comprise the determination of the exact additional power capacity needed till 2025.

Such a recommendation, which should be aligned with the development of master plans for Energy Efficiency/DSM and for Renewable Energy, should cover as well the Energy-Climate nexus. The development of a sectoral Nationally Appropriate Mitigation Action against Climate Change (NAMA) for the power sector is to be considered, with official submission to the United Nations Framework Convention on Climate Change (UNFCCC). This would coincide pertinently with an initiative coordinated by the Ministry of Environment and Sustainable Development to develop NAMAs for the Republic of Mauritius. It would strengthen the position and preparedness of the country to leverage international (multilateral and bilateral) financing for implementing power sector programmes that deliver the global environmental benefit of Greenhouse Gases (GHG) emission reduction.

4.5 Democratisation of the energy sector

A sustainable energy future entails also that a vital sector such as energy productioncannot be controlled by a handful of conglomerates. The effective democratisation of private energy production is essential and can be achieved by encouraging small planters, cooperatives and SMEs to transition into RE production. Also, RE deployment cannot be left to the private sector only. The public service utility needs to maintain a strong stake in the move towards sustainable energy production.

4.5.1 Encouraging small planters and citizens to transit into RE production

Renewable energy, by nature, calls for the dissemination of small plants across the Republic of Mauritius. This should be a golden opportunity to foster the emergence of medium power producers which would break current oligopoly patterns. It seems however that the recent request for proposals for 5x2 MW utility PV power plants did not see much, if any, participation from players outside of the traditional set of private sector big players. With the land they possess, small planters, particularly in cooperatives, should be the prime target in the democratisation of electricity generation.

One way to propagate solar energy production among small planter cooperatives and to attract international funding would be to work out a programme for the coupling of the FairtradeInitiative with aSmall/Medium Scale Distributed Generation (S/MSDG) scheme of 50 kW to 4000 kW (or 4 MW). Currently, some 31 cooperative societies regrouping some 5000 planters, or 50% of the cooperative movement in sugar, produce Fairtrade sugar. The

FairtradeInitiative revolves on best practices in the economic, social, environmental and good governance domains.

In any case, irrespective of the Fairtrade Initiative, small planter cooperatives in general should be encouraged by the Ministries of Energy and that of Agro-industry to transition into modern, renewable energy production. This could be bioenergy, PV or wind energy, or a mix, depending on the nature of their lands.

In addition, the surface area available from the rooftops of buildings and parking lots (residential, commercial, industrial / private or public-owned) is a valuable resource for PV electricity generation. Many countries are forging ahead with rooftop solar programmes. The CEB, with the joint support of the Ministries concerned, could encourage commercial malls, industrial estates, hotels and also, most importantly, citizens cooperatives, to secure part, or all, of their electricity needs through PV.

Energy democracy should be promoted, not corporate welfare. In Germany, energy cooperatives are a way for citizens – especially those who do not own property – to get involved in the massive energy transition programme underway (the "*Energiewende*"). Citizens come together to purchase shares in large wind turbines, biomass units, district heat networks and solar arrays. According to the latest figures, these cooperatives are booming. It is not the privilege of the wealthy, as shares are set at less than 100 euros. The setting up of citizens cooperatives is something that could be replicated in Mauritius, in line with Government's objective of "democratisation of the economy".

Finally, safeguarding the interest of future generations should also allow the current generation to protect its own future. It is proposed that the National Pensions Fund be given a mandatory share of actions on all new privately-owned RE power plants.

4.5.2 Enabling the CEB to develop RE power plants and EE/DSM projects

A second key democratisation element is the re-engineering of the national public utility body, the CEB. It is most unfortunate, and in fact contrary to the Welfare State foundation of our country, that currently investment in RE as per MID is limited to the private sector only. It is hard to see how MID's electricity objectives will be met if the CEB is not empowered to be among the main drivers, alongside the private sector, of both RE deployment and energy efficiency.

MID's Energy targets need the CEB as a driving force to open the way:

- CEB has proven expertise in setting up and operating power plants

- CEB has the technical know-how to support the work of the Energy Efficiency Management Office.
- The CEB needs to be given resources to invest in RE. Keeping RE investments away from the CEB will block it into operating only fossil fuel power plants and render it obsolete in the medium term.
- A public-owned power plant benefits the population, as once investment costs are recouped, the country obtains cheap prices.

CEB needsto be assigned a clear target share in the MID objective of 35% of electricity produced from RE by 2025. Government, through its main bodies, has to lead on MID's implementation. The country needs the public and private sectors to be strong together. State monopoly and complete privatisation are two extremes to be avoided at all costs.

4.6 Policy and Institutional Framework required

4.6.1 Planning

4.6.1.1 The IEP process

A permanent governance arrangement for the IEP should be instituted with a larger participation from relevant government organisations, civil society, business, academia and trade unions. The IEP should be a dynamic plan and be continuously revised and updated, as necessitated by changing circumstances. The IEP should enable the clear, concrete and coherent transition towards a sustainable energy future, as spelt out in MID.

4.6.1.2 Office for Sustainable Energy Development (OFSED)

There is currently a void in terms of formal institutional setup for ensuring that RE project proposals are systematically recorded via a transparent process and undergo a multi-criteria sustainability assessment.

The NEC therefore recommends the setting up of an independent body under the aegis of the Ministry of Energy and Public Utilities, which may be called the Office for Sustainable Energy Development (OFSED), governed by a Board. The members would bring experience and

expertise from a wide range of areas including Industry, Economics, Consumer and Social policy, Health, Science and Technology, Environment, Finance and investment.

The role of that body would be to inter alia:

a) Advise in the formulation of policy and strategies to achieve **sustainability** in the energy sector in line with Maurice, Ile Durable;

b) Promote the effective implementation of the renewable energy programmes;

c) Ensure that the interests of consumers, public health, the environment and future generations are safeguarded in the field of energy;

d) Assess and advise on the **sustainability** of project proposals in the energy sector.

4.6.2 Environmental aspects in electricity generation

4.6.2.1 Environmental standards governing electricity generationin Mauritius

Currently there are gaps in the norms and standards (e.g. Sulphur Dioxide - SO2, Nitrogen Oxides – NOX, particulates, dioxins, ash disposal etc) to be enforced concerning pollution caused by electricity generation. A single, comprehensive set of norms and standards for the Republic of Mauritius needs to be defined. However, environmental standards should reflect the specificity of the local context, in particular the relation between emissions standards and ambient air quality, provided that public safety and pollution aspects are adequately addressed. The review of norms and recommendations for the establishment of adapted norms is thus a matter of urgency.

4.6.2.2 Ash Disposal

- Therecommendations of the Technical Advisory Committee (TAC) of 2008 remain most pertinent.
- The licence for disposal issued to IPPs should be periodically renewed by application to the Ministry of Environment, with all information given on the methods of disposal and with a fee to be charged by the Ministry for enforcement and monitoring purposes.
- Novel applications for ash disposal, such as cement mixing and road filling, should be investigated through research and development.
- Current projects for ash disposal through coal burn-out, as well as application in road construction need to be facilitated, after full environmental impact assessment.

4.7 Capacity-Building, Research and Development

Many aspects regarding the integration of renewables in our island system (e.g., reliability, variability, forecast accuracy, etc.) must be investigated comprehensively. More capacity-building, research and development (R&D) is needed on the mix of solutions that could be put in place to allow higher penetration levels of in the future. Further work includes various technical/economic studies on these topics, as well as an evolution towards probabilistic approaches to properly quantify risk levels and draw meaningful conclusions. The next few years should be devoted to capacity-building and R&D on managing the intermittency and quantifying the capacity credit of RE, as well as on setting up and then operating the Smart Grid.

Other priority projects include:

- Research and development related to gasification technology and its integration in bio-refinery/flexi-factory in the context of the cane or biomass industries
- Research and development related to co-generation (heat and electricity) and tri-generation (heat, electricity and cooling) in the local context
- Development of alternative sustainable forms of energy (geothermal, marine renewable energy, waste, etc.)
- Behavioural research on Demand-Side Management in the local context
- Mathematical modelling to forecast energy and peak demands
- Development of advanced biofuels (including ocean energy)
- Applications of cold sea-water for air-conditioning and power generation

Further research is required on the full costs relating to specific technologies (coal, HFO)around the costs of decommissioning and managing waste

4.8 Funding

RE and EE/DSM deployment will require tremendous research and development, as well as incentives package to accelerate economic feasibility. Restructuring the MID Fund and reviewing the MID levy is critical in that regard. Currently, all MID levy contributions on coal are borne by the CEB and thus by the population. This is contrary to the “polluter pays” principle. Private operators who pollute are passing on the penalty to those who pay them already for

their activity. Furthermore, all MID levy contributions at present are not going directly towards MID activities but instead are merged into the Government's general Consolidated Fund. Consequently, the principle that polluting activities fund the emergence of sustainable activities is not happening in practice.

The MID levy system on fossil fuels needs therefore to be reviewed with the aim of having a new mechanism to charge a levy on coal used for electricity generation, that:

a) **Is applied strictly according to the 'polluter pays principle';**
b) **Is not passed on to the consumers; and,**
c) **Funds strictly RE and EE/DSM projects to facilitate the transition to a sustainable energy future.**

This will enable the setting up of a **Sustainable Energy Innovation and Development Fund (SEIDF)**.It is to be highlighted that operators contributing to the coal levy will be eligible to the SEIDF, if they want to transition towards sustainable electricity production. In the case of the coal-bagasse IPPs, such a system will encourage the shift towards biomass and will benefit the IPPs. **The coal levy for sustainable energy can be as successful as the 2% CSR levyfor social empowerment**which has boosted the impact of private sector funding for the fight against poverty and exclusion.

5. RECOMMENDATIONS FOR ACHIEVING A SUSTAINABLE ENERGY FUTURE AND FOSTERING THE EMERGENCE OF A "GREEN ECONOMY"

NEC 9 **The NEC has identified 2 possible future energy pathways for the Republic of Mauritius. On the basis of economic, environmental and social criteria, the NEC is recommending Pathway 2,** which comprises a combination of bagasse/biomass development for coal substitution, with possible natural gas/biodiesel development, along with the integration of solar, wind and other RE, with electricity storage. Energy Efficiency and Demand Side Management (EE / DSM) are vital components of Pathway 2. The Pathway will lead to **the emergence of a new economic sector: the "Clean Energy" sector, and will lay the foundations of a "Green Economy".** In-depth studies, including the development of master plans for Energy Efficiency/Demand-Side Management and Renewable Energy, need to be conducted to ascertain the exact additional power capacity needed under the MID paradigm. **The energy future of Mauritius is to be worked out with precision, in line with the MID Policy and Energy Pathway Two, through appropriate modelling exercises and detailed feasibility studies. The** development of a sectoral Nationally Appropriate Mitigation Action against Climate Change (NAMA) for the power sector is to be considered.

NEC 10 **Operationalize the Utility Regulatory Authority (URA) before end of 2013** – (MEPU)

NEC 11 **Set up an Office of Sustainable Energy Development (OFSED) by mid-2014**, with members drawn from all key stakeholders, including civil society, to inter alia:

a) Advise in the formulation of policy and strategies to achieve **sustainability** in the energy sector in line with Maurice, Ile Durable;

b) Promote the effective implementation of the renewable energy programmes;

c) Ensure that the interests of consumers, public health, the environment and future generations are safeguarded in the field of energy;

d) Assess and advise on the **sustainability** of project proposals in the energy sector.

NEC 12 **Restructure the MID Fund so as to create a Sustainable Energy Innovation and Development Fund (SEIDF), anddevise for its funding a new mechanism to charge a levy oncoal used for electricity generationthat:**

a) Is applied strictly according to the "polluter pays principle";

b) Is not passed on to the consumers; and,

c) Is used strictly to fund RE and EE/DSM projects to facilitate the transition to a sustainable energy future.

NEC 13 Develop a Long-Term Energy Efficiency/ Demand-Side Management Master Plan for the Republic of Mauritius, complementary with the Renewable Energy Master Plan.

NEC 14 Develop a Renewable Energy Master Plan for the Republic of Mauritius by 2014 and initiate the large scale grid integration of variable RE through the following:

14.1. **Define a methodology for the management of large scale grid integration of variable RE**. Ascertain the potential impacts of variable generation on the national grid and identify the actions needed in terms of backup, storage and demand response, so as to modernise the grid (Smart Grid).

14.2. **Define the precise capacity credit to be assigned to variable RE**. Capacity credit is the measure of the contribution that intermittent generation can make to reliability at peak demand. It has to be defined **by evaluating the overall system and by performing a probability risk assessment**.

14.3. **Based on international best practices,use the existing hydropower, medium-speed diesel engines and gas turbines as backup capacity for variable RE power plants, and give variable RE plants first priority in generation scheduling and dispatching under normal power system operating conditions.**

NEC 15 As part of the RE Master Plan, implement large-scale electricity storage for variable RE to become firm power through the following:

15.1. A feasibility study should be conducted to assess the potential for pumped hydro storage (PHS) in Mauritius, including seawater PHS.

15.2. Initiate utility-scale battery storage demonstration projects (2 to 5 MW, discharging over 3 to 5 hours) by mid-2014, to test various technologies and develop local expertise.

15.3. Competitive bidding for RE projects should include the installation of storage facilities.

NEC 16 Set up a Biomass and Renewable Energy Development Programme (BREDP) to devise a package of measures for the promotion of bagasse/biomass, biogas, solar and wind, by mid-2014. The task of setting up the BREDP could be left to the proposed OFSED.

NEC 17 **Enable CEB to build and operate RE plants**, so as not to limit RE projects only to private promoters, **and define a target share for CEB in MID's objective of 35% of electricity generated from RE**.

NEC 18 **Encourage small planters, SMEs and cooperatives to transition into renewable energy production (e.g. solar parks and wind farms), with the possibility of VAT refund considered as part of a full support package**, **so as to enable the democratisation of private energy production**, **by mid-2014**.

NEC 19 **Review the price of bagasse for small and medium planters so that it encourages bagasse production**. The increase should go to planters, without direct or indirect links with millers or power producers, after negotiations with all parties concerned. An ideal win-win situation for all concerned is possible, as the higher use of bagasse can be economically profitable for both CEB and IPPs, bagasse being considerably cheaper than coal. A volume-related pricing mechanism for bagasse would boost production and availability of bagasse.

NEC 20 **Devise a price mechanism for bio-energy (biogas, biomass, biodiesel) that will encourage the development of bio-energy**. The task of determining the precise prices and the applicability thereof could be left to the proposed OFSED.

NEC 21 **The IEP needs to be updated by early 2014 to implement Pathway 2**,**in line with all the above, in an inclusive, participatory manner, and by using planning tools and methods that align energy planning with sustainable development**. Concurrently steps could be taken:

21.1. To Launch RFPs for new power plants

21.2. For New power plants to be in operation by 2015/2016

21.3 For the new Renewable Energy Procurement Framework to be implemented by 2014

6. CONCLUSION

There may be no power deficit over the period 2014-2016, as this can be avoided through optimising the maintenance schedule of power plants and the proposed introduction of medium-speed diesel engines (60 MW), that can be later retrofitted to run on natural gas/biodiesel. The medium-speed diesel engines will also facilitate the integration of variable renewable energy by providing back-up and will, eventually, act as replacement for the Pielstick engines as well as provide for future peak /semi-peak demand.

The country has, therefore, the breathing space – and the means – to set in motion the necessary measures needed to achieve the transition towards a sustainable energy future.

Persisting with a coal-dominated energy pathway will lock the country into an everlasting coal energy future, with negative impacts in terms of pollution, health hazards and dependency on costly fuel imports. Also, the diversity of concerns and potential of all the islands of the Republic will not be addressed, and the MID target of 35% electricity generated from RE by 2025 will not be met.

Instead another pathway is possible, which reconciles environmental and health concerns with economic priorities (Pathway Two). With the unprecedented reduction in cost as well as rapid technological development taking place in the field of renewable energy, Mauritius can capitalise on its abundance of solar and marine renewable energy and open up a new economic space full of growth potential. This MID-compliant pathway and its numerous benefits (renewables, national effort to reduce demand, role of small planters, SMEs and cooperatives) will not only meet all the socio-economic objectives of Government but also launch a***'Green Economy'***,which has as main features inclusiveness and democratisation of the economy. The emergence of a Clean Energy sector will help bring the Republic of Mauritius to another development level, with strong opportunities to expand in the African region.

The NEC therefore recommends the revisiting of the IEP to implementPathway Two and its compliance with, and relevance to, the MID paradigm in an inclusive and participatory manner.

Giving Mauritius a sustainable energy future will not only benefit us, it will be the gift of a prosperous future to forthcoming generations.

APPENDICES

LIST OF APPENDICES

APPENDIX 1 – COMPOSITION OF THE NATIONAL ENERGY COMMISSION AND ITS TECHNICAL COMMITTEES

1. **Mr D. D. Manraj,** Head, Project Management Delivery Unit, Prime Minister's Office – *Chairperson*
2. **Mr R. Chellapermal**, Ag. Deputy Financial Secretary, Ministry of Finance & Economic Development
3. **Mr J. Chellum**, Representative of Consumers' Interest, Association des Consommateurs de L'Ile Maurice (ACIM)
4. **Mr R. Duva-Pentiah**, Permanent Secretary, Ministry of Energy & Public Utilities
5. **Dr K. Elahee,** Associate Professor, University of Mauritius & Chairman, Energy Efficiency Committee
6. **Mr Y. Hookoomsing**, Representative of the Ecologist Movements & of *KolektifpuLenerziRenuvlab*
7. **Mr R. Imrith**, President of The Public Sector & Other Unions
8. **Mr. R. Kallee**, Deputy Director of Environment, Ministry of Environment & Sustainable Development
9. **Mr. O. Mahomed**, Executive Chairman, *Maurice Ile Durable* Commission
10. **Mr. R. Makoond,** Executive Director, Joint Economic Council
11. **Prof. T. Ramjeawon**, Dean, Faculty of Engineering, University of Mauritius
12. **Dr. A. Suddhoo**, Executive Director, Mauritius Research Council
13. **Mr S. K. Thannoo,** General Manager, Central Electricity Board
14. **Mrs G.Topsy-Sonoo**, Ag. Assistant Solicitor-General,Attorney-General's Office
15. **Mr D.Gopaul**, Deputy Permanent Secretary, Ministry of Energy & Public Utilities –*Secretary*

The Technical Sub-Committees

The Commission set up two sub-committees, the first one to deliberate on specific technical matters in the energy sector, more particularly on the demand and supply matrix of electricity in the country, and the second one to hear organisations and members of the public who have expressed their wish to be heard by the Commission.

The 1st technical sub-committee is constituted as follows:

- Chairman: Dr A. Suddhoo,
- Co-Chairman: Prof. T. Ramjeawon;
- Members: Mr J. Chellum, Dr K. Elahee, Mr Y. Hookoomsing, Mr R. Kallee and Mr R. Makoond.

The 1st technical sub- commitee held its first meeting on 19th March 2013 at the Mauritius Research Council and has held over twenty meetings.

The 2nd technical subcommittee was set up on 21st March 2013. Its composition is as follows:

- Chairperson: Mr. O. Mahomed,
- Members: Mr S.K. Thannoo, Mr R. Kallee, MrR.Imrith.

The 2nd sub-committee held its first meeting on 9th April 2013 and has had 45 public hearings. Its report is in Part 2 of the NEC Report.

APPENDIX 2– MAIN REQUIREMENTS OF AN IEP AS PER THE BEST PRACTICE GUIDE FROM USAID: "*BEST PRACTICES GUIDE: INTEGRATED RESOURCE PLANNING FOR ELECTRICITY*"

1. **Integrated Electricity Planning (IEP)** is a process of planning that satisfies multiple objectives for resource use. Broad objectives can include:
   - Conform to national development objectives
   - Ensure that all households and businesses have access to electricity services
   - Maintain reliability of supply
   - Minimize the short term or long term economic cost of delivering electricity services
   - Minimize the environmental impacts of electricity supply and use
   - Enhance energy security by minimizing the use of external resources
   - Use of local resources
   - Provide local economic benefits
   - Minimize foreign exchange costs
   - Diversify supply
   - Increase efficiency
   - Provide local employment
   - Retain flexibility Developing plans that are flexible enough to be modified when costs, political situations, economic outlook, or other conditions change

   The objectives set by the utility guide the planning. Such objectives as the above conflict with one another to varying degrees. Therefore, preparing, deciding upon, and implementing a preferred plan requires both a series of objective *analyses* and the use of *processes* by which the values and judgements of stakeholders are applied in developing the plan. C*riteria* by which the achievement of each objective may be measured must also be established.

2. IEP approaches to *vertically integrated* power systems should govern the selection of power plants as well as investment in other aspects of electricity supply and in demand-side efficiency measures as well.

3. **IEP is built on principles of comprehensive and holistic analysis.** An IEP should consider a full range of feasible supply-side and demand-side options and assesses them against a common set of planning objectives and criteria. IEP is also a transparent and participatory planning process. It contrasts with traditional planning that is typically top-down, with public consultation occurring only as a last step, when plans are virtually complete. IEP can make planning more open to relevant governmental agencies, consumer groups, and others, thus considering the needs and ideas of all parties with a stake in the future of the electric system.

4. **Investigation of Demand-Side Options:**IEPs are a mix of supply-side and demand-side resources. While the supply-side resources generally dominate, DSM resources can significantly reduce required supply-side additions over a planning period. Demand-side management, or DSM, refers to programs or projects undertaken to manage the demand

for electricity: reducing electric energy use, changing the timing of electricity use (and thereby the profile of peak power demand), or both. By reducing the demand for electric energy and power, DSM options can reduce the use of existing electric supply facilities (or, equivalently, serve more users with given facilities), and defer the addition of new capacity. Review of DSM options begins with identification of all applicable options and their cost and performance characteristics. The more promising DSM options are selected for further study and incorporation in draft DSM programs and plans. It is necessary to collect data on DSM options so that they can be compared with each other and with supply-side options. Another source of ideas and information is utility system customers themselves. Commercial and industrial consumers in particular are likely to be aware of DSM options that fit their needs. Representatives of these groups can be consulted when preparing a list of DSM options.

5. **Preparation and Assessment of Supply Plans and DSM Plans:** Once data on the possible supply-side and DSM options have been assembled, and a list of the most attractive options in each category has been decided upon, the next step in the planning cycle is to compile the options into candidate supply and DSM plans that help to meet forecasted electricity demand. A utility system DSM *plan* is a set of one or more DSM *programs* to encourage the adoption of DSM measures, yielding electricity and/or cost savings to electricity consumers, the utility system, and society. A DSM plan describes the actions that a utility system or other program administrator will take over some period of years. Assessment criteria for DSM plans overlap those for supply plans, and include energy and peak power savings, costs, practicality and applicability, net environmental impacts, etc. The basic measure of the cost-effectiveness of a DSM program or plan is how its costs compare with those of the supply-side resources that it displaces. There exists a variety of software tools that can be used to evaluate DSM plans, including spreadsheet software and programs written especially for the purpose.

6. **Alternative IEPs: Construction and Assessment:** The culminating steps in IEP assemble candidate supply- and demand-side plans into a set of candidate integrated resource plans, evaluate these IEPs, and select a preferred IEP for the coming years. Candidate IEPs combine plans for supply- and demand-side resources into a *resource portfolio* that meets forecasted electricity requirements. With either strategy, candidate IEPs must be reviewed carefully to ensure that the candidate plans are fully practical. Deciding among the candidate IEPs is then a matter of setting the evaluation criteria to be applied, evaluating and ranking the candidate plans according to the criteria, and then using the results of the evaluation to decide on one or more preferred or optimal plans to adopt for implementation (or further study). The criteria used for assessing candidate IEPs will typically include many of the same criteria that were used in evaluating supply- and demand-side plans, and should overlap substantially with the list of basic objectives generated by stakeholders at the beginning of the planning process. Selecting a preferred integrated resource plan (or a few top options) from a wide range of choices is a complex process, and should be decided systematically if the result of the planning process is to be credible. There are several methods, with many variations, for deciding which plan or plans is or are most desirable. These range from simply listing each attribute of each plan in a

large matrix and methodically eliminating candidate plans (noting why each is eliminated), to quantitative approaches involving Multi-Criteria Analysis. One of the critical process principles of IEP is to conduct the decision process in a transparent, clear, and complete manner, so that others may review the decisions made along the way.

Sample Criteria for Assessment of IEP Plans

Financial Criteria

- Overall plan cost (including capital, fuel, and other costs, usually expressed in present value terms)
- Plan capital cost
- Plan fuel costs
- Plan foreign exchange cost
- Interest coverage ratio
- Return on equity
- Utility net income
- Internal generation of funds

Performance Criteria

- Customers served
- Loss of load probability
- Reserve margin
- Efficiency of energy use (on supply- and/or demand-side)

Energy Security Criteria

- Diversity of supply (fraction of each fuel used)
- Use of domestic resources
- Use of renewable resources

Environmental Criteria

- Amount of carbon dioxide produced over the life of the plan
- Amounts of other air pollutants (acid gases, particulate matter, hydrocarbons) produced over the life of the plan
- Amount of land used for energy facilities
- Liquid waste production
- Solid waste production (accounting for differences between hazardous and non-hazardous wastes)
- Plan impact on wildlife, biodiversity

Other Criteria

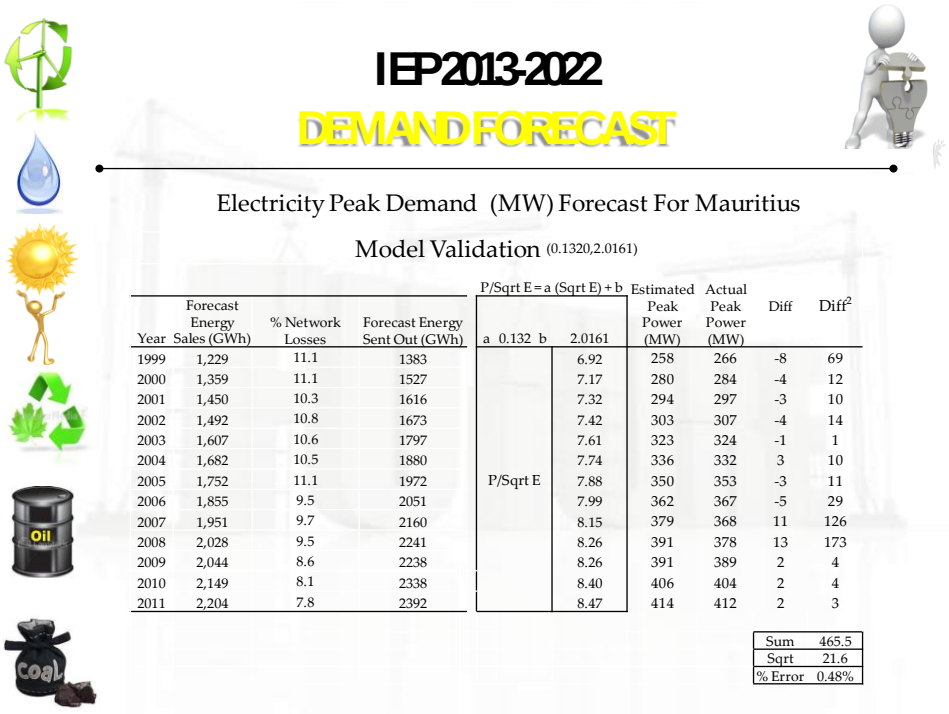
- Aesthetic issues (impact of plan on recreation, tourism)
- Employment impacts of plan
- Impacts of plan on other economic sectors (both positive and negative impacts)
- Political acceptability/feasibility of plan
- Social implications of plan (including impacts on local and indigenous populations)
- Cultural impacts of plans (impacts on culturally important resources)

7. **Implementation, Evaluation, Monitoring and Iteration:**The IEP should be a living document, to be updated as conditions change and as new information becomes available. Since planning is a continuous process, the development of IEPs is repeated periodically. Interim updates may be scheduled, or midcourse corrections may made as necessary to respond to changing conditions. Flexibility is important. When a development occurs that was not adequately foreseen or considered, it is important to revisit the plan, rather than rigidly abiding by it, or, in the alternative, bypassing it. When done properly, IEP provides a structure and an opportunity for utility systems and stakeholders to learn and to develop plans in a co-operative atmosphere. Although the IEP ultimately adopted is considered the blueprint for utility activities, conditions do change. Changes in an IEP over time are inevitable, necessary, and desirable, when made in a transparent and well-documented fashion.

In summary, an IEP provides an opportunity for electric system planners to address complex issues in a structured, inclusive, and transparent manner. At the same time, it provides a chance for interested parties to review, understand, and provide input to planning decisions. Incorporating the views of a broad spectrum of those that will be affected by planning decisions can foster consensus and avoid polarization as the plan is being implemented.

APPENDIX 3 – PEAK DEMAND FORECAST ACCURACY

Peak-demand forecast: The CEB claims an accuracy of within 0.48% in terms of peak demand forecast using the period 1999-2011 to validate its current methodology (see slide below).



Electricity Peak Demand (MW) Forecast For Mauritius

Model Validation (0.1320,2.0161)

Year	Forecast Energy Sales (GWh)	% Network Losses	Forecast Energy Sent Out (GWh)	P/Sqrt E = a (Sqrt E) + b a 0.132 b 2.0161	Estimated Peak Power (MW)	Actual Peak Power (MW)	Diff	Diff^2
1999	1,229	11.1	1383		258	266	-8	69
2000	1,359	11.1	1527		280	284	-4	12
2001	1,450	10.3	1616		294	297	-3	10
2002	1,492	10.8	1673		303	307	-4	14
2003	1,607	10.6	1797		323	324	-1	1
2004	1,682	10.5	1880		336	332	3	10
2005	1,752	11.1	1972	P/Sqrt E	350	353	-3	11
2006	1,855	9.5	2051		362	367	-5	29
2007	1,951	9.7	2160		379	368	11	126
2008	2,028	9.5	2241		391	378	13	173
2009	2,044	8.6	2238		391	389	2	4
2010	2,149	8.1	2338		406	404	2	4
2011	2,204	7.8	2392		414	412	2	3

Sum	465.5
Sqrt	21.6
% Error	0.48%

The validation above rests upon knowledge of the % network losses. The values for the % network losses in the table above refer to observed data, NOT to forecasts (IEP, Percentage Network Losses for the Period 2001-2011, p138). Hence, the peak demand forecast is meaningless at the time it is made as the correction involving actual % network losses is not possible. The 0.48% error margin is based on a flaw in the methodology which requires exact observed data for a parameter (% network losses) to allow a forecast.

As rightly pointed out in the IEP, '' peak demand evolution is, in fact, the key factor that guides the kind, and size, of investments (base, semi-base or peak) in power generation...'' (p39).Thus the flaw in the methodology renders null and void the conclusions drawn on relying the IEP forecast.

APPENDIX 4 – COMPARISON BETWEEN ACTUAL AND FORECAST VALUES FOR PEAK POWER AND DEMAND 2006 - 2012

If we compare the actual peak demand compared to previous forecast, it would seem that there is a systemic tendency to over-estimate actual demand for electricity:

Table 10 - ACTUAL AND FORECAST PEAK POWER FOR YEARS 2006-2013 (MW)

YEAR	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Actual Recorded Values for Peak Power (MW)[a]	367	368	378	389	404	413	430 [b]
CEB Peak Power Forecasts (MW)[c]	**365**	**382**	**401**	**420**	**437**	**456**	**478**
Difference between Forecast and Actual values (MW)	-2	14	23	31	33	44	48
% Difference between Forecast and Actual values	-1	4	6	8	8	11	11
Average discrepancy over 2007 - 2012:	**27 MW**						

[a] Table 3.1, p 40, *Digest of Energy and Water Statistics - 2011*, Statistics Mauritius

[b] Table 7, *Energy and Water Statistics 2012*, Statistics Mauritius

[c] Refer Appendix 3, p 2, ***Outline Energy Policy 2007***

Table 11 - ACTUAL AND FORECAST ENERGY DEMANDS FOR YEARS 2006-2013 (GWh)

YEAR	2006	2007	2008	2009	2010	2011	2012
Actual Recorded Values for Energy-Demands (GWh)[a]	2,091	2,199	2,276	2,274	2,376	2,433	2,495 **c**
CEB Energy-Demands Forecasts (GWh)[b]	**2,129**	**2,250**	**2,378**	**2,510**	**2,632**	**2,769**	**2,924**
Difference between Forecast and Actual values (GWh)	38	51	102	236	256	336	429
% Difference between Forecast and Actual values	2	2	4	10	11	14	17
Average discrepancy over 2007 - 2012:	**207 GWh**						

[a] Table 3.5, p 43, *Digest of Energy and Water Statistics - 2011*, Statistics Mauritius

[b] Appendix 3,***Outline Energy Policy 2007***

[c] Table 9, *Energy and Water Statistics 2012*, Statistics Mauritius

APPENDIX 5 – FORECAST FOR PEAK DEMAND IN THE IEP

In the IEP, the CEP presents three scenarios for future peak demand growth: low, base and high. It is to be noted that it is the "high scenario" that is the foundation for justifying the need for adding 200 MW new capacity in the near future. However, as per the table below copied from the IEP, one can see that the "high scenario" starts immediately with a figure for 2012 that is inaccurate: 444 MW whereas the figure recorded in 2012 was 430 MW (CEB presentation to the NEC). If the baseline figure of the series for 2013-2022 is inaccurate, then the rest of the forecasted figures under the high scenario cannot be relied upon.

Chapter 4: Demand Forecast for Mauritius
Integrated Electricity Plan 2013–2022

TABLE 4.5: Estimated Peak Demand (MW)

	SCENARIOS		
YEAR	LOW	BASE	HIGH
2012	422	430	444
2013	431	447	462
2014	439	461	480
2015	446	475	506
2016	453	492	541
2017	460	508	571
2018	467	521	605
2019	474	534	630
2020	480	548	655
2021	487	561	675
2022	493	574	702

To this must be added the fact that under the « high scenario », huge annual increases year on year are stated, without any backing evidence. Peak demand jumps by 26 MW between 2014 and 2015, then 35 MW between 2015 and 2016, followed by increases of 30 MW between 2016 and 2017 and 34 MW between 2017 and 2018. Yet, when looks at recent patterns, the *2011 Digest of Energy and Water Statistics* indicates that increases of that magnitude have never been recorded. The highest annual increase in peak demand over the past ten years was 20.9 MW in 2004-2005, with an average of 10.6 MW annual increase in peak demand. With the global economy being in a prolonged state of recession for the foreseeable future, it is therefore most unlikely that the huge increases forecasted in the "high scenario" will materialise.

APPENDIX 6 – COST ESTIMATES FOR ELECTRICITY GENERATION

Table 12 below gives the average levelized costs for generating technologies in the US that are brought in service in 2018, as calculated by the US Energy Information Administration (http://www.eia.gov/forecasts/aeo/er/index.cfm.) The levelized costs are calculated based on a 30 year cost recovery period. It should be pointed out that while levelized costs are a convenient summary measure of the overall competitiveness of different generating technologies, actual plant investment decisions are affected by the specific technological and regional characteristics of a project, which involve numerous other considerations.

Table 92 - Estimated levelized cost of new generation resources in the USA, 2018

Table 1. Estimated levelized cost of new generation resources, 2018

		U.S. average levelized costs (2011 $/megawatthour) for plants entering service in 2018				
Plant type	Capacity factor (%)	Levelized capital cost	Fixed O&M	Variable O&M (including fuel)	Transmission investment	Total system levelized cost
Dispatchable Technologies						
Conventional Coal	85	65.7	4.1	29.2	1.2	100.1
Advanced Coal	85	84.4	6.8	30.7	1.2	123.0
Advanced Coal with CCS	85	88.4	8.8	37.2	1.2	135.5
Natural Gas-fired						
Conventional Combined Cycle	87	15.8	1.7	48.4	1.2	67.1
Advanced Combined Cycle	87	17.4	2.0	45.0	1.2	65.6
Advanced CC with CCS	87	34.0	4.1	54.1	1.2	93.4
Conventional Combustion Turbine	30	44.2	2.7	80.0	3.4	130.3
Advanced Combustion Turbine	30	30.4	2.6	68.2	3.4	104.6
Advanced Nuclear	90	83.4	11.6	12.3	1.1	108.4
Geothermal	92	76.2	12.0	0.0	1.4	89.6
Biomass	83	53.2	14.3	42.3	1.2	111.0
Non-Dispatchable Technologies						
Wind	34	70.3	13.1	0.0	3.2	86.6
Wind - Offshore	37	193.4	22.4	0.0	5.7	221.5
Solar PV[1]	25	130.4	9.9	0.0	4.0	144.3
Solar Thermal	20	214.2	41.4	0.0	5.9	261.5
Hydro[2]	52	78.1	4.1	6.1	2.0	90.3

Table 13by the European Commission (European Commission (2008), *Energy Sources, Production Costs and Performance of Technologies for Power Generation, Heating and Transport*) provides a range of estimates for various technologies under a moderate fuel-price scenario.

Table 13 - Cost of Energy Technologies for power generation in the EU under a moderate fuel price scenario.

Energy source	Power generation technology		Production cost of electricity (COE)				Life cycle GHG emissions			
			State-of-the-art 2007 £2005/MWH	Projection for 2020 £2005/MWH	Projection for 2030 £2005/MWH	Net efficiency 2007	Direct (stack) emissions Kg CO2/MWh	Indirect emissions Kg CO2eq/MWh	Life cycle emissions Kg CO2eq/MWh	Fuel price sensitivity
Natural gas	Open cycle gas turbine (GT)	-	65-75[b]	90-95[b]	90-100[b]	38%	530	110	640	Very high
	Combined cycle gas turbine (CCGT)	-	50-60	65-75	70-80	58%	350	70	420	Very high
		CCS	n/a	85-95	80-90	49%[c]	60	85	145	Very high
Oil	Internal combustion diesel engine	-	100-125[b]	140-165[b]	140-160[b]	45%	595	95	690	Very high
	Combined cycle oil-fired turbine	-	95-105[b]	125-135[b]	125-135[b]	53%	505	80	585	Very high
Coal	Pulverised coal combustion (PCC)	-	40-50	65-80	65-80	47%	725	95	820	Medium
		CSS	n/a	80-105	75-100	35%[c]	145	125	270	Medium
	Circulating fluidised bed combustion (CFBC)	-	45-55	75-85	75-85	40%	850	110	960	Medium
	Integrated gasification combined cycle (IGCC)	-	45-55	70-80	70-80	45%	755	100	855	Medium
		CSS	n/a	75-90	65-85	35%[c]	145	125	270	Medium
Nuclear	Nuclear fission	-	50-85	45-80	45-80	35%	0	15	15	Low
Bio-mass	Solid biomass	-	80-195	85-200	85-205	24%-29%	6	15-36	21-42	Medium
	Biogas	-	55-215	50-200	50-190	31%-34%	5	1-240	6-245	Medium
Wind	On-shore farm	-	75-110	55-90	50-85	-	0	11	11	Nil
	Off-shore farms	-	85-140	65-115	50-95	-	0	14	14	
Hydro	Large	-	35-145	30-140	30-130	-	0	6	6	Nil
	Small	-	60-185	55-160	50-145	-	0	6	6	
Solar	Photovoltaic	-	520-850	270-460	170-300	-	0	45	45	Nil
	Concentrating solar power	-	170-250[d]	110-160[d]	100-140[d]	-	120[d]	15	135[d]	Low

a. Assuming fuel prices as in "European Energy and Transport: Trends to 2030 – Update 2007" (barrel of oil 54.5 $2005 in 2007 and 63 $2005 in 2030). b. Calculated assuming base load operation. c. Reported efficiencies for carbon capture plants to first-of-a-kind demonstration installations that start operating in 2015. d. Assuming the use of natural gas for backup heat production.

Table 6: Energy technologies for power generation in the EU – moderate fuel price scenario
Source: European Commission (2008)

Latest Costs Estimates for RE Technologies

Table 14 gives the latest cost estimates regarding RE technologies from the Renewable Energy Policy Network for the 21st Century (REN 21), released in June 2013.

Table 104 - Status of RE costs

TABLE 2. STATUS OF RENEWABLE ENERGY TECHNOLOGIES: CHARACTERISTICS AND COSTS

Technology	Typical Characteristics	Capital Costs (USD/kW)	Typical Energy Costs (LCOE – U.S. cents/kWh)
Power Generation			
Bioenergy combustion: Boiler/steam turbine Co-fire; Organic MSW	Plant size: 25–200 MW Conversion efficiency: 25–35% Capacity factor: 50–90%	800–4,500 Co-fire: 200–800	5.5–20 Co-fire: 4–12
Bioenergy gasification	Plant size: 1–10 MW Conversion efficiency: 30–40% Capacity factor: 40–80%	2,050–5,500	6–24
Bioenergy anaerobic digestion	Plant size: 1–20 MW Conversion efficiency: 25–40% Capacity factor: 50–90%	Biogas: 500–6,500 Landfill gas: 1,900–2,200	Biogas: 6–19 Landfill gas: 4–6.5
Geothermal power	Plant size: 1–100 MW Capacity factor: 60–90%	Condensing flash: 2,100–4,200 Binary: 2,470–6,100	Condensing flash: 6–13 Binary: 7–14
Hydropower: Grid-based	Plant size: 1 MW–18,000+ MW Plant type: reservoir, run-of-river Capacity factor: 30–60%	Projects >300 MW: <2,000 Projects <300 MW: 2,000–4,000	2–12
Hydropower: Off-grid/rural	Plant capacity: 0.1–1,000 kW Plant type: run-of-river, hydrokinetic, diurnal storage	1,175–3,500	5–40
Ocean power: Tidal range	Plant size: <1 to >250 MW Capacity factor: 23–29%	5,290–5,870	21–28
Solar PV: Rooftop	Peak capacity: 3–5 kW (residential); 100 kW (commercial); 500 kW (industrial) Capacity factor: 10–25% (fixed tilt)	2,275 (Germany; average residential) 4,300–5,000 (USA) 3,700–4,300 (Japan) 1,500–2,600 (Industrial)	20–46 (OECD) 28–55 (non-OECD) 16–38 (Europe)
Solar PV: Ground-mounted utility-scale	Peak capacity: 2.5–250 MW Capacity factor: 10–25% (fixed tilt) Conversion efficiency: 10–30% (high end is CPV)	1,300–1,950 (Typical global) Averages: 2,270 (USA); 2,760 (Japan); 2,200 (China); 1,700 (India)	12–38 (OECD) 9–40 (non-OECD) 14–34 (Europe)
Concentrating solar thermal power (CSP)	Types: parabolic trough, Fresnel, tower, dish Plant size: 50–250 MW (trough); 20–250 MW (tower); 10–100 MW (Fresnel) Capacity factor: 20–40% (no storage); 35–75% (with storage)	Trough, no storage: 4,000–7,300 (OECD); 3,100–4,050 (non-OECD) Trough, 6 hours storage: 7,100–9,800 Tower, 6–15 hours storage: 6,300–10,500	Trough and Fresnel: 19–38 (no storage); 17–37 (6 h. storage) Tower: 20–29 (6–7 hours storage); 12–15 (12–15 hours storage)
Wind: Onshore	Turbine size: 1.5–3.5 MW Capacity factor: 25–40%	1,750–1,770 925–1,470 (China and India)	5–16 (OECD) 4–16 (non-OECD)
Wind: Offshore	Turbine size: 1.5–7.5 MW Capacity factor: 35–45%	3,000–4,500	15–23
Wind: Small-scale	Turbine size: up to 100 kW	3,000–6,000 (USA); 1,580 (China)	15–20 (USA)
Hot Water/Heating/Cooling			
Bioenergy heat plant	Plant size: 0.1–15 MW_{th} Capacity factor: ~50–90% Conversion efficiency: 80–90%	400–1,200	4.7–29
Domestic pellet heater	Plant size: 5–100 MW_{th} Capacity factor: 15–30% Conversion efficiency: 80–95%	360–1,400	6.5–36
Bioenergy CHP	Plant size: 0.5–100 kW_{th} Capacity factor: ~60–80% Conversion efficiency: 70–80% for heat and power	600–6,000	4.3–12.6
Geothermal space heating (buildings)	Plant size: 0.1–1 MW_{th} Capacity factor: 25–30%	1,865–4,595	10–27
Geothermal space heating (district)	Plant size: 3.8–35 MW_{th} Capacity factor: 25–30%	665–1,830	5.8–13
Ground-source heat pumps	Plant size: 10–350 kW_{th} Capacity factor: 25–30%	500–4,000	7–23

Costs of generating electricity from Renewables

With Rs 6.8 billion spent in 2012 on importing fossil fuels for electricity, and 2,218 GWh generated from fossil fuels, each fossil fuel GWh substituted by RE would enable**Rs 3 million saved on imports**. This figure is higher for CEB's thermal plants which require nearly Rs 4.19 million of fuel imports per GWh. RE plants are more costly to build, but cost next to nothing to run as they avoid costly combustible imports.

Important conclusions that can be reached from the cost comparison are as follows:

a) The competitiveness of gas-fired combined cycle turbines compared to coal-fired power plants which could provide a cheap source of electricity in Mauritius in the future, and so considerably lower environmental and health impact. CEB has set the objective to conduct a comprehensive pre-feasibility study for the use of Liquefied Natural Gas (LNG). However no time period has been defined for this feasibility study.

b) The production cost of electricity from on-shore wind is now almost competitive with conventional technologies. The cost of electricity from PV utility scale plants has fallen significantly and is projected to continue so in the coming years. Already the NEC is in receipt of a proposal from a private promoter of a 7 MW solar PV plant quoting a starting PPA price of Rs 5.29 KWh. A full listing of price estimates for RE plants can be found in annex.

c) Economically speaking, higher cost of electricity produced from renewable energy sources should normally be translated by the CEB into higher cost of electricity, unless it is subsidized by the Government through the MID fund. CEB can only afford to pay the average system cost of generation and the MID Fund has to cover the additional costs implied in the tariff(s) of renewable energy generation. The latest data suggest that such a subsidy might be required. However, it has to be understood that:

    - with time the cost of renewable energy will decrease whilst the cost of fossil fuels will increase. Hence, the need for subsidy may not only end as grid parity is reached but fossil fuels may be more costly (related to oil prices and to environmental control costs related to coal power generation).

    - RE makes the country save on important fossil fuel import costs. This should be factored in.WithRs 6.8 billion spent in 2012 on importing fossil fuels for electricity, and 2,218 GWh generated from fossil fuels, each fossil fuel GWhthat would be substituted by RE would save the countryRs 3 million on imports.This figure is higher for CEB's thermal plants: nearly Rs 4.19 million for each GWh generated as they use fuel oil, diesel and kerosene. RE plants are more costly to

build, but for each GWh they then produce, they will allow the country to avoid millions in terms of imports. Over a twenty year period, electricity from RE plants can in fact be cheaper for the country.

Table 115 - Renewables v/s fossil fuel imports in electricity generation in 2012

Fuel	Average CIF value per tonne (Rs)	Tonnes imported for electricity generation	Total CIF value (Rs)	Total Electricity Generated (GWh)	Import cost per GWh (Rs)
Fuel oil	20,523	213,032	4,371,980,959	1,057	4,189,663
Diesel oil	30,422	1,857	56,493,139		
Kerosene	30,619	3,437	105,239,085	11	9,567,190
Sub-total for petroleum fuels (CEB thermal plants)			**4,533,713,183**	**1,068**	**4,245,050**
Coal (IPP thermal plants)	3,509	649,157	**2,277,996,078**	**1,150**	**1,980,177**
TOTAL - Fossil Fuels			**6,811,709,261**	**2,218**	**3,070,551**
Renewable energy *(hydro,wind, landfill gas, photovoltaic & bagasse - CEB, IPPs, SIPPs)*	**0**	**0**	**0**	**578**	**0**
OVERALL TOTAL			**6,811,709,261**	**2,796**	**2,435,885**

Source: *Energy and Water Statistics2012,* Statistics Mauritius, June 2013

The Price of Bagasse

Bagasse is a by-product of cane where the costs of production from the field to power plant are either met from growing or milling activities and bagasse has no cost except the handling costs. It is when it enters the power plant that it has a value as a combustible. This also applies to the bagasse from higher fibre and sugar cane. The new forms of cane material to be used in a power plant are those that require processing at the sugar mill, for instance, the reduction of moisture content from 48-50 % to some 42 %; cane cleaning and/or the use of additional cane tops and trash.

Review the price of bagasse price as compared to coal prices. The increase should go to planters, without direct or indirect links with millers or power producers, after negotiations with all parties concerned. An ideal win-win situation for all concerned is possible, as the higher use of bagasse can be economically profitable for both CEB and IPPs, bagasse being considerably cheaper than coal. A volume-related pricing mechanism for bagasse would boost production and availability of bagasse. By 2014 (OFSED)

The Price of Biomass

In the case of other biomass (graminae and wood chips, local and/or imported), where all cultivation to processing costs have to be met from the KWh price, a different pricing mechanism will have to be evolved. The costs involved have not yet been determined as ventures into these forms of biomass are only starting as from 2013/14. At this stage only a range of values can be mentioned using the fact that such energy, with nil or negligible emission of SO_2 and no additional emission of CO_2, will displace coal in spreader stoker boilers but also displace the highly polluting HFO used as base load on the grid. This gives a range starting with the coal price and ending at the HFO price.

The cost of PV electricity generation

The CEB has just awarded tenders in lots of 2MW per site, to accommodate what the CEB considers as the capacity of the grid to absorb solar energy at a given site, for a total of 10 MW. The KWh price agreed upon after negotiations between the CEB and the lowest bidders is approximately Rs6 KWh, or even lower, for the lifetime of the PPA. These plants will be on the grid in 2014

However, there is a huge global decrease in PV module prices underway over the past years according to IRENA: “A 60% reduction has been achieved over the last two years and more than a 40% reduction is likely to occur by 2020.”

IRENA forecasts that “*the LCOE of utility-scale systems for both thin* film and c-Si [popular types of PV modules] could decline to between USD 0.06 and USD 0.10/kWh by 2020”.**This works out as Rs 1.86 per KWh and Rs 3.1 per KWh.** One can already see the range of profit that consumers will bear with PPAs of Rs 6 KWh. It is therefore essential that the CEB gets to build and operate PV plants, alongside private-owned ones.

According to IRENA, the **capital cost of utility-scale PV is at around USD 2 million per MW, i.e. Rs 62 million per MW.** According to IRENA, Chinese and Indian ground-mounted PV utility systems are achieving low installed costs of around USD 2.2/W and USD 1.7/W respectively. The Chinese figure is similar to that found in Germany, where ground-mounted systems are estimated at an average cost of USD 2.1/W over 2012. It can thus be assumed that the capital cost of utility-scale PV is at around USD 2 million per MW, i.e. Rs 62 million per MW.

IRENA sets **Operations and Maintenance (O&M) costs at USD 6.5 per KW per year**, i.e. MUR 200K per MW.

Annual degradation in performance for PV is negligible: the US NREL reports a median annual rate of 0.5% per year.

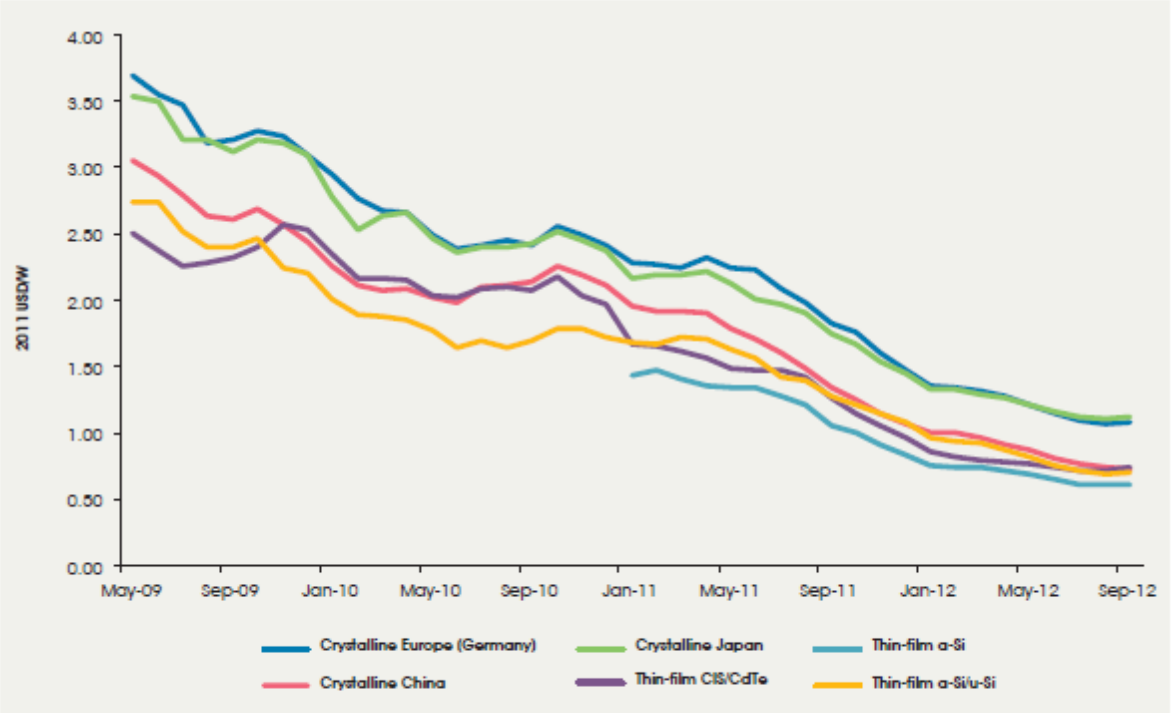


FIGURE 6.1: AVERAGE MONTHLY SOLAR PV MODULE PRICES BY TECHNOLOGY IN EUROPE, 2009 TO 2012

SOURCE: SOLOGICO, 2012.

Figure 8 - Average monthly PV module prices in Europe, 2009-2012

Source: "Renewable Power Generation Costs in 2012: An Overview", IRENA, January 2013.

Cost of large-scale electricity storage in batteries

Vanadium Redox Flow is currently among the battery technologies providing increased performance, safety and cost-effectiveness. According to estimates from the US Department of Energy, aVanadium Redox Flow battery discharging 50MWh for 5 hourswould cost in the USA US 227 million (Rs 7 billion) for construction and 15 years of operations and maintenance. This works out to be at least **Rs 5.22 per KWh**. IRENA is more optimistic: USD 175 million, about Rs 5.4 billion. This works out to be **Rs 4.02 per kWh**.

For a full RE system generating firm power, one can add a solar PV power plant to the battery system. At a capacity of 65 MW (15 MW excess for weather variability compared to the 50 MW of the battery), and operating in regions such as Albion (average PV performance of 1450 hours per year at full capacity),IRENA and US Department of Energy cost estimates indicate the following:

- Total construction and O&M costs (battery + plant) = between USD 305 million and USD 357 million, i.e. between Rs 9.3 and 11 billion.

- Electricity cost = between **Rs 7.04 and Rs 8.30 KWh for a complete overall FIRM RE system producing 50 MWh for 5 hours each day.**

The price of firm solar power is still a bit high. However, considering that prices for both PV plants and battery storage are fast decreasing, firm solar power in the years ahead will be very cost-competitive, without the high environmental and public health costs that fossil fuels have on top.

External Costs

International studies on energy externalities suggest that the high impact areas for power generation are climate change impacts and outdoor air pollution health impacts, with climate change impacts by far the greatest. Various renewable technologies could already be competitive if important external costs were internalised to producers and consumers. Because these external costs are not adequately reflected in energy prices, consumers, producers and decision-makers do not receive accurate price signals that are necessary to reach decisions about how best to use resources.

Current costs for electricity generation

The least–cost policy is a fundamental element of the CEB's strategic objectives which underpin the Integrated Electricity Plan (IEP). Under the least-cost policy, CEB through its *merit order dispatching plan* seeks to operate with the best mix of inputs in order to produce electricity. *Dispatching Order* is the order of priority to start generators based on their marginal cost of production. Generally, the generator with the cheapest marginal cost of production is dispatched first followed by the more costly ones to meet demand.

Electricity is generated from base-load coal or bagasse power plants owned by independent power producers or IPPs (CTDS, Beau-Champ, FUEL, CTSAV and CTBV). The other plants are owned by the Central Electricity Board (CEB) which provides base-load as well as semi-base load and peak load. Currently more than 60% of electricity is generated by the IPPs, the CEB being responsible mostly for the semi-base and peak load power supply areas.

The table below summarizes the present estimated direct generation cost of the CEB power plants (mainly fuel cost) and the average cost of electricity purchased by the CEB from the IPPs. The figures are based on prices obtained in May-June 2013.

In 2011, CEB had produced 1096 GWh, which was around 45% of the total electricity demand for the country. Hence, despite gas turbines having a high running cost, the average cost of CEB's generation is close to the cost of generation from HFO engines (about Rs 6/kWh).

Table 16 - Estimated Unit Costs of Existing Power Plants

	Load	Estimated Cost (Rs/kwh)
CEB Power Plants		
Fort George largest power plant owned by the CEB. It generates about 25% of the total energy generation for Mauritius.	Base 5 heavy fuel oil operated slow-speed type engines having a cumulated effective capacity of 134 MW. Due to their high efficiency (typically 44.5% to 45.8%), they are operated as base-load generators throughout the year. Its annual *plant load factor* is estimated to be about 55%.	Rs 6.00
Fort Victoria six new Wartsila units and two MAN engines of 8.5 MW each	Semibase All the engines are medium-speed type -provides a total capacity of 107 MW with an annual plant load factor of around 35%.	Rs 6.50
Saint Louis	Semibase 5 Pielstick and 3 Wartsila medium-speed type engines with a total *effective capacity** of 74 MW. Its average annual plant load factor is around 30%. The Pielstick engines have exceeded, by far, their normal operating life and run inefficiently. CEB is envisaging their retirement in the near future.	New Engines-Rs 6.50 Old Engines-Rs 8.00
Nicolay The plant is primarily used as a peak-lopping facility, dispaNEChed only in exceptional cases	Peak It consists of three open-cycle gas turbines with a total effective capacity of 75 MW. The Nicolay Power Station has the highest running costs and, therefore, generally has a low annual plant load factor of around 3%.	Rs 18
Hydro Power Plants	Base/semibase/peak 9 stations in operation, with a total effective capacity of 55.8 MW. They account for approximately 9% of the island's total effective capacity. In a good season (rainy), these stations can meet 10% to 12% of the electricity demand in Mauritius, while in a less favourable season (drought), such as in 1999, the energy produced	About Rs 1.00

	can be as low as 2%.	
Generation costs of CEB power plants		About Rs 6
IPP Power Plants		
CTBV	Base (Bagasse/Coal)	Rs 2.75
FUEL	Base (Bagasse/Coal)	Rs 3.95
CEL	Base(Bagasse/Coal)	Rs 2.80
CTSAV	Base(Bagasse/Coal)	Rs 3.60
CTDs	Base (Coal)	Rs 3.80
Generation costs of IPPs		Rs 3.35
System Generation Costs		About Rs 5.45

APPENDIX7 – BEST PRACTICES AND OPTIONS FOR INTEGRATING LARGE SHARES OF VARIABLE RE ON THE GRID

Dealing with weather variability

A number of countries are already very successful in integrating large shares of variable RE. Some are faced with similar structural constraint as Mauritius, i.e. a **national grid which is isolated.** Such countries are moving their electricity supply away from systems based on traditional (relatively inflexible) base loadthat is complemented by marginal cost-driven balancing power to more flexible systems that are driven by and designed for variable renewables.

Therefore, while weather variability poses challenges indeed in terms of large-scale integration on the national grid, it can be solved. This calls for a new management system, based on the following:

1. advanced ICT (Smart Grid) and forecasting tools. The cost will be substantial butsuch a modernisation will alsosupport more effective energy efficiency programmes, such as Time-of-Use tariffs

2. flexible backup through the use of dispatchable power plants: natural gas and hydropower plants are ideal, but medium speed diesel enginesalso can be effective backups

3. energy storage: pumped hydro and advanced energy storage through batteries.

Furthermore, the increased geographic dispersion of intermittent sources and investment in a diverse portfolio of intermittent renewables will mitigate against the effects of weather variability, as well as distribute production closer to consumption points.

To guide on the way forward on how to integrate large shares of RE, the US Department of Energy's National Renewable Energy Laboratory (NREL) released in April 2012 a very rich and action-oriented guidance document for policy-makers and utility companies, entitled "*Integrating Variable Renewable Energy in Electric Power Markets: Best Practices from International Experience*":

> *Many countries—reflecting very different geographies, markets, and power systems—are successfully managing high levels of variable renewable energy on the electric grid, including that from wind and solar energy. This study documents the diverse approaches to effective integration of variable renewable energy among six countries—Australia (South Australia), Denmark, Germany, Ireland, Spain, and the United States (Colorado*

and Texas)—and summarizes policy best practices that energy ministers and other stakeholders can pursue to ensure that electricity markets and power systems can effectively coevolve with increasing penetrations of variable renewable energy. There is no one-size-fits-all approach; each country has crafted its own combination of policies, market designs, and system operations to achieve the system reliability and flexibility needed to successfully integrate renewables. Notwithstanding this diversity, the approaches all coalesce around five strategic areas:

- *lead public engagement, particularly for new transmission;*
- *coordinate and integrate planning;*
- *develop rules for market evolution that enable system flexibility;*
- *expand access to diverse resources and geographic footprint of operations;*
- *improve system operations.*

Other useful sources are:

1. The Intergovernmental Panel on Climate Change (IPCC), which released in 2011 a *Special Report on Renewable Energy (IPCC 2011)* that includes an assessment on integrating large amounts of renewable energy and recommended policy best practices.
2. The International Energy Agency (IEA), whose *Grid Integration of Variable Resources (GIVAR)* project seeks to better understand the technical and market characteristics of a power system that facilitates integration of variable RE. The Phase 2 report, *Harnessing Variable Renewables* (IEA 2011), proposes a tool to assess how much renewable energy can be added to existing systems.

http://www.iea.org/publications/freepublications/publication/Harnessing_Variable_Renewables2011.pdf

Variability and uncertainty are familiar aspects of all power systems: the need for flexible resources to balance them has been long understood. Those who assert that large shares of variable supply represent an insurmountable, additional challenge to power-system operation may be looking with too narrow a gaze. Variability and uncertainty are not new challenges; power systems have long taken them into account. Fluctuating demand — from hour to hour, day to day, season to season — has been a fundamental characteristic of all power systems since the first consumer was connected to the first power plant. (Page 15)

Flexibility, in power system terms, is traditionally associated with quickly dispatchable generators. But balancing is not simply about power plants, as is often suggested. While existing dispatchable power plants are of the greatest importance, other resources that

may potentially be used for balancing are storage, demand-side management or response, and interconnection to adjacent power systems for trade. (Page 35)

The example of Spain, an isolated electricity grid

Between November 2012 and January 2013, wind farms in Spain produced more electricity than any other source for a 3-month time period. In January, wind power actually set a record for being the number one energy in the country's energy mix, with 6 terawatt-hours (TWh).

Renewables accounted for 54% of the country's electricity generation in April 2013, outpacing March's record total of 51.8%. Spanish hydropower made up 25% of April's overall electricity generation. Meanwhile, wind power was second with 22%. Solar photovoltaic energy provided 3.6%, and solar thermal energy had 1.3%, based on Red Electrica De Espana (REE) data.

According to the Spanish Wind Energy Association (SWEA) the Spanish economy has gained €3 for every €1 of wind power incentives it has given. In other words, while Spain is suffering through some difficult economic times, wind power subsidies have had a positive net effect that has kept the country in a better situation than the one in which it could have landed.

The NREL reports on how Spain is able to integrate such large shares of variable RE:

[…] the integration of RE production has also been conditioned by the particular characteristics of the electricity system in Spain. Isolation is one of its most relevant structural features. From an electric point of view, Spain has one of the lowest interconnection ratios in the European Union. This lack of sufficient interconnection capacity has prevented the Spanish system from taking advantage of cross-border exchanges for the integration of RE, as cross-border exchanges enable electricity exports when the surplus of renewable production cannot be properly dispatched in the system, thus diminishing RE curtailments and increasing the overall efficiency.

In response to this challenge, the system operator in Spain established a control center of special regime, the Spanish Control Centre of Renewable Energies (CECRE), whose objective is to monitor and control RE production, maximizing its production while ensuring the safety of electrical system. CECRE was established in June 2006 as wind generation started to become a relevant technology in the Spanish electrical system. It is composed of an operational desk where an operator continuously supervises RE production.

The use of information and communication technologies has been a key factor to achieve the success of the control center. The great potential of information and

communication technologies to monitor and control energy and to dematerialize physical equipment, represents both an immediate and long-term solution to coping with increasing world energy consumption and managing variable availability of renewable sources (in order to achieve a sustainable economic model).

[…]

(CECRE monitors RE installations on the basis of real-time information availability. RE installations must provide real-time telemetry each 12 seconds as well as voltage control following orders of the transmission system operator (TSO). CECRE has made it possible for more than 50% of electricity demand to be met by wind energy over the course of several hours—a particular challenge for a country with an isolated grid.

Other successful examples of large-scale grid integration of variable RE

a) China, even if its grid is currently predominantly coal-driven, has passed a Renewable Energy Law and related regulations, which state that RE should be given first priority in generation scheduling and dispatching under normal power system operating conditions. China is the number one country in the world for wind energy.

b) Just alongside us, several innovative projects have been launched in Reunion like the Pegase and Millener projects to increase RE penetration.

c) In Germany, the Renewable Energy Sources Act (EEG), enacted since 2000, grants priority grid access and priority dispatch to renewable energy and has facilitated a process of transforming the power grid to accommodate increasing shares of renewable energy. With solar radiation levels much inferior to our tropical country, Germany had a staggering total of 32.4 GW of PV capacity installed in 2012. For us to have a sense of comparison, this corresponds to 403 MW of PV capacity for each million inhabitants.

Best practices and options for Flexible Backup

According to the International Electrotechnical Commission (IEC), the best options for dispatchable power plants as flexible backup are hydroelectric plants, then gas-fired power plants, as they can modulate their output very quickly (“ramping”), without suffering from frequent start/stops (“cycling”). Considering that our hydroelectric potential is saturated, a gas-fired plant should be the preferred future option for new flexible backup capacity.

However, for the time being, Mauritius is already endowed with sufficient flexible capacity resources through the CEB's fleet of medium speed diesel generators and its kerosene units:

- They can fire up quickly;
- They are already used intermittently as are very costly to operate and are highly polluting;
- They can therefore act as backup for RE.

With the addition of 4x15 MW medium-speed diesel engines in 2015 and 2016, that can later be converted to natural gas, the country will have even greater capacity for RE backups.

APPENDIX 8 – ENERGY GAINS THROUGH STRONG ENERGY EFFICIENCY

A key question is the following: is there really a need to build new plants for peak demand records that happen only during a few days and for a few hours in the year? Simply by distributing one million energy-saving bulbs, the CEB has been able to avoid the equivalent of 14 MW of power. **This cost merely 35 million rupees**. If the CEB had done the opposite, i.e. built a new plant of 14 MW, this would have cost hundreds of millions at least. The CFL lamps also caused a decrease in electricity consumption during evening peak hours of 12.3 GWh. Similarly, the experiment with Daylight Saving Time, **at virtually no cost**, generated a decrease in electricity consumption during peak hours of 4 GWh, corresponding to an 18 MW reduction in electricity demand. Again, hundreds of millions were not spent and were available instead for other national priorities.

These two recent experiments by the CEB demonstrate clearly the tremendous economic returns our country could make if it were to embark on ambitious energy efficiency programmes. When demand increases, it can be a tragic error to immediately think that the answer is to increase production. We should seek on the contrary to reduce waste and reduce demand. This has now become a pressing imperative. Over the past decade, the country's consumption of electricity has grown by a staggering 44.8%, from 1,721.07 GWh in 2002 to 2,492.38 GWh in 2011. We have to start curtailing ever-rising demand.

Increasing energy efficiency is the quickest and least costly way of addressing energy security, environmental and economic challenges. Promoting energy efficiency is one pillar of a sustainable energy policy. Investing in curbing electricity demand now is more cost-efficient than investing in new fossil fuel power plants. Also, to reach the target for renewable energy penetration, we need EE/DSM.

As per the JEC-AFD study (Mapping of Energy Efficiency in the Mauritian private sector) there is a potential through short term actions (at no cost to low cost: quick wins) of more than Rs 400 m/year in large industries and buildings. The total potential through profitable EE actions in large industries and buildings is an energy saving of Rs1.1 billion/year. The electricity saving is 150 to 200 GWh/year, leading to a reduction of needed power of around 40 MW. There is according to a Joint AFD/JEC Report scope to reduce demand but so far no measures have been put in place. The action would have to involve not only the public and private sectors but equally the CEB which has the resources and data base to monitor demand in the most effective manner. This would be a bottom up approach as opposed to a top to bottom approach of a centralised institution.

The proposed private sector action plan will allow targeted companies to reduce their electricity bill by 14%, amounting to one billion rupees of savings of per year. This will have a

powerful impact on economic growth and employment.By avoiding huge new infrastructure investments, energy efficiency frees up vital financial resources for the development of the country.

The main barriers to EE are insufficient expertise and consultancy services, limited financing capacity for some industries and an insufficient favourable framework and commitment from authorities. Burden sharing has to be clearly defined between government and private sector. Incentives can be given by government for energy audits for example while funding partners can help in getting the required expertise. Green loans schemes to industries to be enhanced.

Proposals for an Urgent Action Plan

Energy Efficiency/ Demand-Side Management is essential as a way of reduction of demand in the supply-demand matrix. It also promotes integration of renewable at the demand-side. Finally, it enhances the stability of the grid to variations at the supply-end.

The introduction of renewables as SSDG/MSDG is not considered here as demand-side reduction but is pertinent. Similarly, as in Reunion with its project for Cold-Sea Water Air Conditioning at demand-end, the local Deep Ocean Water Applications project will avoid investment in additional capacity, particularly at peak demand periods. This is also not discussed here is it is viewed as a medium-to-long term prospect.

As a conservative estimate for the short-to-medium term (2014-2016), the following reduction in peak demand is retained referring to cumulative peak MW reduction of 10 MW per year:

2014: -10 MW

2015:-20 MW

2016: -30 MW

It is to be highlighted that currently each 5 MW saved will improve the RCM by one point. So, each year DSM can improve the RCM by 2 points at least over 2014-2016.

The requirement for the above targets is to be defined in terms of specific projects related to peak-demand reduction including:

- New low-energy lighting project (CFL)

  Replicate the 1 million CFL lamps project with a target of 10 MW peak reduction at an investment of Rs 50 million

- Replacement of old refrigerators project

  Similar to a project developed in Reunion and elsewhere with the replacement of 20 000 low efficiency fridges giving a 2 MW peak reduction, at a cost of Rs 100 million. Other social and environmental benefits will accrue from this project (e.g. elimination of CFC and electrical/electronic waste).

- Time-of-use tariff in industries project

  To replace so-called concessionary tariffs at no cost to the CEB through the definition of specific ToU agreements with relevant clients to promote peak power reduction. Estimated potential is a 10 MW reduction. Benefits to the utility will come from the end of concessionary tariffs. Scheme can be designed also to be revenue-neutral.

- Solar-water heater project

  Pursuit of SWH subsidy programme with FOCUS on sensitization on its potential to reduce peak demand. Estimated peak load reduction is 2 MW. No additional cost (subsidies already budgeted). Use of SWH for cooling purposes is an alternative that can be introduced under the SWH subsidy programme towards reducing peak demand in summer (day-time).

- Air-conditioning peak power demand reduction project

  EEMO has already worked out Regulations on audits, minimum performance standards, energy efficiency labelling and differentiated duties. Regulations being processed and urgent implementation is needed accompanied by education and sensitization. A minimum of 10 MW expected to be reduced (hot humid days)

- Variable speed drives in industry

  Under the joint project by the AgenceFrançaise de Développement (AFD), the Joint Economic Council (JEC) and the Association of Mauritian Manufacturers (AMM),project, the introduction on variable speed drives on motors alone can lead to at least 20% reduction in power consumption including at peak hours. Potential will depend on scope of project. Pay-back is less than 1 year.

- Street-lighting project

  Already an estimated 2 MW peak saving noted in the past as a result of introduction of energy-efficient lighting.To replicate the project. Application of green procurement policy needed.

- Sensitization on peak demand reduction

  Already proposed by Energy Efficiency Committee of EEMO, this programme will support and help towards achievement of above targets through listed activities.

Evidence of potential of EE/ DSM, costs and benefits are well referenced in the literature worldwide. It should be noted that Nova Scotia has its peak demand even decreasing as a result of EE/DSM.

The current challenge we are faced with stems from institutional and regulatory teething problems with the coming into force of the Energy Efficiency Act. In Box 1, proposals are made for amendment to the latter Act.

PEAK POWER WATCH PROGRAMME

The above list of projects is not exhaustive but includes the main ones identified. These relate to projects which have payback of less than 2 years (where applicable) and that are implementable within the short-to-medium term. It is recommended that the EEMO is mandated to define the specific details of these projects and is given the necessary means to coordinate, facilitate and promote their materialization. The following are needed for the PEAK POWER WANECH programme covering the identified specific projects:

- Setting up of a High-Powered Steering Committee at the level of the EEMO with the participation of key stakeholders to oversee the implementation of the specific projects related to peak demand DSM.
- Setting up of a High Level Technical Team at the level of the EEMO with the appointment of competent staff to monitor the implementation of the specific projects
- Provision of seed-money towards the definition of the specific projects and the initiation of same (through grants / zero-interest loans)
- Reporting and feedback on the status of Peak Power DSM (Peak Watch) through the full empowerment of the Observatoire de l'Energie in terms of required resources (management and administrative, statistical support, ICT, technical support, etc).

Last but least, it is essential to seek all possible means to provide the EEMO with the minimum critical mass in terms of human resources in order to deliver the above objectives. It is to be reckoned also that a range of technical expertise is called for from Mechanical Engineering to Communication and Public Relation through Building or Transport Systems. Education and training is also another specific area where dedicated staff will be needed. The Proposals

made under the Pre-Road Map of the EEMO 2015-2030, as well as in its Action-Plan 2012-2014 should be considered.

The Budget Speech 2013 in the second indent of paragraph 281 mentioned that:

"*All large beneficiaries of concessionary electricity tariffs will be required to conduct an energy audit if they are to preserve this benefit and implement all commercially viable recommendations. '*

This measure does not seem to have led to meaningful results. Opportunity should be taken of the constraints of the WTO SCM Agreement and establish a carrot and stick approach after due consultations with the International Trade Division of the Ministry of Foreign Affairs and International Trade. RT Knits, a textile factory based at the La Tour Koenig Industrial Estate has adopted a greening policy to reduce its electricity bill and foster the use of renewable energy. Thus, it has installed solar panels on the factory and designed the building so as to use air currents to limit the use of air conditioners to the strict minimum. The reduction in demand objective requires that careful consideration be given to the advisability of allowing the establishment of local grids partly or totally independent of the CEB, except in situations of Force Majeure, by the private sector. Obvious examples could be the commercial, business and SME parks, the forthcoming Freeport in the airport area, the Port area and upmarket and high value added property developments.

Equally, at household and enterprise level, the policy intent specified at the third indent of paragraph 281 of the 2013 Budget Speech needs to be reviewed and expanded to foster demand limitation.

"Differentiated excise duties will be applied on household appliances to discourage the purchase of energy inefficient products. Energy inefficiency appliances will be subject to a modulated penalty levy of up to 25 percent. "

Load management measures can also reduce peak demand significantly by shifting power use from times of high power demand (for example, during the day or early evening) to times of lower demand (during the night). Other examples include:

(i) These can be simple timers that turn off appliances during peak times, or electronic controls (load control) activated by the utility system operator.

(ii) Ice-storage systems for air conditioning. Ice is made at night by refrigeration, and stored until air conditioning is needed (for example, in an office building or hospital) during the day. The ice is then melted in a heat exchanger and used to cool the building.

(iii) Unloading agreements and Special interruptible rates.: large electricity users may be offered price discounts in exchange for allowing the utility to disconnect all or a portion of their electrical equipment when the utility system is short of generating capacity. This is already being used in Reunion. stand by generators from big customers(Airport terminal, the cyber tower, big hotels, port, etc) could play a significant role in peak load management. The total such capacity available in the country could be at least 20 MW. If there was a price incentive given to these customers CEB could use these generators in an emergency situation.

Role of CEB in EE/DsM: Traditionally, the earnings of utilities providers expand along with increased utilities usage, resulting in a perverse disincentive for them to support energy efficiency. In a number of countries utilities providers are rewarded for leading the way in efficiency measures, for instance, analysing residential homes and then installing energy-efficient appliances for them. Simultaneously, they allowed utilities providers to institute higher rates to recoup lost revenue as a result of customers requiring less electricity. Hence, there is a need for CEB to receive incentives so they could, for instance "take the lead and help an industrial customer retrofit their building to be more energy-efficient, in locations where the customer lacks expertise to do so or faces competing demands for its capital". CEB, with its strong technical capacity and existing relationship with consumers should be made to play a greater role in Energy Efficiency as it is best positioned to deliver efficiency programmes. The main driver should be a regulatory compliance (devised by the future URA probably) with an obligation to deliver an energy saving target. Advice and assistance should also be an energy saving activity for CEB. But there could also be a financial incentive mechanism whereby CEB creates a subsidiary company - an EsCO (Energy Services Company) - who would work with customers to reduce demand through a win-win perspective. CEB would receive payments (as any other consultancy company would receive) for any reduction in demand from their customers following a contract agreement.

Note: Energy efficiency at the supply end is also possible but this has to be treated separately with the supply options.

APPENDIX 9 - MAPPING OUT EXISTING SUPPLY OPTIONS

Currently available energy options are listed below, without taking into account their sustainability aspects.

1. Immediate availability from existing IPPs and from existing or former CPPs

There is very little additional capacity that can come from existing IPPs and CPPs on the basis of current installations (except for CEL during the crop season-see below).

2. Potential additional availability from existing IPPs

The table below provides details on potential for additional capacity presented by three companies which made submissions to the Commission.

Table 17 - Possibilities of plants from existing IPP Groups

Item	Alteo	Omnicane	Terra
Preferred mode of procurement	Open and transparent RFP	Open and transparent RFP	Open and transparent RFP
Existing installations	Spreader Stoker , wet scrubber ,44 bar 440 ^{o}C	Spreader Stoker , electrostatic precipitator ,82 bar 525 ^{o}C	Spreader Stoker , electrostatic precipitator ,82 bar 520 ^{o}C
Need to modernise existing installations	Yes	No	No

Capacity that would be offered in an open and transparent RFP	50 MW as soon as possible and 50 MW when biomass quantities become substantial. May consider earlier entry of the second plant depending on requirements of authorities.	50 MW as soon as possible , coal only or initially coal driven and then biomass would step in.	50 MW as soon as possible, coal only or initially coal driven and then biomass would step in.
Preferred technology	Spreader Stoker at 110 bar 538 ^{o}C	Coal only: pulverised coal Coal and biomass : state of the art Spreader Stoker	Coal only: pulverised coal Coal and biomass : state of the art Spreader Stoker
Time from issue of RFP to commissioning	36 months i.e in second semester of 2016 if process initiated now	36 months i.e in second semester of 2016 if process initiated now	36 months i.e in second semester of 2016 if process initiated now
Strategic partners /advisers	Avantgarde of India	SIDEC with wide experience in coal and biomass /coal burning .	SIDEC with wide experience in coal and biomass /coal burning .

3. Biomass

The above existing IPPs have also the expressed the wish to enhance the use of biomass and displace coal, where a lot of progress has been achieved in this domain in Reunion Island. They plan to invest and embark on a series of sub-projects (cane tops and trash, reduction of the moisture content of bagasse, cane combustible, wood chips, C4 plants, eNEC.) to increase the contribution of biomass in their energy mix. ALTEO mentions that the amount of biomass in the form of additional extraneous matter accompanying canes to the sugar factory that can be available in the short term is equivalent to some 100,000 tonnes of bagasse. This amount could

increase with the availability of other sources of biomass in the medium to long term. These initiatives would be over and above gains resulting from the introduction of suitable cane varieties and transfer technology to small and medium planters. These projects will only be feasible if the proper incentive schemes are put in place, similar to those in the Bagasse Energy Development Programme (BEDP). A**new type of BEDP - for example a BREDP i.e. Biomass and Renewables Energy Development Programme needs to be devised. A type of scheme, similar to the Field Operations Regrouping and Irrigation Project (FORIP), would allow planters to engage in the cultivation of biomass.**Within this framework, it is necessary to ensure that these expected increases continue to take place within a sustainable framework. Biomass sustainability is therefore a key issue.

For biomass, all the costs of plantation, harvest, transport, preparation and handling have to be met through the sale of the combustible. In this case, the producers and processors of biomass require a payment system which is different from that of bagasse. Bagasse will always accompany cane, a proven plant whose revenue comes essentially from sugar, and is thus perennial and sourcing is not an issue in the future. The situation for other biomass is different; such resources have to be sustainable for the producer, local or regional, and perennial for purposes of power production and an adequate price incentive need to be worked out. A price incentive should be worked out.

4. Bagasse

Our country over the past decade has lost 18,128 hectares of cultivated sugar cane land. Overall, in 2012, bagasse helped the country avoid Rs 954 million of coal imports. 481.7 GWh of electricity were produced from bagasse, i.e. 17.2% of total electricity generation. However, ten years before, in 2002, bagasse represented 23.2%. It is crucial to reverse the decline of bagasse in electricity generation.

Greater electricity generation from bagasse could be achieved through the modernisation of the existing coal-bagasse plants and the introduction of new cane varieties with higher energy content. The Multi Annual Adaptation Strategy for the Sugar Sector, 2006 – 2015 Action Plan had noted that:

> *So far 50% of the potential of bagasse is tapped to generate electricity for export to the grid. No use is made in energy terms of the molasses resulting from sugar manufacture. Technological development and the introduction of canes with higher sucrose and fibre content can significantly enhance the energy potential of the cane plant*.

5. Hydropower

The hydro potential has almost reached its limit on the island. However it is believed that there is still room for the development of mini-and micro hydro plants and enhancement of existing dams capacities. A proper feasibility study need to be carried out to quantify the potential increase electricity generation from hydro and identify potential sites for the installation of mini-and micro hydro plants. The problematic of electrical energy storage will be one of the most important for integration of renewable intermittent electricity generation in the future. Using hydro pumping can be a good solution if one wants to increase the penetration rate of wind and solar energy systems. It is important that potential sites for pumped hydro storage are investigated.

6. Natural gas

Natural gas can be transported through two forms: liquefied or compressed. Liquefied natural gas requires the fuel to be at very low temperature while compressed natural gas is at ambient temperature. CNG thus entails less logistical infrastructure than liquefied natural gas.

Several islands, such as Cyprus, are planning to almost completely switch the fuel used for their power production from oil to gas/LNG by 2020. LNG has been investigated as an alternative fuel for the future. Using natural gas as a fuel for power generation offers considerable emissions benefits over traditional liquid fuels such as diesel or heavy fuel oil. Typically CO2 emissions can be reduced by up to 25%, NOx by up to 85% whilst SOx and particulate emissions are virtually zero for natural gas. The main technical problems with use of gas would be the requirement for a new LNG shipping carrier, storage tanks, unfamiliarity with the handling and usage of LNG and issues associated with the very cold temperatures.

LNG is widely available with worldwide production increasing, including the shale-gas boom. **LNG has the potential to provide an economic fuel**. LNG prices on international market compares favourably to crude oil. For island utilities, this price advantage however erodes due to lower consumption, re-liquefaction and transportation issues. Renewable energy sources and natural gas can also complement each other well. Natural gas—a flexible fuel that can be controlled and dispatched quickly to follow varying loads—can be an ally of intermittent renewable energy sources like solar and wind. **An investment in renewable energy in addition to natural gas can lead to a more dynamic power system, giving a nation more flexibility to react to any changes in global politics, economics, or energy pricing in the future.**

Natural Gas is thus a potential replacement fuel for coal and HFO in Mauritius in the medium to long term. It could be imported from countries in the region. The recent discovery of vast deposits of natural gas in Tanzania and Mozambique will create an opportunity for Mauritius to

use LNG. In order to properly evaluate the pros and cons of LNG, the government should immediately order a feasibility study . In addition to a highly efficient combined cycle gas turbine (CCGT) power plant near the landing and storage site, existing diesel engines and bagasse-coal boilers could be retrofitted for natural gas. As per a submission by GDF-Suez to the commission, a 346 MW electricity production from LNG natural gas could be feasible. CEB has already earmarked a 7 hectare site for the storage tanks and for a power plant at Fort Williams if the project is feasible. Liquefied Natural Gas (LNG) could thus be potent in the late 2010s/early 2020s once all logistics issues are resolved and if this is the case, they will be cheaper with lesser emissions of SO_2 and additional CO_2 per KWh produced.

Strategically, LNG is an ideal transition fuel in view of the possibility of using local biogas e.g. from waste/biomass/bagasse gasification in the long term future. In the same way, LNG or local biogas in the future, can be used for land transport including powering of electric mass transit systems. This is a key aspect as transport is the main driver of our rising fossil fuel imports, more than electricity. Investing in an LNG facility would help address both sides of the energy issue: electricity as well as transport.CNG also can be considered

7. Diesel / Biodiesel

Delays in implementing planned projects and the abandonment of the waste to energy project has resulted in the CEB having to invest in HFO plants (medium speed diesel engines) of a total installed capacity of 90 MW during the past few years. There is the potential of recourse to medium speed diesel engines to cope with the risks in the short term and which can be used as base load, semi base load and peaking plants. This issue is important if, as is now obvious, a new plant can only come on the grid in mid-2016 at earliest; then, the options to make good any power deficit would be either these new diesel plants or the prolonged life of old but existing equipment. **An engineer's report on the operating capacity of these old units would confirm whether the Pielstick engines have to be phased out immediately in 2015.**

8. Coal

Under a least-cost expansion plan (which neglected external cost) pulverized coal technology was identified by CEB as addition for new generation capacity. An IPP proposal-the 110 MW CT Power project - is currently under negotiations. It would seem CT Power on account of delays, including those stemming from compliance with the conditions imposed in the EIA, would not be commissioned before mid-2016.

Unfortunately the NEC could not develop further analysis on CT Power, on account of non-submission of information requested for clarifications.

In general in a business-as-usual approach where externality costs are not factored in, coal provides the cheapest source of energy for electricity generation. However, the price of coal has been rising steadily over the past 10 years and is set to continue to do so, even if there might be temporary price drops due to contextual factors.

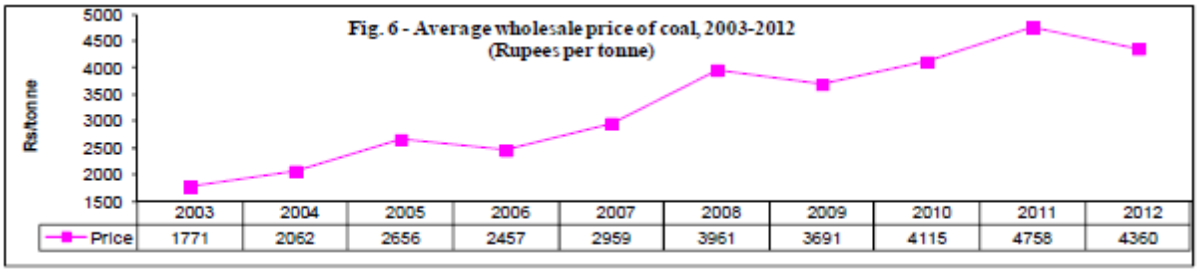


Figure 9 - Average wholesale price of coal, 2003-2012

Source: Energy and Water Statistics, Statistics Mauritius, June 2013

The IEA's World Energy Outlook 2012, which presents projections of energy trends for policy-makers through to 2035, confirms that over the coming years global coal prices are set to increase. The EIA highlights how the current volatility of global coal prices is heavily driven by domestic demand in China:

> *"The international coal market remains very sensitive to developments in China. […]Because of the sheer size of China's coal demand and production, relatively small changes in either its consumption or production have major impacts on the global markets. For example, a drop in demand or a rise in production of just 3% could halve China's coal import needs based on current levels. Therefore the success of China's efforts to curb coal-demand growth, for example by improving the thermal efficiency of its coal-fired power plants or more rapid diversification in the power sector, would have sharp and immediate effects on global international coal trade and prices. […] Even small fluctuations in China's coal trade volumes will continue to shape global markets and prices in the near to medium term."*
>
> *(pages 169-170)*

Furthermore, the EIA projects increases in the price of coal independently of China's influence, due to future deposits being less accessible for development:

> *"As coal production increases, mining companies will need to exploit poorer quality or less accessible deposits, often in areas located further from demand*

centres and necessary infrastructure. In the longer term, cost will play an important role in determining prices, both on international and domestic markets. Increasing mining and rail costs, as well as higher sea-freight costs (current costs are low), are expected to put some pressure on coal prices. However the sheer abundance of coal worldwide means that large quantities are available at similar cost levels, reflected in a relatively flat long-run supply cost curve. Although it is possible that technological advances could help to drive the cost curve down to some degree, this effect is likely to be largely, if not entirely, offset by underlying inflation in the cost of materials, equipment and labour."

(page 176)

APPENDIX 10 – LARGE-SCALE ELECTRICITY STORAGE: PUMPED HYDRO STORAGE AND BATTERIES

The IEC, the IRENA and theNational Renewable Energy Laboratory of the Department of Energy of the USA (NREL) have each produced overviews on the performance and costs of the various technologies available or being developed. A list is hereafter provided, extracted from the 2013 Electricity Storage Handbook produced by the US Sandia National Laboratories in July 2013 for the US Department of Energy:

> *The Electricity Storage Handbook (Handbook) is a how-to guide for utility and rural cooperative engineers, planners, and decision makers to plan and implement energy storage projects. The Handbook also serves as an information resource for investors and venture capitalists, providing the latest developments in technologies and tools to guide their evaluations of energy storage opportunities. It includes a comprehensive database of the cost of current storage systems in a wide variety of electric utility and customer services, along with interconnection schematics. A list of significant past and present energy storage projects is provided for a practical perspective.*
>
> *(2013 Electricity Storage Handbook, US Department of Energy, July 2013)*

http://www.sandia.gov/ess/publications/SAND2012-10314.pdf

Large-scale Electricity Storage

On top of backups, a second important component of "firming up" variable RE is to store electricity for use when demand requires it. Electrical Energy Storage (EES) systems are classified into mechanical, electrochemical, chemical, electrical and thermal energy storage systems, as per the figurehereafter from the IEC.

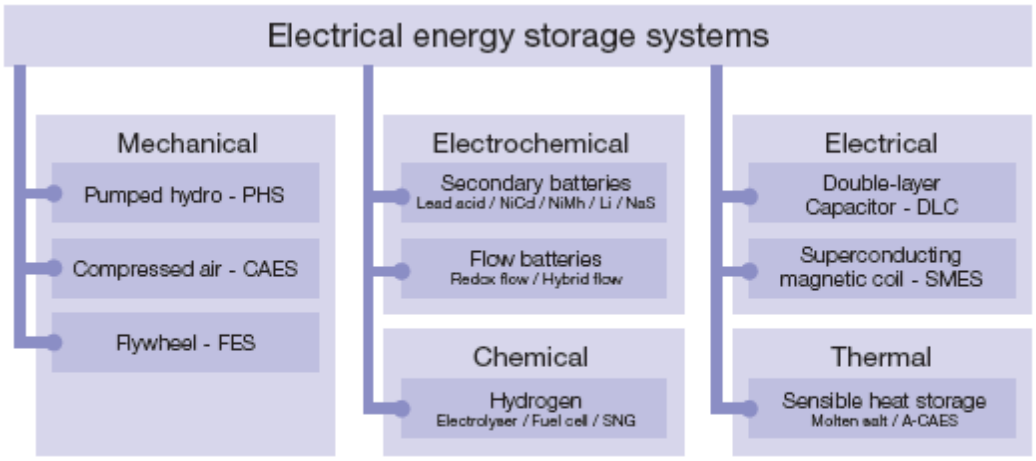


Figure 2-1 – Classification of electrical energy storage systems according to energy form
(Fraunhofer ISE)

Figure 10 - Classification of electrical storage systems according to energy form

The two most suitable EES solutions for Mauritius are **pumped hydro storage** and **large-scale batteries**.

Pumped hydro storage (PHS)

PHS is simple in principle. During the periods of the day when intermittent RE operates, water is pumped uphill into a dam. Then, during moments of peak demand, the water is discharged downhill to run a hydroelectric plant and electricity is thus supplied to the grid, enabling RE to meet peak demand when it is needed.

Pumped hydro storage is the most widespread electricity storage system across the world. According to the IEC's White Paper on the grid integration of large capacity RE plants, there are at present over 129 GW such systems in operation worldwide. The IEC states that, as a general rule, a reservoir one kilometre in diameter, 25 metres deep, and having an average head of 200 metres would hold enough water to generate 10,000 MWh. PHS operate at about 76%–85% efficiency, depending on design. A feasibility study on the potential for such a solution in Mauritius should be carried out.

According to the IRENA, "*pumped hydro is the cheapest option for large-scale electricity storage. The current capital cost of new pumped hydro facilities is estimated to range between USD 2000–4000/kW, with dam and civil infrastructure accounting for 60%, pump-turbine devices for 15% and other components and systems for the remaining 25%.* ***Upgrading existing dams with additional electricity generators to increase production flexibility is by far the cheapest option among energy storage technologies with costs as low as USD 100–***

300/kW.*The overall cost of pumped hydro energy storage is estimated at between USD 50 and USD 150 per MWh*."

Large-scale batteries

Various technologies are already availableor are being developed.

- **Sodium-Sulphur**

This technology is rated as having **significant recent commercial experience**. Currently, about 316 MW of Sodium-sulphur (NaS) installations have been deployed globally at 221 sites, representing 1896 MWh. NaSbatteries are a commercial energy storage technology finding applications in electric utility distribution grid support, wind power integration, and high-value grid services. It has long discharge period (approximately 6 hours) and is capable of prompt, precise response to such grid needs as mitigation of power quality events and response to AGC signals for area regulation.EDF is experimenting a NaS battery system in Reunion Island.

Unfortunately, high safety issues do not make NaS a recommended choice. NaS batteries use hazardous materials including metallic sodium, which is combustible if exposed to water. Any fire situation cannot be dealt with by normal firefighting systems. But NaS has proven that batteries can achieve market scale and that an initially expensive technology can become very cost-competitive. The future looks therefore very good for other, safer, battery technologies.

A NaS battery discharging50MWh for 6 hours would cost in the USA USD 157 million (Rs 4.7 billion) for construction and **15 years** of operations and maintenance. This works out to be **Rs 2.91 per KWh** (with 5 days of maintenance per year).

- **Vanadium redox flow**

This technology is rated at Pre-commercial Stage. Vanadium redox systems have been demonstrated in a number of applications and large-scale field trials. Japan's Ministry of Economy, Trade and Industry (METI) selected in April 2013 Vanadium Redox for a very large-scale battery storage system, 62 MW, to be built by end of 2014 and which currently ranks as the biggest battery system in the world. Vanadium redox is newer than NaS in terms of massive deployment. It is for now more expensive but safe and still very cost-competitive.

Unlike many other battery technologies, cycle life of vanadium redox systems is not dependent on depth of discharge. Systems are rated at 10,000 cycles. Vanadium redox systems have a useful life estimated at about 10 years. Vanadium redox systems are capable of stepping from zero output to full output within a few milliseconds, if the stacks are already primed with reactants. In fact, the limiting factor for beginning battery discharge is more commonly the controls and communications equipment.

A Vanadium Redox battery discharging 50MWh for 5 hours would cost in the USA US 227 million (Rs 6.8 billion) for construction and **15 years** of operations and maintenance. This works out to be **Rs 5.05 per KWh** (with 5 days of maintenance per year). The IRENA is more optimistic in its figures than the US Department of Energy: "*Vanadium flow cells are also projected to reduce their capital cost from the current level of USD 3000 to USD 4000 per kW to about USD 2000/kW with a prospective overall storage cost of USD 250–300/MWh, depending of actual lifetime*. […]*Unlike other rechargeable batteries, VRBs need little maintenance*." (*Electricity Storage Technology Brief, IRENA, April 2012*). Using IRENA's figures, one can estimate the capital cost at USD 3,500 per KW. A 50 MW system discharging daily for 5 hours would thus cost USD 175 million, about Rs 5.25 billion. This works out to be **Rs 3.83 per kWh**.

- **Sodium-nickel-chloride**

This technology is rated at **Demonstration Stage**. Sodium-nickel-chloride batteries are high-temperature battery devices. There is limited testing and filed experience, but by the end of 2013, several fully integrated systems are expected to be deployed for utility grid support and renewable integration.

A sodium-nickel-chloride battery discharging53 MWh for 5 hours would cost in the USA US 300 million (Rs 9 billion) for construction and **15 years** of operations and maintenance. This works out to be **Rs 6.28 per KWh** (with 5 days of maintenance per year).

- **Iron-chromium redox flow**

This technology is rated at **Laboratory Stage**. Iron-chromium redox flow are still in the R&D stage but steadily advancing toward early field demonstrations in 2013-2014. The low-cost structure of these systems also makes them worth evaluating for grid-storage solutions. The technology indicates less-complex and lower-cost design, controls, materials and reactants than Li-ion, lead-acid, NaS, Zinc-bromine, and others.

There are no such batteries already in utility-scale demonstration. **Theoretically, an iron-chromium redox flow battery discharging 50MWh for 5 hours** would cost in the USA US 83.7 million (Rs 2.5 billion) for construction and 15 years of operations and maintenance. This works out to be a **theoretical Rs 1.86 per KWh**(with 5 days of maintenance per year).

- **Zinc-air**

This technology is rated at Laboratory Stage. Zinc-air technology is still in early R&D phase for stationary storage systems for grid services markets. Despite substantial technical obstacles faced in the past, this technology holds a great deal of potential because of its low capital cost for grid support. The technology is also far more stable and less dangerous than other battery technologies.

Zinc-air batteries have up to three times the energy density of Li-ion, its most competitive battery technology. Unlike lithium-ion, however, Zinc-air batteries neither produce potentially toxic or explosive gases, nor contain toxic or environmentally dangerous components. Zinc-oxide, which is the main material in a zinc-air battery, is 100-percent recyclable.

There are no such batteries already in utility-scale demonstration. Theoretically, a zinc-air battery discharging 50MWh for 6 hours would cost in the USA US 74.7 million (Rs 2.24 billion) for construction and 15 years of operations and maintenance. This works out to be a **theoreticalRs 1.36 per KWh** (with 5 days of maintenance per year).

- **Advanced Lead acid Battery Systems**

This technology is rated at Demonstration Stage, but that some advanced systems can be classified as commercial. Lead-acid batteries are the most commercially mature rechargeable battery technology in the world. VRLA batteries are used in a variety of applications, including automotive, marine, telecommunications, and uninterruptible power supply (UPS) systems. However, there have been very few utility T&D applications for such batteries due to their relatively heavy weight, large bulk, cycle-life limitations, and perceived reliability issues (stemming from maintenance requirements).

One disadvantage of lead acid batteries is usable capacity decrease when high power is discharged. For example, if a battery is discharged in one hour, only about 50 % to 70 % of the rated capacity is available. Other drawbacks are lower energy density and the use of lead, a hazardous and toxic material. Advantages are a favourable cost/performance ratio, easy recyclability and a simple charging technology.

An advanced lead acid battery discharging 50MWh for 4.8 hours would cost in the USA US 141.7 million (Rs 4.25 billion) for construction and 15 years of operations and maintenance. This works out to be **Rs 3.23 per KWh** (with 5 days of maintenance per year).

- **Lithium ion**

This technology is rated at Demonstration Stage, but with systems verified in several field demonstrations in a variety of use cases. MW class for grid support and PV smoothing is being introduced.

In the past two years, Li-ion battery technology has emerged as the fastest growing platform for stationary storage applications. Li-ion systems dominate the current deployment landscape for grid-scale storage systems in the United States.In total, more than an estimated 100 MW of grid-connected advanced Li-ion battery systems have been deployed for demonstration and commercial service.

Safety however is a serious issue in lithium ion battery technology. Most of the metal oxide electrodes are thermally unstable and can decompose at elevated temperatures, releasing oxygen which can lead to a fire breaking out. It is therefore not a recommended solution.

A Lithium-Ion battery discharging 50MWh for 5 hours would cost in the USA US 227 million (Rs 6.8 billion) for construction and 15 years of operations and maintenance. This works out to **be Rs 9.77 per KWh** (with 5 days of maintenance per year).

There are many other types of energy storage technologies, still in the R&D phase, that are very promising and which will undertake demonstration phase by 2015: H2/Br Flow, Liquid Air Energy Storage Systems, Nano-Supercapacitors. The IRENA released in April 2012 a special *"Electricity Storage – Technology Brief"*, which states:

> *"Energy storage technologies are quickly evolving since the share of renewable electricity is growing fast and there is an increasing need for storage capacity. Storing low-cost electricity (e.g. overnight) and selling it during peak-demand periods could soon become cost effective due to the increasing cost of peak electricity."*
>
> *"While Li-ion batteries are still expensive, new types of low-cost batteries for large-scale electricity storage are under development (e.g. sodium-ion batteries). The cost decline of batteries and other storage technologies will make them appealing for power companies and householders to install more renewable capacity. Until then, policy measures are needed to support the energy storage market.*

Some major country examples currently underway, are listed hereafter. They are taken mostly from the IEC's "*White Paper on Grid integration of large-capacity Renewable Energy sources and use of large-capacity Electrical Energy Storage*".

Current status in the United States of America

The US Department of Energy has set up two flagship programmes to accelerate the deployment of electricity energy storage:

1. the Energy Storage Technology Advancement Partnership (ESTAP): http://www.cleanenergystates.org/projects/energy-storage-technology-advancement-partnership/
2. the Energy Storage Systems (ESS), operated by the Sandia National Laboratories: http://www.sandia.gov/ess/

These 2 programmes have recently supported the islands of Hawaii in setting up utility-scale battery systems for the grid integration of large PV and wind farms. For instance, a special study was conducted to assist the Hawaiian Island of Maui in its objective of providing upwards of 40% of its system capacity by renewable energy resources by 2015. The Maui Electric Company (MECO) plans for three large wind

farms and a significant distributed deployment of photovoltaics. The study investigated strategies to mitigate anticipated wind energy curtailment on Maui, with a focus on grid-level energy storage technology: http://www.sandia.gov/ess/publications/SAND2012-10314.pdf

The study team developed an hourly production cost model of the Maui Electric Company (MECO) system, with an expected 72 MW of wind generation and 15 MW of distributed photovoltaic (PV) generation in 2015, and used this model to investigate strategies that mitigate wind energy curtailment. It was found that storage projects can reduce both wind curtailment and the annual cost of producing power, and can do so in a cost-effective manner

Current status in Japan

In 2008, the Japan Wind Development Co. (JWD) began operating the first commercial "Wind and NAS Battery Hybrid System". This plant consists of 51 MW (1 500 kW × 34 units) of wind turbines and 34 MW (2 000 kW × 17 units) of NAS batteries.

The NAS battery application regulates the output of the plant to produce more electricity during high demand (price) periods, and less during low demand (price) periods. Output can also be reduced when system conditions require. JWD has operated its wind and electrical energy storage technologies in combination according to plan for 3 years.

Furthermore, in April 2013, Japan's Ministry of Economy, Trade and Industry (METI) announced plans to install the world's largest battery at an electrical substation in the prefecture of Hokkaido, which has a high number of solar installations. The battery is expected to have a storage capacity of around 60MWh, and to be set up by March 2015. The project cost will total an estimated ¥20 billion (US$200 million), with financial assistance expected from the Ministry of Economy, Trade and Industry. The project is expected to use up a large proportion of a ¥29.6 billion (US$299.5 million) fund allocated to battery projects by the Japanese government in its 2012 budget. Hokkaido is Japan's second largest island. The battery will be based on vanadium redox flow technology.

Current status in China

China is implementing two massive projects:

- A national wind power, solar power, energy storage and transmission demonstration project, in Zhangbei, North Zhangjiakou. The planned capacity of the project is 500 MW wind power, 100 MW PV power and 110 MW energy storage. Phase I of the project, which was completed in 2011, consists of 100 MW wind power, 40 MW PV power and 20 MW energy storage. In order to test the performance of different types of battery storage, three types of battery storage are used in the 20 MW energy storage station: 14 MW of lithium iron phosphate (LiFePO4, LFP) batteries, 4 MW of NaS batteries and 2 MW of vanadium redox flow batteries (VRFBs).

- A demonstration lithium iron phosphate battery storage station has been built in Shenzhen for both commercial and research purposes. The storage station was planned to have a capacity of 10 MW/40 MWh, divided equally into two phases. 4 MW/16 MWh of the phase I project has already been put into operation.

Current status in Germany

During the next five years, Germany is expected to lead the residential storage segment with installed storage capacity of 2 GWh.

A new solar storage incentive program was launched by the German Federal Government on 1st May 2013. It provides interest reduced loans and a repayment allowance up to 30 percent of battery costs and EUR 660 per PV capacity (kWp) respectively eligible for the purchase of batteries in conjunction with PV systems smaller than 30 kWp. PV storage systems are forecast to grow by an average of more than 100 percent a year over the next five years, reaching nearly 7 GWh in 2017. With the German legal framework enabling own-consumption and the direct sale of electricity to third parties as well as the new energy storage support schemes, Germany now offers an attractive chance to test new business models in a grid parity market environment.

PART TWO

REPORT OF THE PUBLIC HEARINGS AND

SUBMISSIONS TO THE NATIONAL ENERGY COMMISSION

1. BACKGROUND

During the first sittings of the National Energy Commission (NEC), many written proposals were made by members of the public, in relation to the energy sector. With a view to opening up the debate to all the citizens of Mauritius and to enhancing the value of its work in the spirit of participative democracy, the Commission decided at its meeting of 12 February 2013 to invite through a communiqué, organizations and members of the public to share their views in relation to its terms of reference (TOR), which are to:-

(i) review national energy requirements.

(ii) advise Government and other authorities concerned in the planning and execution of major projects in the Energy Sector to fully meet medium and long term needs; and

(iii) oversee the operation of the MID Fund.

After the closing date of 15 March 2013, several submissions were still being received. This led to the National Energy Commission (NEC) deciding at its sitting of 21 March 2013 to extend the closing date to 30 April 2013 and to set up a Sub-Committee to hear all the submissions and to submit its report to the main committee.

The Sub-committee comprised:

(i) Mr. O. Mahomed, Executive Chairman, MID Commission as Chairperson;

(ii) Mr. S. Thannoo, General Manager, Central Electricity Board, as member;

(iii) Mr. P. Kallee, Deputy Director of Environment as member; and

(iv) Mr. R. Imrith, President, Federation of the Public Sector and other Unions as member

A Secretariat was provided by the Ministry of Energy and Public Utilities to assist the Sub-committee in its deliberations. Logistics were provided by the Office of the MID Commission. All hearings were thus held in the Conference Room of the MID Commission, 1st floor, Belmont House in Port Louis.

The sessions started on 09 April 2013 and ended on 12 June 2013. However, this was again extended due to additional requests.

Following a decision taken at main NEC meeting of 02 May 2013, the press was invited through the Government Information Services (GIS), to attend hearings. Deponents were

therefore informed of the presence of the representatives of the press in their respective letter of convocation and none of them raised any objection in that respect. They also unanimously agreed that their presentations be made public and posted on the website of the NEC. All hearings have been recorded by the GIS.

Sixty-three (63) submissions were received and after examination, this figure was brought down to forty-one (41), given that there were cases where parties submitted for more than one hearing. Moreover, many who had written could either no longer be reached or simply did not turn up. One person namely, Ms SaloniKisnah passed away in the meantime. All respondents were directly convened to make their presentation in front of the main Committee.

Given that there were four more requests for hearings, including two from overseas, the main NEC Committee decided at its 15th sitting to extend the hearings to these four parties. Consequently, the Sub-committee fixed the date for the hearing of all parties in the afternoon of Wednesday 14 August 2013. Consequently, the total number of hearings was 45 and these were effectively held over sixteen (16) sessions. For each and every session, hearings of four respondents were scheduled over 20 minutes approx. each. A complete list of the respondents and their date of hearings is found in this report

The Sub-committee met regularly once weekly initially but had to increase the frequency to twice weekly as from mid-May 2013. The Sub-committee heard all respondents without any discriminations and irrespective on their background. The views of the charcoal seller who was banned to do his work because of environment issues, local and foreign promoters wishing to invest in energy sector, young professionals who came forward with valuable proposals are amongst others included in this report.

The gist of the hearings may be categorized in three main subjects as follows:

- Views on the CT Power project
- Energy and Environment
- Specific projects

Views on the CT Power project

As far as CT Power is concerned, thirteen (13) respondents expressed their views and concerns on the project and objected to its implementation. However, two others did not raise any objection, of whom one justified the project as an initiative towards energy security and

the other one mentioning that the project was subject to 31 very stringent conditions compared to other existing IPPs.

Energy and Environment

As regards energy and environment, most of the deponents who expressed on energy issues advocated the diversification of the energy mix and protection of the environment.

Specific Projects

Twelve (12) of the submissions were related to projects. Following a request from the NEC, the Sub-committee compiled a separate list of specific projects and same is included in this report.

2. LIST OF PROJECTS PRESENTED.

2.1 Renewable Energy at Bagatelle Mall of Mauritius

ENL Property proposes to generate electricity at Bagatelle Mall, using photovoltaic panels. It will invest in the solar farm project and sell energy generated to the shop owners there. A PV system of capacity 2.65 MW will be installed in the employees parking car shed. Actually the estimated cost of production from PV system is very close to the cost of tariff of CEB, that is, Rs 5.70 per Kwh from PV, compared to Rs 5.80 per Kwh from CEB. ENL Property can produce 35% of the consumption of the mall during daytime representing a savings of Rs 500,000 annually for an investment of Rs 200 M. ENL has submitted a formal offer to CEB to install its PV panels and to sell the electricity thus produced to the tenants. However, the CEB has informed that under the Electricity Act 1939, nobody is allowed to sell electricity, except itself. According to the ENL, a review of the system to sell energy is required and in that regard a leasing agreement as in Singapore was proposed to sell the energy. This project was discussed at main NEC and it was understood that MEPU would initiate necessary procedures to amend the Electricity Act 1939.

2.2 Biomass as an alternative to Fossil Fuel

Arundodonax is an energy crop cultivated by EQUILIBRE– Bioenergy Production Ltd from locally found species. It is a cane-reed like plant and can be harvested 2-3 times a year. According to the promoter, the University of Mauritius and the Ministry of Agro Industry and Food Security have raised no objection to the project. 3,000 hectares (with approx. 700 ha for each phase) of marginal/unutilised land would be required to cultivate the crop. Allocation of 250 Ha of land has been guaranteed by the planters in Solitude, but the problem is that the portions are scattered. 5,000 hectares of cultivation of *arundodonax* would be required in the medium term. It would be used to produce diesel and electricity that would be equivalent to the importation of 4,000 tons of coal.

Two proposals were therefore made to be considered by the NEC as follows:

(a) to put in place a grant scheme for the production of electricity, e.g, Rs 50,000 per ha for the 3000 ha of land required. This would not apply for production from diesel. The Scheme would cover, in the first instance, the conversion of land so as to enable the production of 'arundodonax'; and

(b) Government to also make land available to the promoter.

2.3 Production of electricity from residual waste from industrial composting at La Chaumière through pyrolysis.

Solid Waste Recycling Ltd operates an industrial composting plant at La Chaumière on a land leased from Government. SWRL receives about 300 tons of solid waste daily at La Chaumière for composting and the treated compost is sold as fertiliser. SWRL is actually receiving only half of the waste allocated by the Government. It is proposing to increase its daily input to some 550 tonnes of waste daily in the near future. From the wastes that SWRL receives, some 30% to 40% cannot be composted and goes to the Mare Chicose landfill. The owners of SWRL have decided to set up a new company, Ultimate Power Producer Ltd (UPPL) to use the residual waste at the composting plant to generate electricity which would be sold to CEB. The representatives of UPPL informed that they have already presented their project to the Board of Investment (BOI) last year and that there is a Cabinet decision related to the project.

Based on a preliminary assessment of prospective technologies, the plant would be running for 8000 hours annually to produce some 15 MW per hour of electricity **(based on the reject from processing of 550 metric ton of solid waste daily)** while at the same time it would fully abide by the stringent EU standards on exhaust emission. UPPL has appointed WSP Future Energy based in London as Consultant to provide advisory services for the planning and development of its waste-to-energy project at La Chaumière. The consultant has already shortlisted four technologies which are environmental friendly to produce some 15 MW of electricity for 8000 hrs annually. All four technologies pertain to pyrolysis.

2.4 Biodiesel Production from use vegetable oil and algae.

The project consists buying and collecting the used oil from hospitals and hotels. This is treated and processed to be used as fuel in vehicles possessing diesel engine systems such as huge excavations, minibus, several 4x4 pickup trucks, trailers etc. A pilot project is presently processing 700 litre of used oil per day to produce around 600 lts of biodiesel through a biodiesel processor capable of producing 250 lts per batch. Around 3 batches can easily be processed per day which makes around 750 litres. 2.9 million litres of used oil is generated every year out of which 2 million litres can be effectively recovered. The proposed selling price of the Biodiesel is estimated at Rs 39 per litre. The company is purchasing the used/waste vegetable oil from hospitals and hotels at the rate of Rs 5.00 per litre. The company is also

proposing to extract oil from algae, which can be mixed with the used oil to produce biodiesel. In this respect, algae is being cultivated in Rodrigues, at BaieDiamant.

2.5 Project of a 4MW solar power plant equipped with energy storage system

According to the promoter, Valo Re, the project would require an extent of land of about 10 Ha, preferably in the west or north-west region. It will be fully financed to the estimated tune of EUR 7M and will be run by the promoter for 20 years. Finally, it will be handed over to the CEB. The life span of the plant is estimated at 30 years. The project consists of an installation of 16640 panels and a storage of a capacity of 1000 kW/h. A yearly output of 6.7 million kW/h is expected. the project proposal has already been sent to the CEB on 29 April 2013, and the promoter would like the NEC to consider it as a valid proposal and act as facilitator for its implementation. A premium is expected by the promoter for the storage system. A complete technical dossier would be submitted to the CEB on 15 July 2013.

2.6 Proposal for the setting up of a compressed Natural Gas Power Barge.

Eaglefin Structured Finance Mauritius Ltd, the company is submitting a project proposal incorporating a fully funded solution to the energy needs of Mauritius based upon the importation and storage of compressed natural gas (CNG).

The proposed project will cover the following:-

(a) CNG import and bulk supply project.
(b) a 120 MW Floating Power Plant project.
(c) a CNG Vehicle Transportation Distribution Network (NGV) project.

The price of electricity production in Mauritius cannot be ascertained at this stage. However, in Ghana, a country where there is no available gas, the price is USD 0.12 - USD 0.19/kW/h.

2.7 10 MW Solar Power PV Power Plant at Mon Choisy

According to the Company, HarelMallac, the most adapted technical components for the 10 MW PV Power Plant as follows will be used:

(i) crystalline modules which are most cost-effective;
(ii) simple, single-axis sun tracking system with very few moving parts; and
(iii) integrated inverter/transformers.

The representative of HarelMallac Group informed that the Consortium HarelMallac Group/Dhamma Energy had forwarded their bid to the CEB in the 10 MW (5x2) Solar PV project. The company has been selected as being the cheapest bidder, however, no contract had yet been awarded to them.

Regarding their proposal for 10 MW PV Plant, land would be secured along side the 2 MW PV Plant. The construction works of the 10 MW PV Plant was expected to be completed in six months.

2.8 Solar Thermal Energy project

Mr Ajay Jogoo stated that he is now working on an IRS project which would be carbon free and the estimated cost of the project is Rs 14 Billion. He pointed out that funds have been secured for a 4.6 MW clean electricity project. A MoU has been signed on 19 April, 2013 and an application for undertaker's license has been made and was still being awaited from the CEB. A presentation was also made on a new Solar Thermal Energy project for a 100MW energy generation (with storage facility) that the promoter has submitted to the Chairman of the NEC on 10 March 2013. He added that the same technology has been tested in many countries, like, USA, Spain and Germany etc. According to Mr Jogoo, the pricing would be less than Rs 5 per kW per hour, during the first year (without carbon credits) and will decrease gradually; and

2.9 Biodiesel from algae

Island Power Ltd proposes to produce 500o litres of oil daily from algae cultivated on 10 acres of land. Application for land has already been made in February 2013 and a reply is awaited.

2.10 Domestic Biogas Plant

Dr K. Ramdhun circulated a paper on his project regarding the KievnovSyrod Environmental Technology Domestic Biogas Plant. He informed that, at Kievnov Science and Environmental Technologies Co. Ltd, they are engaged in the implementation, promotion,

popularization and research in Bio-waste Management, non-conventional energy and energy conservation programmes. He was referred to the MID Fund for consideration.

2.11 Waste to Energy

Solarprod Ltd, a member of the FSB Holding, a French group, came with a proposal for an experimental station in Mauritius for the gasification of waste to produce energy. The process consists of partial oxidization of organic matter at low temperature (400 degrees), which is converted to thermal and electrical energy. The plant, called 'energo' plant extracts up to 95% thermal energy contained in organic matter with a humidity rate of 60%. One such plant will treat 60,000 tons of waste to generate 1 MW of electricity. The project may be experimented on a regional grid.

2.12 MSW/WTE Project

The Promoter, Green Waste Energy Group did not depone in front of the Sub-Committee because of confidentiality reason.Mr.DevenMaulloo, the CEO contacted the Chairman of the Sub-committee for submission. After consultation with Mr Manraj, it has been agreed that the proposal of Green Waste Energy Group be considered herein.

Letter dated 27th August 2013 from Mr.DevenMaulloo, CEO of Green Waste Energy Group (Mauritius), addressed to the Chairman, National Energy Commission

Green Waste Energy Group (GWEG) is an integrator, producer and exporter of equipment and "turn-key" systems used to process municipal solid waste (MSW) - biomass, all forms of plastic, tyres, hospital wastes and animal manure among others - to generate clean electricity. GWEG uses ultra-high temperature gasification, which is a carbon-neutral process that can convert all MSW (except glass and metals) into electricity, aviation fuel and diesel. According to GWEG, the technology has the following advantages:

- Zero waste to landfill, zero emissions and zero noise
- Self-sufficient plants which use PV and own power to operate

In its letter addressed to the Chairman of the NEC, dated 27th August, the promoter stated that Minister Herve Aimee has agreed to allocate 600 MSW to him subject to the concept and technology being accepted by the relevant authorities. With the given 600 tons of MSW, GWEG will be able to generate about 40 MW of electricity per day, on a 24-hour basis, connected to the national grid. The project is expected to cost USD50 million as FDI (Rs1.5 billion) for one

typical 100 tons MSW a day plant capacity. GWEG would construct its plants in different geographical locations.

The GWEG does not require any cross subsidy from the M/Local Government, except for the direct allocation of the required MSW. In addition, the M/Local Government would not need to invest in transfer stations in the North and the South for onward transportation to Mare Chicose. The promoter stated that the price of electricity would be between Rs6.50 and Rs6.70.

3. LIST OF SUBMISSIONS TO THE NATIONAL ENERGY COMMISSION

SN	FROM	Status
1	**J PEM**	Heard on 09/04/13
2	**MR PRITIVIRAJ RUNGLOLL**	Heard on 16/04/13
3	**HAREL MALLAC**	Heard on 23/04/13
4	**MR ROLAND DO MANDARIN**	Heard on 23/04/13
5	**MR SUTTYHUDEO TENGUR-ASSOCIATION FOR THE PROTECTION OF THE ENVIRONMENT AND CONSUMERS (APEC)**	Heard on 23/04/13
6	**MR T BEEHARRY - RETIRED CONSULTANT-BIOCHEMIST**	Heard on 30/04/13
7	**CHERREN PONAMBALUM**	Heard on 30/04/13
8	**MR RAMESH MAUDHOO, PDSM**	Heard on 30/04/13
9	**MR D GANGARAM, GS PARTNER CONSULTING ENGINEERS LTD**	Heard on 30/04/13
10	**MR V VENKATASAMY**	Heard on 07/05/13
11	**DR MICHAEL ATCHIA, VICE PRESIDENT OF FAFICS**	Heard on 07/05/13
12	**MR MADOO DESHA**	Heard on 07/05/13
13	**DR MICHAEL ATCHIA, VICE PRESIDENT OF FAFICS**	Heard on 07/05/13
14	**African Development Bank (AfDB)**	Heard by both sub-committees on 13/05/13
15	**MR SOMDUTH DULTHUMUN, CHAIRMAN OF MAURITIUS SANATAN DHARMA TEMPLE FEDERATION**	Heard on 14/05/13
16	**EVECHE DE PORT LOUIS MR M PIAT**	Heard on 14/05/13
17	**MR REHMAN TOOFANY**	Heard on 14/05/13
18	**MRS SHESHMA DAUMOO**	Heard on 15/05/13
19	**MR DILIPSING PURGUSS**	Heard on 15/05/13
20	**MR ZAHEER ALLAM**	Heard on 15/05/13
21	**MR ASHLEY APPADOO, ENGINEER AT EDF ENERGIES NOUVELLES EN FRANCE**	Heard on 15/05/13
22	**Agence Française de Développement (AFD)**	Heard by both sub-committees on 17/05/13 and 23/05/13
23	**MRS JAMAL**	Heard on 21/05/13
24	**MR ALIAN ALIDHON**	Heard on 21/05/13
25	**MR YANNICK CORNET**	Heard on 22/05/13
26	**MR FABIANI BALISSON**	Heard on 22/05/13
27	**MRS MARIE MICHELLE TROUBAT**	Heard on 22/05/13
28	**MR KUGAN PARAPEN**	Heard on 28/05/13
29	**MR SANJU DEENAPANRAY, DIRECTOR ECOLOGICAL LIVING IN ACTION LTD**	Heard on 28/05/13

30	**MS MINAKSHI SOHUN, DIRECTOR OF LAKE EYRE WIND POWER LTD / MR AJAYE JOGOO**	Heard on 28/05/13
31	**MR AJAYE JOGOO**	Heard on 28/05/13
32	**MR M L'ECLUSE, SPR LTEE**	Heard on 28/05/13
33	**KOLEKTIF PU LENERZI RENUVLAB**	Heard on 29/05/13
34	**Mr. R. Awotar, Executive Director, MAUDESCO**	Heard on 29/05/13
35	**Valore**	Heard on 29/05/13
36	**Sotravic**	Heard by both sub-committees on 30/05/13
37	**MR HURRYNARAIN SEEPAUL, DIRECTOR OF ALGAE BIODIESEL COMPANY LTD**	Heard on 04/06/13
38	**Patrick Tardieux**	Heard on 04/06/13
39	**MR LAURENT DE MORELOS, DIReCTOR OF EQUILIBRE BIOENERGY PRODUCTION LTD**	Heard on 05/06/13
40	**EQUILIBRE BIOENERGY PRODUCTION LTD - CD**	Heard on 05/06/13
41	**MR LOUIS APOLLON**	Heard on 05/06/13
42	**Mr. Patrick Maurel CEO of Ultimate Power Producer Co Ltd**	Heard on 05/06/13
43	**OMNICANE**	Heard by both sub-committees on 06/06/13
44	**PLATEFORM MORIS LANVIRONNMAN - MS ADI TEELOCK**	Heard on 11/06/13
45	**MR KARIM JAUFEERALLY, PRESIDENT OF IELS**	Heard on 11/06/13
46	**Director, Eaglefin Structured Finance Mauritius Ltd**	Heard on 12/06/13
47	**PLANTERS REFORM ASSOCIATION**	Heard on 12/06/13
48	**Alteo**	Heard by both sub-committees on 20/06/13
49	**Terragen**	Heard by both sub-committees on 20/06/13
50	**TUV SUD South Africa (Pty) Ltd**	Heard on 14/08/13
51	**Solarprod**	Heard on 14/08/13
52	**Mr. A. Bundhoo Island Power Ltd**	Heard on 14/08/13
53	**Dr. Kevin RamdhunKievnov International**	Heard on 14/08/13
54	**MR Vincent Bollore through the MID Commission**	Written submission
55	**GDF SUEZ**	Written submission
56	**United Nations Development Programme (UNDP)**	Written submission

Name/Organisation: Mr.JeewonNarainPem

Date **:** 09 April 2013

Subject Matter : Energy issues and clean energy

Presentations/Submissions

1.0 Mr. Mr J.N Pem, a very well-known Chemistry teacher, made his presentation, mainly focussed on the use of clean energy. The main points raised are as follows:

Main concerns

(i) With the use of fossil fuels there is an increase of CO2 emissions, which deposit on leaves and plants, thus limiting the presence of oxygen in the atmosphere;

(ii) The importation of fossil fuels continues to rise as well as the cost of those fuels and this will have an impact on the economy; and

(iii) In times of war, fire and other calamities, the scarcity of fossil fuels will be felt and there would be no alternatives.

ToR 1-Proposals

(i) Use of fossil fuel only when needed;

(ii) Aggressive campaigns against wastage of energy;

(iii) Limit the emission of CO2; and

(iv) Decrease our dependence on fossil fuel and other carbon fuels by using RE sources of energy.

ToR 2- Proposals

(i) Gris Gris and Poste Lafayette are two areas where sunshine is very high, wind is very strong and waves have tremendous power. There are a few waterfalls around the island;

(ii) those might be used as energy sources and we should find ways and means to harness their energy to produce clean energy; and

(iii) used batteries and photovoltaic plates should be safely disposed of so as they do not contaminate and pollute aquifers and rivers.

ToR 3-Proposals

The MID Fund should be used to finance environment friendly source of energy generation projects. It should work in close collaboration with the Mauritius Research Council, the University of Mauritius, the private sector and other organisations to promote such projects.

2.0 Recommendations

The Chairperson thanked Mr.Pem for his intervention and informed that:-

(i) the points raised by him regarding renewable source of energy was already being taken into consideration;
(ii) the MEPU is working on different RE projects so that by 2025, 35 % of the total energy generation would be from RE sources;
(iii) the CEB is implementing various projects, such as, solar PV projects, wind parks (including one in Rodrigues), a landfill gas to energy project at Mare Chicose and also a pre-feasibility study on geothermal energy; and
(iv) the MID fund is financing many of those projects.

3.0 The Chairperson closed the hearing by thanking the media and press for their presence and informed Mr Pem that the gist of his presentation would be conveyed to the main Committee of the NEC.

Name/Organization: MrPritivirajRungloll residing at Bois Mangues, Plaines des Papayes

Date of Hearing : Tuesday 16 April, 2013

Subject Matter : Effects on coal ash in relation to water pollution

Presentation/Submissions:

- MrRungloll circulated a paper published by Mr Nick Barrickman on 22 October, 2012 regarding the extensive coal ash contamination found in US water supply. According to this article, coal ash impoundment sites, called wet ash ponds in certain cases contained contaminant level so toxic that in case of overflow of ponds, this would result in a loss of human life.

- MrRungloll wanted to have answers to the following questions:-

  (i) the risks coal ash represents on our ground water pollution;

  (ii) reference was made to the EIA report on CT Power which mentions that there are two (2) concrete structures to collect polluted water and coal ash each. He enquired whether the water will be treated and if there is provision for any treatment plant in the EIA report;

  (iii) what will be done in case the ponds would be filled in; and

  (iv) he has also referred to the declaration made by Mr SomduthDulthummun and the Chairman of CEB to the media in February 2013 to the effect that the IPP's are spreading coal ash in sugar cane fields. In that regard, he enquired whether the EIA report has made provision for the disposal of coal ash for the existing IPP's and what measures have been taken so far following these declarations.

Recommendations:

- The Committee thanked Mr Rungloll for his questions and assured him that the issues raised have been noted/captured. Mr Kallee informed him that his contribution on CT Power was valid and stated that the issues have been taken into consideration in the condition of EIA licence. The licence makes provision to treat coal ash instead of being sold.

- The Sub-committee will hear Mr Rungloll for a second time in as much as the members were not in presence of his questions during the hearing. Mr Rungloll has agreed to be heard after the hearing of the other 60 submissions.

Name/Organization: HarelMallac Group

Date of Hearing : Tuesday 23 April, 2013

Subject Matter : 10 MW Solar Power PV Power Plant at Mon Choisy

1.0 Mr S.K.Thannoo chaired the meeting in the absence of the Chairman, Mr O.Mahomed, who was on mission abroad.

Presentation/Submissions:

2.0 Mr Antoine L. Harel circulated a project brief on a 10 MW Solar PV Power Plant at Mon Choisy to members of the Sub-Committee. He stated that HarelMallac Group is working in collaboration with a Spanish Company namely Dhamma Energy, in a Consortium.

2.1 Dhamma Energy has developed power plants in Europe, Africa and Latin America. He, then, highlighted the four main advantages of solar energy environment.

Environmental

- Environmentally-friendly source of energy, which is unlimited and available everywhere.
- Use of silent, non-polluting and recyclable equipment.
- Limited visual impact.
- No transport of polluting raw material involved (fossil fuels).

Economic and Social

- Local energy production which increases energy independence.
- Decentralized production (close to large cities) enables to limit use of grid network.
- Stimulation of economic growth through creation of local jobs (construction, maintenance, security).
- Known cost of energy (set price over a period of 20/25 years).

Educational

- Local training programs.
- Possibility of partnerships with local universities and research centres.
- rise in environmental awareness.

Mature, reliable and adaptable technology

- Use of solar panels for over 40 years.
- Reliable production forecasts.
- Flexibility and adaptability to local needs.
- Adapted to cyclone prone regions
- Limited maintenance.

3.0 He referred to the two countries namely Corsica and Reunion Island where PV Power Plant have been installed and production of energy is fairly high. According to HarelMallac, Mauritius has more advantage compared to those two countries in terms of radiation.

4.0 The Company would use the following adapted technical components for the 10 MW PV Power Plant:

(iv) crystalline modules which are most cost-effective;
(v) simple, single-axis sun tracking system with very few moving parts; and
(vi) integrated inverter/transformers.

5.0 The representative of HarelMallac Group informed that the Consortium HarelMallac Group/Dhamma Energy had forwarded their bid to the CEB in the 10 MW (5x2) Solar PV project. The company has been selected as being the cheapest bidder, however, no contract had yet been awarded to them.

6.0 Regarding their proposal for 10 MW PV Plant, land would be secured along side the 2 MW PV Plant. The construction works of the 10 MW PV Plant was expected to be completed in six months.

7.0 The Chairperson enquired from the representative of HarelMallac Group about how the latter feel about the future of renewable energy.

8.0 Mr A. L. Harel stated that:

(i) according to him solar energy was the best and cheapest source.

(ii) with solar energy, the cost of energy was a known factor. The price would be set over 20/25 years; and

(iii) RE projects were pollution free and in line with the Maurice Ile Durable Concept.

Constraint in the implementation of the project

9.0 However, Mr A. L. Harel stated that the main constraint in the implementation of the project was the selling of the electricity to the CEB.

10.0 The representative of HarelMallac Group was agreeable to have the project brief posted on the website of the NEC.

Recommendations:

11.0 The Chairperson thanked the representative of HarelMallac Group for his presentation. He informed that the National Energy Commission would be apprised of gist of their submission.

Name/Organization: Association for the Protection of the Environment represented by Mr S. Tengur

Date of Hearing : Tuesday 23 April, 2013

Subject Matter : The future of the country in respect to Renewable Energy projects

1.0 MrS.K.Thannoo chaired the meeting in the absence of the Chairman, MrO.Mahomed, who was on mission abroad.

Presentation/Submissions:

2.0 Mr S. Tengur submitted a paper which was a summary of the five Newsletters he had submitted to the National Energy Commission. The main issues which were highlighted in the paper were:

(a) energy requirements;
(b) sources from which electricity was being produced currently;
(c) energy management;
(d) wastage; and
(e) suggestions.

3.0 He stated that every state or civilization needed affordable energy and our country was no exception and it had its need for reliable source of energy to support its socio-economic development. He added that the high cost of energy had a weightage on scale of importation.

4.0 He added that it was important to produce clean energy for our requirements in the short, medium and long terms. He, further, indicated that the CEB should look for alternative affordable price for energy.

5.0 He indicated that the best option for Mauritius is to make use of renewable energy which come from sources like sun, sea, wind. He highlighted the main advantage of renewable energy, which is its environment friendly.

6.0 He also emphasized on the need to carry out a study on the disposal of coal ashes. He also wanted to know whether the guidelines of the EU and World Bank were being followed and what proposals have been made in the EIA licence for CT Power. He also pointed out that the Energy Efficiency Management Office should be proactive and should sensitize people on

the need to preserve electricity. There should also be monitoring and enforcement and sanctions should be taken against those who do not comply.

7.0 He asked whether, as projected by Government, 35% of RE energy would be achievable in 2025.

8.0 He remarked that the NEC should be guided by the CEB's forecast in its IEP, which had been based on realities.

9.0 He pointed out that in the short and medium term, the authorities should be concerned mainly with the regular and steady supply of electricity in order not to jeopardize various sectors of the economy and have negative impacts on the country.

10.0 He expressed that it was a reality that conventional production of electricity could not be halted at once but would continue for some time alongside the RE projects.

Recommendations:

11.0 The Chairperson thanked the representative of Association for the Protection of the Environment for his presentation. He informed that the National Energy Commission would be apprised of gist of the presentation.

Name/Organization: Mr Roland de Mandarin residing at Pointe aux Sables

Date of Hearing : Tuesday 23 April, 2013

Subject Matter : Destruction of the marine environment

1.0 MrS.K.Thannoo chaired the meeting in the absence of the Chairman, MrO.Mahomed, who was on mission abroad.

Presentation/Submissions:

2.0 Mr Roland de Mandarin informed the Committee that he has been a resident of Pointe aux Sables for 44 years and he has seen many changes taking place in the region due to rapid economic development. He stated that he has been a diver since many years and he has noticed that at Pointe aux Sables and Pointe aux Caves, there were many caves under the sea. He pointed out that if a coal power plant was to be constructed at Pointe aux Caves, it would cause much harm to the natural landscaping and that there would be serious erosion under the sea and the marine environment would be affected. Moreover, the caves would be destroyed due to vibrations during excavation works.

3.0 He expressed his concerns about the disposal of the coal ash in the environment and he made an appeal to the authorities to protect our marine environment, endemic plants and species in the region.

Recommendations:

4.0 The Chairperson reassured him that that his concerns/apprehension regarding the destruction of marine environment would be transmitted to the National Energy Commission. However, concerning the coal power plant, expert's advice was being followed to protect the environment and marine life.

Name/Organisation: Mr. T. Beeharry, Biochemist

Date of Hearing : Tuesday 30 April 2013

Subject matter : Environmental impacts of coal plants

Presentation/Submissions

Impacts of coal power plants

- Mr. T. Beeharry circulated a paper on the expected environmental impacts of a 600 MW coal plant in Mauritius. The salient issues raised by Mr. T. Beeharry are highlighted below:-
- The adverse effects the coal power plants would have on the environment, economy and health of the population plants and animals.
- The disposal of mercury would cause pollution to our aquifers thus causing a threat to the marine species like fish making its unsafe to eat.
- The toxic substances in the wastes containing mercury would contaminate drinking water supplies and damage vital human organs, marine life and aquifer.
- According to his survey the disposal of 125,000 tons of Fly Ash/Soot would seriously affect human health for eg. acute bronchitis, serious asthma, premature death and visibility reduction.
- If sludge is disposed into the sea, besides killing the marine environment, it will have an impact on the tourism industry. Tourists will not be able to enjoy the good quality of sand, sea and sun.
- The disposal of carbon dioxide would contribute in global warming.
- The release of about 14,000 Tons of Sulphur Dioxide can cause acid rain and damage crops, forest soil and the aquifers.
- The disposal of about 225 pounds of Arsenic would cause skin cancer.
- He also evoked that the material used in coating solar water heaters, i.e. zinc, is not good and that stainless steel should be used, which is considered to be a food grade material.

2. **The second part of his presentation focused on the reasons/justifications as to why power plants should not be implanted.**

The main reasons put forward by Mr. T. Beeharry are highlighted below:-

- Coal fired generation is inefficient, dirty and no longer economically competitive compared to natural gas or other sources of renewable energy such as wind and solar. A coal fired power generating unit is costlier to operate and maintain.

- There will be an increase in global warming with carbon emission. The sulphur they emit causes acid rain. Mercury releases poison waterways and causes neurological damage in children.

- The coal plants are the largest single source of Co_2 emission.

Alternative Energy Sources

Suggestions

- Government should encourage the use of other alternatives that would reduce electricity demand, e.g, encouraging the use of solar water heaters (SWH) by subsidising their purchase. People should be sensitised that SWH, which are used mostly in bathrooms, can also be used in the kitchen for making tea and for other purposes to help reduce consumption of electricity.

- The Mauritius Research Council should carry out a survey on energy saving. Standards should be set for SWH.

- Rain Water Harvesting should also be promoted. The population should be encouraged to collect rain water, which is of very good quality and has no pollutants like pesticides, and can be used for domestic and irrigation purposes.

- The CEB should consider a system for the disposal of electric lamps and bulbs which contain mercury. The unused lamps are thrown in the open and finally go to landfills. The mercury found therein is absorbed on in the soil and goes in the underground water thus causing a danger to human health and the environment.

- The replacement of coal plants by plants using RE sources, such as wind and solar is the best and most effective strategy to reduce global warming emissions and move the country towards a clean, healthy and sustainable future.

What should be done to protect the future generations

- Appropriate Legislation should be put in place to control the use of carbon intensive technologies and other pollutants. Policies are needed to develop more efficient and less carbon intensive energy sources.

- Government need to have a preparedness programme for the country.

- The support of media should be solicited to sensitise the population to change their mindset and make use of more energy saving practices.

- Before issuing an EIA Licence, Government should see to it that appropriate provisions have been made therein. For so doing, competent authorities should be nominated, such as, scientists, professionals and hydrology experts to write an EIA Report.

- He concluded that we should ask ourselves whether the present generation is leaving a clean legacy to the future generations.

Recommendations:

- The Committee thanked Mr. T. Beeharry for his valuable contribution and assured him that several of the issues raised in his "Exposé" have/were been considered by Government. The Chairperson referred to the relevant provisions made in Sections 1, 17, 27 and 30 of the EIA Licence for the CT power project and invited Mr. T. Beeharry to go through same, so that he may be reassured that they were being catered for.

- Mr. T. Beeharry was agreeable to have his submission posted on the website of the NEC.

Name/Organisation: Mr. Ramesh Maudhoo

Date of Hearing : Tuesday 30 April 2013

Subject matter : Energy Production on Medium/long term basis and energy savings

Presentation/Submissions

- Mr. R. Maudhoo deplored the fact that the representative of CEB was absent and stated that his exposé was mainly focused on the TOR of the NEC.
- His exposé was mainly based on the role of the CEB as the distributor of electricity. According to him, CEB should consider using other environmentally friendly source of energy which is available everywhere for the production of electricity. The use of oil, petrol, fossil fuel and other pollutants should be avoided and used to the strict minimum.
- CEB should consider using sun, wind and should consider mixing paper with bagasse/coal for producing electricity. In that regard, reference was made to Ireland which is self sufficient in producing clean energy and the remaining is exported.
- He also stated that if no action follows , there is no use having a commission on energy.
- He also thinks that a country cannot function without a reliable source of energy to support its socio-economic development. We need to adopt a long term energy strategy which should be above politics, irrespective of the Government in place. The population and relevant authorities should work as a team in planning the energy strategy and encouraging energy savings options.
- Proposals were made to the need to recycle paper and plastic bottles.
- Reference was also made to America which is producing electricity from old rubber tyres and plastic products.
- Suggestion was also made for the use of dry leaves and other waste as compost for agricultural and livestock purposes and to produce biogas.
- Solar energy should be used to the maximum to produce electricity through PV panels.
- Schools/ colleges and other institutions, like District Councils and Municipalities, should consider using biogas to produce electricity.
- Appropriate legal framework should be put in place for the use of ethanol and bio-ethanol. Incentives should also be given to planters to produce ethanol and bio-ethanol for use in cars and production of energy, which would be cheaper than petroleum

products. The sugar planters and sugar cane industry should be encouraged to use molasses instead of exporting them. Government should consider these options in the sugar sector reform.

- Reference was also made to the declaration of the former president of India, Prof Abdul Kalam during his visit to Mauritius to the effect that the population should be encouraged to plant accacia trees which can be used to produce electricity.

- He expressed his concerns on the huge wastage of electricity and that the CEB has not taken any remedial action. Street lightings and football grounds lights are not put off during the day in many regions like La Vigie, St. JulienD'hotman etc. These should be closely monitored so as to avoid wastage of public funds.

Recommendations:

- The Chairperson thanked Mr.Maudhoo for his presentation and informed him that in fact 18% the country energy requirements comes from renewable sources. The Long Term Energy Strategy of Government advocates 35% of RE by 2025. Government has already put forward a framework for the use of ethanol in cars. The Government is looking into the issue of allowing vehicles to make use of ethanol as fuel.

- He also informed him that his submission and proposals would be transmitted to the NEC.

- Mr Maudhoo had no objection that his submission be posted on the website of the NEC.

Name/Organisation: Mr C. Ponambalum

Date of Hearing: Tuesday 30 April, 2013

Subject Matter: Liquefied Natural Gas (LNG) Project

Presentation/Submission

1.0 Mr. C. Ponambalum informed that he works for a Shipping Company which uses Liquefied Natural Gas (LNG).

Advantages of LNG

2.0 He highlighted some of the advantages of LNG which are as follows:-

(i) it is a natural gas (predominantly methane, CH_4) that has been converted to liquid form for ease of storage or transport;
(ii) LNG produces less greenhouse gas and toxic emissions than low-sulphur diesel;
(iii) it is sound and safe;and
(iv) it is a cheap and clean energy.

3.0 He submitted a copy of the presentation to the Sub-Committee found at Annex 1.

4.0 The Chairperson informed that the CEB has launched a Request for Proposal to carry out a pre-feasibility study on the use of LNG for electricity generation.

5.0 MrPonambalum agreed that his presentation be posted on the website of the NEC.

Recommendations

6.0 The Chairperson stated that the main Committee of the NEC would be informed of the gist of his submission.

Name/Organisation: Mr. D. Gangaram Consulting Engineer, GS Partners.

Date of Hearing : Tuesday 30 April 2013.

Subject matter : Use of Renewable Energy

Presentation/Submissions

- The exposé of Mr.Gangaram was focused on the use of renewable energy. Reference was made to Saudi Arabia where there was a shift in paradigm from use of fossil fuel to renewable energy. He also stated that NEC has to take geopolitics into consideration in advising Government.
- He also gave the example of the US which, 20 years ago, had started to keep its reserves and had started buying from other countries.
- He has also referred to the Kyoto protocol where it is mentioned that there is need to be a change in policy and to find a substitute to fossil fuel that will last forever and at the same time to reduce the carbon.
- Reference was also made to Germany where the Government has encouraged its population to install solar panels on their house roofs for their own electricity consumption and to reduce the use of carbon to the minimum. Mention was also made of South Africa which has lots of coal but it is trying to shift from the coal to other clean sources of energy. Also, in Gujarat solar panel has been installed on feeder canals and the state is self-sufficient in electricity. According to him, those countries have invested in RE as they realise that if they do not do so, the world would need another planet.
- Emphasis was laid on the measures to reduce the use of fossil fuel and carbon and encourage use of alternatives like biogas, windmill and geothermal. He also added that by 2025, there will be a phasing out of nuclear plants because of what happened in Japan.

Recommendations

- According to him, the National Energy Commission (NEC) has a very important role to play and should advise Government on (i) energy efficiency, (ii) building domain and (iii) RE projects, including geothermal. He added that NEC should advise people about the best pathway for the use of energy system. Unfortunately, very few people are aware what is happening in the renewable energy sector.
- Recommendation was made for the use of PV panel and carbon module which are cheaper. Government should give the example. For e.g in the region of Pointe aux

Caves where there are lots of rocks, Government should consider converting the CT power into a solar PV farm or a RE park.

- Consideration should also be given to produce a 15 MW solar power plant at the St. Martin Sewerage treatment plant. There is need to put a converted solar power at the treatment plant where the wastewater is treated at tertiary level. In that regard he has referred to South Africa which has implemented a 15 MW project with a 9-hour storage.
- Government should also consider the installation of a geothermal power generation to address some energy requirements. However, this depends on water requirement.

He concluded by stating that he worked at CWA in 2003 and that he gave an advice which if considered would have benefitted the organisation with a savings of Rs 70M per year over a loss of Rs 800M currently being made.

Name/Organization: Dr Michael Atchia

Date of Hearing : Tuesday 07 May, 2013

Subject Matter : Renewable energy for a sustainable future

Presentation/Submissions:

1.0 Dr M. Atchia circulated a copy of his presentation which is found at Annex 1 to all members. He informed that the same presentation was made at the UNESCO/UNEP International Conference in EE in Ahmadabad in November 2007.

2.0 He wanted to express himself mainly on how to succeed the transition from fossil fuel energy to a renewable energy civilization. He pointed out that in a few years, shortage of petrol would be felt and as a result, the price thereof will increase drastically and petrol would be only affordable by the rich in rich countries.

3.0 He opined that by making a move from fossil energy into a renewable-energy, one will contribute to the restoration of the earth. He added that our country should consider the following sources of energy:

- Wind
- Hydro power
- Solar
- Geo-thermal
- Tidal & other
- Bio-fuels
- Nuclear fusion

4.0 He also proposed that the use of electric cars with individual solar PV panels should be favoured. He gave the example of Denmark which has exploited the use of wind farms.

5.0 According to him, 80% of RE would warrant a smart grid and hence, geothermal energy is the answer. He added that planning for energy is not a 4-5 years issue but a long term one, like the 2025 horizon. Moreover, no research is needed in a small country like Mauritius, but we need to adapt.

6.0 He added that a sustainable energy policy for a small island like ours in the medium term should be made up of the following mix:

(i) 30% Solar;

(ii) 20% Wind;

(iii) 10% Hydro power;

(iv) 20% Bio-fuels; and

(v) 5% Geo-thermal

The remaining 15% would still be fossil fuel and could be used as a back up in specific areas/fields. That could be achieved by 2020 as programmed.

6.0 He proposed that Government considers the setting-up of new rural production units (also called Bio-gas villages) on the premises of ex-sugar factory areas, that would be run locally by the people, but centrally run by experts, to produce wind and solar generated electricity, methane gas.

7.0 He talked on one important aspect which is Education for Sustainable Development for all and strongly recommended that the proposal be considered by the NEC.

8.0 He also highlighted the steps to be taken in order to achieve sustainable development:

(i) to identity and target whom to educate;

(ii) to use traditional low-cost technologies;

(iii) to find ways and means to convert traditional houses into ecological houses (house without electricity, natural cooling devices, etc);

(iv) to change eating habits (eat ecologically);

(v) to sort out wastes in order to recycle them effectively; and

(vi) to achieve green living (composting, rain water harvesting, etc).

9.0 He remarked that up to now Renewable Energy projects have been realised in small scale and suggested that we move to large scale production.

Recommendations:

10.0 The Chairperson thanked Dr Atchia for his interesting presentation. He informed the latter that a few initiatives/actions have already been taken, namely:

(i) the MID Fund with the collaboration of the private sector has prepared a programme called ECOTV (based on sustainable development and eco-friendly habits and attitudes) which is broadcasted on MBC television;

(ii) a MID club has been launched in France Boyer de la Giroday SSS and is being actively replicated in other secondary schools;

(iii) Master degree on Sustainable Development courses are available at the University of Mauritius and University of Technology;

(iv) the MID Action Plan would be endorsed shortly;

(v) talks have been organised for public officers joining the service on the issue of sustainable development;

(vi) the MEPU has worked out a Long Term Energy Plan up to year 2025;

(vii) several RE projects are being implemented;

(viii) the CEB has launched the Small Scale Distributed Generation scheme for Small Independent Power Producers and some 100 families/organizations are already connected to the CEB grid;

(ix) a Landfill gas to Energy Plant has been installed at Mare Chicose and is generating electricity; and

(x) two Hydro Power stations have been constructed at Midlands Dam and La Nicolière respectively.

11.0 Dr Atchia agreed that his presentation be placed on the website of the NEC.

12.0 The Chairperson stated that the NEC would be apprised of the gist of the discussion.

Name/Organisation: Mr. V. Venkatasamy, Venkat Tech Consultancy Services Ltd.

Date of Hearing : Tuesday 07 May 2013.

Subject matter: Demand and Supply Management and Restructuring of the Electricity Sector

Presentation/Submissions

- Mr.Venkatasamy is an Environmental Consultant. His exposé was mainly focused on the Demand and Supply Management and the restructuring of the CEB. The salient issues raised are highlighted below:-

Restructuring of the CEB

- Though CEB is not a policy maker, it holds a monopoly in the generation, transmission and distribution of electricity. This should be reduced in order to allow for more transparency and fairness to consumers and the population at large, who will benefit from an affordable electricity tariff.
- There is need to promote competition among private promoters. The transmission and distribution facilities should be removed from the CEB to IPP's to allow them to benefit from the same facilities and bring down the electricity tariff.
- Too much energy is being wasted through transmission and distribution network of the CEB because of the long distances from the power stations to the customers.
- He also remarked that CEB was not observing the DSM policy.
- He advocated the opening up of the electricity sector. More power stations should be constructed in the centre of the island. According to him the following measures could be considered to reduce such losses:-

  (i) A company be set up consisting of the CEB, IPP's and the Sugar Investment Trust (SIT), which represent the interest of planters, in a partnership to produce energy at an affordable price. Government should stop the exportation of molasses which could be used to produce ethanol/bioethanol and steam for production of energy and use in cars instead of petroleum products which are more expensive and polluting.

  (ii) Prior to the construction of a new power station, the CEB has to ensure that the distribution lines can afford the voltage capacity in order to avoid any massive black out in the country.

(iii) CEB should consider the least cost planning and distribution concept to produce electricity as cheaper as possible.

(iv) CEB could consider leasing its existing transmission and distribution lines to the IPP on a Lease, Develop and Operate (LDO) model. He was of the opinion that under the SSDG, SIPPs were exporting electricity to the grid and this is creating disturbances on the lines.

(v) There is a need to adopt an Operation, Maintenance and Management (OMM) concept to improve our transmission and distribution lines.

(vi) He also suggested that sugar factories and other large textile industries produce their own sources of energy through their by-products and other waste. These industries can also use boiling water steams to generate energy for their own consumption and lighting systems.

(vii) During off peak period, pumped water used for irrigation and recycled water could be used for generating electricity.

(viii) Suggestion was made to use pump storage method instead of electricity storage. Efficient pumps are available in the market and can be utilised to pump water near the sea by using renewable energy sources, wind or solar to produce electricity.

(ix) A smart grid should be put in place to accommodate all types of energy technologies.

Recommendations:

- The Chairman thanked Mr.Venkatasamy for his professional delivery and informed him that his suggestions were worth retaining. The Chairman informed him of the measures taken by Government to reduce the monopoly of the CEB and in that regard the Utility Regulatory Authority will be effective in the forth coming months. The Ministry of Energy and Public Utilities (MEPU) has also created the Energy Efficiency Management Office (EEMO) to promote energy savings and efficient use of energy. Also, the Building Control Act has been promulgated so that new buildings are conceived with a "Green" perspective. He also mentioned other large RE projects, namely, the Landfill Gas to Energy project at Mare Chicose, already operational, 2 wind farms at Plaine Sophie and Plaine des Roches and a 10 MW solar PV farm, which are in the pipeline.

- MEPU, JEC and the AFD are actually working on a project to save energy in industries. The PPP concept is being considered in coming projects.

- Mr.Venkatasamy did not have any objection for his exposé to be posted on the website of the NEC.

Name/Organization: Mr M. Desha

Date of Hearing : Tuesday 07 May, 2013

Subject Matter : Energy Efficiency & MID Fund

Presentation/Submissions:

1.0 Mr M. Desha made a presentation on energy efficiency and MID Fund found at Annex I. He expressed that the aims of Energy Efficiency can be defined as follows:

(i) obtaining more output by using less energy;
(ii) using technology available for significant reduction in the consumption of energy:
- for key sectors such as Transport, Buildings, Lighting, Equipment.
- For main categories of consumers of electrical power (domestic, industries and businesses).

Energy Efficiency precedes renewable energy

2.0 He added that renewable energy is very costly in general (except solar PV) with financial returns exceeding 7 years (if no subsidy is provided) and that for energy efficiency (EE), the payback period is lower, that is, 3 years for an energy efficient refrigerator.

3.0 Energy efficiency can be achieved by savings of up to 35% through properly designated and targeted energy audits, a more stringent Energy Efficiency Act and mandatory measures for the construction of new buildings. So, we should optimize on EE first, then proceed to RE.

Policy/Legislations

4.0 He made a few proposals as follows:

- To accelerate energy labelling for domestic appliances and enlarge range of appliances at the level of the Energy Efficiency Management Office. In this respect, appropriate resources to be allocated to the latter.
- To increase penalties associated with low power factors (PF). The penalties are not sufficient on low performing devices.
- Review of electricity tariffs to include the "pay as you use/pollute" concept so that people pay according to the rate and there is no wastage.
- To encourage industries to be more pro-active regarding energy efficiency.

- To use electronic meters for the small number of consumers (probably around 2-3%) that use over 60% of electrical power, in order to promote better Demand Side Management measures and the smart grid.
- To increase the target percentage of energy efficiency and realize the achievements as mentioned in the Long Term Energy Strategy (LTES).
- To promote greater awareness for green buildings and energy efficiency practices on the supply side.
- To review current policy measures with a view to reduce need for transportation.
- Land use has to be carefully planned.

MID Fund

5.0 He stated that:

(i) since the creation of the MID Fund in 2008 under the aegis of the Ministry of Energy and Public Utilities, funds have been used for energy projects only;

(ii) in May 2010, MID Fund was placed under the aegis of Ministry of Environment and Sustainable Development which has a mandate for Sustainable Development also; and

(iii) MIDF should have a clear plan according to its budget. Allocation of funds for the different sectors has to be made. Public should be informed accordingly and invited to submit their projects.

(iv) MIDF should allocate 20% of funds to each of the 5Es of the MID policy.

Conclusions

6.0 He concluded that the country should invest in Renewable Energy projects. Being given the volatility of renewable sources, a conventional back up (using fossil fuel) is imperial. Investment in Renewable Energy coupled with Energy Efficiency practices should be continued without increasing the use of fossil fuels and coal plants.

Recommendations:

7.0 The Chairperson stated that the MID Fund, under the aegis of the Ministry of Environment and Sustainable Development is implementing projects in not only in the energy sector but in other various sectors promoting sustainable development.

8.0 Mr M. Desha agreed that a copy of his presentation be placed on the website of the NEC.

9.0 The Chairperson stated that the NEC would be informed of the gist of discussions.

Name/Organisation: Mr.SomduthDulthumun, Chairman Mauritius Sanatan Dharma Temples Federation

Date of Hearing : Tuesday 14 May 2013.

Subject matter: Future of the Energy Sector in Mauritius and the CT power project

Presentation/Submissions

Mr.SomduthDulthumun expressed his gratitude to the Commission for having agreed to hear him. His presentation was focused on the future of the energy sector in the country and the CT power project. The salient features raised by him are summarised below:-

- According to the Integrated Energy Plan 2013-2022 of the CEB, the increase in the demand of electricity is around 4.5% annually. It is expected that the peak demand will increase from 430 MW to around 575 MW in ten years time, that is, an average annual increase of around 14 MW per year. In the short term, it is expected that the country will require an additional 100 MW in 2015 and another 100 MW in 2016/2017.
- Taking into consideration the economic growth of the country, it is estimated that an additional capacity of around 200 MW will be required by 2033.
- According to him, the use of renewable sources of energy which are environmental friendly such as solar, wind, hydro, LNG and geothermal could be considered as alternative to cater the energy demand. However, these sources are very expensive and the technologies are still in process of developments to make it affordable to all. He added that storage of energy was still at an experimental stage and the disposal and lifetime of batteries are still important issues to be tackled. The available storage batteries are causing hazard/risk to the environment and thus increasing the cost of electricity from these sources.
- Mr Dulthummun expressed doubts about the target of 35% of RE by 2025 as Mauritius will still need to have recourse to Heavy fuel oil (HFO) and coal. CEB relies a lot on heavy fuel oil for its substations to produce about 40% of the total electricity requirement of the country.
- He also said that nuclear power was out of question. As far as LNG is concerned, a large deposit is available in Tanzania, however, it would be explorable only in 20 years.
- Hence for the time being CEB has to invest in HFO or gas turbines to meet the energy requirement of the country. But these sources of energy are more than twice expensive compared to coal, which is the most readily available and least expensive option to produce energy.
- According to him the best and most feasible option to cater for the immediate needs of the country is the 2 x 55 MW coal project at Pointe aux Caves and it hs been confirmed that the site at Pointe aux Caves is the best site in Mauritius for a thermal station.

- He further added that, the CT power plant was found to be the most suitable and profitable project for the Government and CEB. The project will be handed over to CEB after 20 years at no cost. The coal will be purchased by CEB and the latter will have a control on the prices, unlike the other existing IPP's. CEB will also have an obligation to control the composition of the coal to ensure its quality; for e.g a no-mercury coal.
- The CT Power has obtained its EIA Licence with 31 stringent conditions and it has to fulfill those before starting the project.
- He further stated that other existing IPP's are not bound by such conditions and are disposing their ashes everywhere in fields and rivers.
- If the CT Power project had been allowed to start its operation since 2006, consumers would not have had to pay excessive electricity bills compared to investment made by CEB in purchasing HFO and gas turbines.
- He concluded that the CT power project is the most viable and plausible solution to cater for the short term requirements, and should be allowed to materialise. This will be beneficial for the whole country so as to satisfy the growing demand of electricity in future.
- CT Power will democratize the electricity sector and in this project there will be sharing of profits between CEB and the private promoter, whereas, in other IPP cases, all profits are pocketed by the promoters.
- With the 31 conditions imposed on CT Power in the EIA Licence, and not on the existing IPPs, Mr Dulthummun questioned whether there was a level playing field extended to the promoter.
- In the meantime the country will be forced to have recourse to HFO for electricity generation and will have to invest some Rs 5 Billion.

Recommendations:

- The Chairperson thanked Mr.Dulthummun for his exposé. Being given that the latter was concerned about whether the NEC had put away the CT Power Project, he was informed that NEC is an advisory committee and has been set up to advise Government on energy requirements and other major projects. As such it has no powers to stop projects by itself.

Name : Mgr Maurice E. Piat

Date : 14 May, 2013

Subject Matter : The moral dimension of energy production

1.0 Mgr M. E. Piat stated that in his pastoral letter in 2011, he indicated that electricity is produced with 80% of diesel or coal which consequently when burnt, give off carbon dioxide in the atmosphere. Therefore, this result in global warming which destroys life on earth. He, therefore, emphasized on the importance to take measures to save energy at home, work and school. He stated that electricity should be produced from other sources (sun, wind, water, biogas, bagasse, biomass etc).

2.0 He added that he is fully agreeable with the statement by Dr. K. Elahee in an interview in the newspaper "Le Mauricien" dated 13 May, 2013 regarding our increasing dependency on coal for the production of electricity. He stated that Dr. K. Elahee pointed out that bagasse and biomass should have been used instead of coal.

3.0 He also drew the attention of the NEC on the fact that this dependency on fossil fuel, which is a highly technical issue, has also taken a moral dimension. This moral dimension comes from the question of the choice of sources to be made with respect to energy sources. But the moral question and the technical one are linked.

4.0 He added that the society should choose whether it wants to contribute to the reduction of pollution and global warming, in order to give a viable planet to the future generation.

Proposals

5.0 He also pointed that:-

(i) The cheaper options are the more polluting ones and there should be strong political will inspired by moral responsibility towards the population;

(ii) morality contributes to give a direction to technical research;

(iii) morality is a source of motivation for a mobilisation of the population;

(iv) NEC should advise Government to prepare a concrete plan for implementing the transition from our heavy dependency on different sources of fossil fuels for the production of our electricity to the utilisation of renewable energy sources. In this respect, he requested the NEC to invite technical people in the field of environment/ecology to carry out research work and to develop means and resources how to make the transition;

(v) sensitization campaigns should also be organised to encourage the public to reduce the wastage in the electricity consumption. This motivation should start at school, in families and in local authorities;

(vi) participation of the whole nation is essential to be able to attain this objective;

(vii) the Diocese is ready to collaborate to this national mobilisation through its different educational and social institutions. In this respect, the Diocese has launched a programme for the production of electricity by using photovoltaic panels in schools. A project on the ecology in schools and colleges has been launched;

(viii) he also opined that this was an opportunity and provides an excellent "plate-forme" where all principal religious heads can work together on the matter for the betterment of the country.

Recommendations

6.0 The Chairperson talked on the 5E's of the concept of the Maurice Ile Durable. He added that several projects have been implemented with a view to attaining sustainable development.

7.0 Mgr M. E. Piat agreed that his submission to the Sub-Committee of the NEC be placed on the website of the NEC.

Name/Organisation: Mr.RehmanHabibToofany

Date : 14 May, 2013

Subject Matter : Good governance, compliance and transparency

2.0 Mr. R. H. Toofany informed that he would express his views on the following three aspects which are of national interest:-

Good Governance, compliance and transparency

(i) He stated that electricity is purchased from 8 full-time and part-time private suppliers at different prices in complicated agreements which cannot be understood by everybody. This does not reflect good governance and transparency. He added that the purchase of electricity should be effected on annual basis by tendering procedures and according to the Public Procurement Act as public funds are involved. There should also be open competition and transparency in the process.

Strategy

(ii) He added that the CFL bulb project was a good one but it encountered a few problems and had to be stopped. CEB should re-launch that project. He is of the view that importation of conventional bulbs should be discouraged if not banned completely.

Management and Change

(iii) All electric appliances should be economic and environment friendly.

(iv) Punitive rates at peak hours should be introduced.

(v) Rates after 100kw/h should be more prohibitive.

(vi) Bonus rates should be envisaged during off peak hours.

(vii) Offer of Discounts on bills where consumers pay electricity in advance.

(viii) To do away with the exemption made for CEB under the Public Procurement Act.

(ix) To tax all vehicles entering the capital at peak hours.

2.0 **Recommendations**

The Chairperson thanked Mr. R. H. Toofany for his intervention and informed that:-

(i) the Utility Regulatory Authority will be set up and operationalised shortly; and
(ii) the Energy Efficiency Management Office is preparing regulations on labelling of electrical appliance.

3.0 The Chairperson stated that the NEC would be apprised gist of discussions.

4.0 Mr Toofany agreed that his submission be posted on the NEC website.

Name : Mr.DilipsingPurguss

Date : 15 May, 2013

Subject Matter : Need for clean energy

Presentations/Submissions

1.0 Mr. D. Purgass started by saying that we should preserve our "paradise island" that attracts many tourists by its fresh air and beauty, where they can enjoy the sun, sand and sea. We have to preserve this image.

2.0 He stated that during the past 20 years, the price of fuel has been rising and will continue to rise. He added that gradually petrol would become rare and more expensive. In this respect, electricity should be produced from clean sources. In Mauritius, two sources of energy are freely available, the sun and the wind.

Proposals

3.0 He made an appeal to Government to request all heads of families to install solar panels on their houses so as to produce electricity for their own consumption. However, this should be accompanied by incentives like financial assistance and technical "know-how" for it to be successful. On the other hand, the Solar Water Heater project should continue.

Proposals/Suggestions

4.0 He pointed out that solar panels could be installed on all public buildings, including:-

(i) line barracks in Port Louis and SMF Headquarters;
(ii) prisons and police stations;
(iii) district courts;
(iv) hospitals;
(v) public schools;
(vi) post offices; and,
(vii) also private schools.

5.0 He stated that during crop season, the dried leaves of sugar cane could be burnt to produce electricity. The dried sugar cane leaves are being wasted and burnt in sugar cane fields during crop season.

6.0 Government should request Municipalities and District Councils to install solar panels on public roads for street lighting. He pointed out that very often, street lamps are still lighting during the day. This certainly results in wastage of electricity and of public funds

7.0 Private sector should be encouraged to install wind turbines in sugar cane fields where there are high tension lines connection.

8.0 All owners of a car should pay a tax fee of Rs 10. However, motorcycles should be exempted from the payment of tax.

Recommendations

9.0 The Chairperson stated that his suggestions have been noted and the NEC would be informed of the gist of the discussions. He added that the following measures have been taken:

(i) Small Independent Power Producers Scheme has been launched and is working satisfactorily;

(ii) talks have been given on sustainable development;

(iii) the Energy Efficiency Management Office has been created; and

(iv) other initiatives/measures have to be taken to encourage rain-harvesting, composting and utilisation of energy-saving bulbs.

10.0 Mr Purguss did not have any objection that his submission be posted on the website of the NEC.

Name : Mr. Ashley Appadoo

Date : 15 May, 2013

Subject Matter : The future of energy sector and energy efficiency in Mauritius

Presentations/Submissions

1.0 Mr. A. Appadoo introduced himself to members of the Sub-Committee as an Engineer. He submitted a copy of his presentation found at Annex 1.

Preparation of future changes

2.0 He stated that we have to prepare today for the future and to prepare for the changes in the energy sector in the future, we need to consider the following:-

(a) choice with respect to efficiency, availability and their economic sustainability; and

(b) the following questions should be asked:-

(i) are we going in the right direction?

(ii) Is there an established programme?

(iii) Is there a pilot project?

(iv) What is the assessment of energy projects at the moment?

(c) What is happening today will determine what the future will be, in all sectors of our country.

Examination of our energy requirements

3.0 He described our requirements of energy in 2011.

2011

- Consumption = 2730 Gwh (+1,5) % = 2
- Renewable energy = 20.2 %; fossil fuel = 79.8 %
- Capacity installed = 758 MW
- Effective Capacity = 669 MW
- Peak consumption = 412,5 MW + (2,1) %

3.1 According to him, the following points should be taken into consideration.

- Actual Energy consumption in various sectors and their energy saving capacity;
- The present status of the transmission network of electricity and solutions to their improvement;
- The real needs of secondary energy for the production of electricity;
- Natural sources of Renewable Energy and their use for electricity generation, without affecting the ecological and environmental aspect, while constructing their plants;
- Production and energy saving leading to the stability of the network for future projects; and
- Energy Efficiency.

4.0 He also talked on the following:-

- the medium and long-term active energy efficiency;
- Energy Efficiency measures in existing public and private buildings; and
- Active energy efficiency in the domestic sector.

5.0 He added that the long term vision is the production of electricity from RE sources as:-

- solar;
- wind farms; and
- hydro power energy.

Conclusion

6.0 The Key to Success towards energy transition:-

(a) a complete assessment on energy needs, capacity of production and transmission of electricity should be made;

(b) the need to have a tertiary, industrial and domestic energy efficiency in the short and long term;

(c) development of a system for energy storing to achieve the stability of the network; and

(d) connection and integration of production of renewable energy together with conventional system of production of energy, for a stability in the network.

He concluded by saying that development becomes sustainable with three fundamental elements, namely, social equity, the preservation of the environment and energy efficiency.

Recommendations

7.0 The Chairperson thanked Mr Appadoo for his insightful presentation and stated that he will evoke this presentation to the Sub-committee chaired by Dr Suddhoo, being given the technical pertinence of his exposé.

8.0 The Chairperson talked on the 5E's of the MID concept. He added that, following consultations, six (6) reports were produced, including one on energy sector. The Action Plan has to be approved by Cabinet before implementation. He also took the opportunity to inform Mr Appadoo that several initiatives have been taken as follows in the energy sector.

(i) the Energy Efficiency Management Office has been created;

(ii) measures have been taken to reduce energy consumption in buildings;

(iii) the new Building Control Act has been promulgated;

(iv) energy audits have been carried out in industries;

(v) the Small Independent Power Producers Scheme is working satisfactorily; and

(vi) renewable energy projects are being implemented by the CEB.

9.0 Mr. A. Appadoo agreed that a copy of this presentation be placed on the website of the NEC.

Name/Organisation : MrZaheerAllam who is an independent scholar with a background in Green Architecture and project management

Date of Hearing : Wednesday 15 May 2013

Subject Matter : Global warming, Energy reduction and CT Power project

Presentation/Submissions

MrZaheerAllam circulated a paper which mainly focused on:

(i) the climate crisis;
(ii) energy reduction in the field of Green buildings and urbanism; and
(iii) the views of prof Nikos Salingaros on the coal power plants.

Climate crisis/global warming

- He stated that the climate crisis is worsening much more quickly than predicted. Recently the US Nation Oceanic and Atmospheric Administration revealed that a new record of Carbon Dioxide emission in our atmosphere, exceeding 400 ppm, had been registered.

- The effects of global warming such as sea level rise, weather pattern fluctuations and ecosystem disruptions and then impact on the immediate surroundings are not familiar to many people. Summer temperatures have risen by 1°C.

- The global warming effects are also threatening the food security/safety in our neighborhood, i.e, in the Indian Ocean. As regards Mauritius we can consider ourselves lucky to be a remote island in the Indian Ocean as we live in a low density area as compared to Maldives which is considered the 'Ground zero' of global warming.

- The 'Energy observatory Mauritius Report of 2011' reveals that the energy industry is solely responsible for 60.3% of our national carbon dioxide emission. The eventual increase in energy demand annually might lead to the conclusion that the co_2 emission linked to energy production will show a similar increase.

Energy Reduction

- There is a pressing need to reduce our dependency on fossil fuels and to move towards more renewable sources of energy. According to him, the decision to construct the coal power plant of 110 mw at Pointe Aux Caves simply is in contradictory with our objectives towards a cleaner and sustainable nation in line with the Maurice Ile Durable concept.

- Consideration should be given to an intelligent and sustainable urban planning towards reducing, not only our energy but in parallel, our carbon emissions.

- Incentives should be given to people to construct Green buildings. People should be encouraged towards the concept of ecological design for new buildings as well as upgrading of our existing infrastructure.
- New buildings represented 1% of buildings stocks but attention should be paid to older buildings as well.
- Reference was made to the research undertaken by Davis Langdon in the field of ecological Architecture which reveals that it is ultimately more expensive not to go green. This is highlighted by the fact that while a green building might represent a more expensive initial investment, it becomes more economical in the long run and this is mainly due to the fact that it can reduce its energy consumption by up to 80%.
- He felts that the price of RE will continue to go down and that of fossil fuels will continue to increase. By the end of this decade the unsubsidized cost of renewable power from solar and wind energy will be no more expensive than that from oil, natural gas and coal.

Views of Prof Nikos Salingaros on the CT Power Project

- He introduced the views of Prof Nikos Salingaros who is a holder of numerous international awards and honours, ranked 11 'best urban thinker of all times' and ranked amongst the 50 visionaries that are changing the world today. In March 2013 Prof Nikos Salingaros has animated a teleconference with the press in Mauritius entitled 'A Sustainable Energy Future of Mauritius'. He has shared his views regarding '**how does coal – powered plants fit in a small island in Mauritius**' and replied that it **does not fit** at all since Mauritius is a tourist destination and we should not ruin that industry by generating smoke like in China. Throughout this exchange, Prof. Salingaros explained that a better design of our cities can create a healthier relationship between its inhabitants and the urban fabric as well making enormous savings in the transport industry. He expressed that we should not look at our energy policy in such a way that we cannot change it through better options come along.
- As a concluding note emphasis was laid on Intelligent thinking to turn towards cleaner and renewable sources of energy. Reference was made to the declaration of Prof. Salingaroswho said 'Here is a chance for a small country to be more advanced than larger ones, by redefining what 'modernity' really means within the context of sustainability and not tied to catastrophic consumerism'.

Recommendations

The chairperson thanked Mr ZaheerAllam for his presentation. The committee decided to refer his presentation to the first Technical Committee for consideration. Mr ZaheerAllam was invited to submit a concrete proposal on how to achieve energy reduction to Dr A. Suddhoo, chairman of the First Technical Committee.

Name/Organization: Mr Thierry Rey, Business Director Development, Sky Investment Holding Ltd (ENL Property) and MrKhannaCarooppunnen

Date of Hearing : Wednesday 15 May, 2013

Subject Matter : Renewable Energy at Bagatelle Mall of Mauritius

Presentation/Submissions:

Mr Thierry Rey of ENL Property circulated a power point presentation on the Renewable Energy at Bagatelle Mall of Mauritius. ENL Property proposes to generate electricity at Bagatelle Mall, using photovoltaic panels. The PV system would be installed on the roofs of the Mall to generate electricity. It will invest in the solar farm project and sell energy generated to the shop owners there.

- The aims and objectives of the project are namely:-
    - Make use of Renewable Source of Energy.
    - Reduce electricity cost and CO_2 emissions.
    - Embrace the 'Maurice Ile Durable' National Strategy.
    - Take advantage of the relative constant solar radiation in the Bagatelle region.
- A PV system of capacity 2.2 MW will be installed (2.5 MW on the roof and 0.45 MW) in the employees parking car shed.
- The challenge of the ENL property is to produce electricity at almost grid parity with the CEB. Actually the cost of production from PV system is very close to the cost of tariff of CEB, that is, Rs 5.70 per Kwh from PV, compared to Rs 5.80 per Kwh from CEB.
- ENL Property can produce 35% of the consumption of the mall during daytime representing a savings of Rs 500,000 annually for an investment of Rs 200 M.
- The solar panels have a guarantee up to 20 years (80% of its capacity will be operational up to 20 years).
- ENL has submitted a formal offer to CEB to install its PV panels and to sell the electricity thus produced to the tenants. However, the CEB has informed that under the Electricity Act 1939, nobody is allowed to sell electricity, except itself.
- According to the ENL, a review of the system to sell energy is required and in that regard a leasing agreement as in Singapore was proposed to sell the energy.

- As regards funding, ENL has already approached the AFD which has agreed to fund the project under the Green Loan with the accompanying grant of 12%..

Recommendations:

- The Committee noted that there was need to look at the legal aspect and that could be addressed under the Utility Regulatory Authority.
- The Chairman told Mr Rey that he would bring the matter up at the coming sitting of the NEC main committee.
- The Chairman thanked ENL for their presentation on the very useful project and informed them that the project will be brought before the NEC.
- Mr Rey agreed that his submission be posted on the NEC website.

Name : Mrs Jamal

Date of Hearing : Tuesday 21 May, 2013

Subject Matter : CT Power Project

Presentation/Submissions:

1.0 Mrs Jamal stated that she has been living in Albion since 29 years. She added that someone called Mr J. Christor used to produce charcoal in albion, but had to stop this activity because of Police intervention on grounds of the pollution he was causing.

2.0 She inquired as to why people, like Mr J. Christor, should be forced to stop this sort of activity while big promoters are implementing a big Coal Power Plant at Pointe aux Caves. This tantamounts to injustice towards the 'petit dimoune'.

3.0 She also pointed out that inhabitants in Albion are not allowed to carry out small businesses, whereas big promoters from outside are being allowed to set up their businesses there. Moreover, the inhabitants are not being employed by those big firms thus creating injustice to them.

4.0 Mrs Jamal ended by saying that Mr J.Christor was supposed to be heard by the Sub-committee on the same afternoon but he could not do so as he was not released from his work.

Recommendations:

5.0 The Chairperson thanked her for her submission and informed that CT Power has to satisfy 31 conditions of the EIA before implementing the project. He stated that the NEC would be apprised of the gist of discussions.

6.0 Mrs Jamal had no objection that her submission be posted on the NEC website.

Name : Mr Alain Aliphon

Date of Hearing : Tuesday 21 May, 2013

Subject Matter : CT Power Project

Presentation/Submissions:

1.0 Mr A. Aliphon is an inhabitant of Albion and a Councillor of the village but he was deponing in his personal capacity. He stated that several projects were not implemented in Albion due to the protest of the inhabitants of Albion (for e.g. a pig farm and the incinerator at La Chaumière).

2.0 He added that in 2008, Government decided not to go ahead with the CT Power project, because of objections by the inhabitants there. However in 2012, Government has revived the project.

3.0 He stated that in the 31 conditions of EIA Licence did not take on board the views of Dr Joel de Rosnay, who is an Adviser of Government. He pointed out that the voice of Dr. J. de Rosnay is missing in the 31 conditions.

4.0 He informed the Committee about the apprehension of the inhabitants in Albion with regard to the implementation of the CT Power project which will use coal to produce electricity. Also, people who intended to come to live in the region are having second thoughts.

5.0 He added that the 14 Village Counsellors of Albion and himself were against the implementation of the CT Power project. They are raising concerns about:-.

(i) the disposal of the ashes of coal which would be spread on the sea bed and thus destroy marine life; and
(ii) the construction of a jetty there.

6.0 He also talked about the wind blowing inwards during some time of the day, which would bring the pollution nearer the inhabited zone.

7.0 He concluded that if mistakes had been committed elsewhere in the past, they should not be repeated now, but there is a need to amend. Therefore, the CT Power Plant project should not exist neither in Albion nor elsewhere.

Recommendations:

8.0 The Chairperson thanked him for his submission and stated that the NEC would be informed of the gist of the discussions.

9.0 Mr Aliphon did not object to his submission being posted on the NEC website.

Name/Organisation : MrYannick Cornet, *PlateformeCitoyenne*

Date of Hearing : Wednesday 22 May 2013

Subject Matter : CT Power project

Presentation/Submissions

Mr Yannick Cornet circulated a presentation on the Fort William Thermal Power – Project Feasibility Study, based on the K&M Report of 2001. According to him, the choice of the site of Montagne Jacquot for the CT Power Project was based on this study.

- Moreover, the fesibility study was for a 300 MW plant and not 100 MW one. The 300 MW plant would be located on an 18 ha site compared to the 100 MW plant now located on a 92 ha site, which issue has even led to compulsory acquisition, including wayleaves.

- The K&M Team prepared a Preliminary Environmental Impact Assessment (PEIA). Different factors, namely, technology, emissions, effluents, waste and noise from the proposed plant were evaluated in relation to the more stringent conditions of the World Bank. Electrostatic precipitators or bag houses would have to be installed to remove fly ash from the gas stream before discharging it to the atmosphere through the stack. Coal handling and ash handling and disposal systems would be designed and operated in a manner that would minimize dust emissions.

- According to him, previously the CT Power Project was to be situatedy in the southern part of the island but the site was not found suitable as the cost involved for the storage of the coal was exorbitant.

- He further stated that the final EIA report for the CT Power Project does not correspond to the Preliminary Report published by K&M Team in 2001 as follows:-

  (i) K&M Report makes provision for the construction of a jetty for coal unloading at Montagne Jacquot while the CT Power Project is accepted without such condition;

  (ii) the K&M best solution was not coal but a combined cycle of diesel and steam which would be cheaper;

  (iii) the measures that need to be taken regarding the sulphur dioxide (SO_2) emission were not found in the CT Power Project;

  (iv) the K&M Report contains a Power Purchase Agreement and a Concession Agreement;

(v) when the K&M Report was designed and published there was no inhabitant within 11 km of the proposed site for the coal power plant. However, construction of concrete houses started in 2001 and now, the number of inhabitants in the region of Albion have increased considerably to 6000.

- Mr Cornet made specific refernce to Condition 1.A of the K&M Report on emissions, which is very controversial because of the several stringent standards spelt out.

- It was also found that no survey was conducted when the CT Power Project was designed in 2006 to 2007. This was against the provision of the K&M Report.

- The site at Montagne Jacquot is 20 m from the sea and the region is very poor in water supply. Adequate quantities of cooling water should be made available. It was found that about 7,000 m^3/hour of sea water and 60m^3/hour of fresh water would be required by the CT Power.

- The CT Power should abide to international laws and the promoter should adhere to and to comply with conditions regarding emissions. The promoter should submit a Compliance Certificate prior to implementation.

- Proposals have been made in the K&M Report for the setting up of a hotel complex. The site of an extent of 18 hectares facing the sea is actually underdeveloped, unoccupied and is not used for any beneficial purpose. The promoter of the CT Power Project should consider this issue.

Recommendations

The Chairman thanked Mr Cornet for his presentation and requested him to forward a summary of his presentation to the Committee. He did not have any objection for his presentation to be posted on the website of the NEC.

Name/Organisation: Mr.FabianiBalisson "PlateformeCitoyenne" (Deponing in his own name).

Date of Hearing : Wednesday 22 May 2013.

Subject matter : Impact of coal on human health.

Presentation/Submissions

Mr. F. Balisson thanked the Commission for giving him the opportunity to express himself and his presentation was mainly based on the impact of coal to human health.

- Mr.FabianiBalissson circulated two documents on coal namely:-

    (i) A report on coal's Assault on Human health which was published in November 2009 by Physicians for Social Responsibility (PSR); and

    (ii) A report on "the True cost of coal' – published in December 2008 by Greenpeace. The report highlights how people and the planet are paying the price for the world's dirtiest fuel. The Greenpeace Africa has supported the outcry of the Association against the setting up of the coal power plant in Mauritius.

- Reference was made of the K & M Report and published in 2001 which revealed that the site at Pointe aux Caves was found suitable/appropriate for the construction of the coal power plant. However, during that period ie (the year 2000), there was a small population in the Albion region. The demographic structure has changed considerably in that region and the population has increased by more than 80% from 2000 to 2010 with more than 6000 inhabitants now in Albion comprising mainly of young professionals. Kensington Palace, at Petit Verger, which is 400 m opposite the site proposed for CT Power plant, has about 200 families.

- There is a general apprehension of the inhabitants of the region about their future and that of their families in case the CT Power project is implemented. They are concerned about the health hazards that the project represent to them.

- He gave an example of the outcry from the inhabitants of the southern region recently who are complaining/protesting against the disposal of coal ashes in the roads, sugar cane fields and the aquifers.

- According to the Report 'coal Assault on Human Health' for each mega watt of electricity generated from coal per hour from the coal power plant about 24 persons would die. Some 225 persons will suffer from severe health problems and some 13,228 persons will suffer from less severe disease.

The True cost of coal

- The real cost of coal is not known. The External costs which are inevitably paid by the population should also be taken into consideration. The external costs may include the health risk associated with the use of coal, damages due to climate change and fatalities due to major accidents resulting from mining operation.
- The report on the "true cost of coal" reveals that coal burning contributes more to climate change that any other fossil fuel. Each year more than 11 billion tonnes of carbon dioxide are released in the atmosphere around the world.

Impacts of Coal Power Plant

- The construction of the power plant will have an impact on the tourism, marine life and aquifers. The ashes will have an impact on the environment. During drought period more water will have to be used to cool down the generators.
- He also refers to the democratisation of the energy sector that is incentives provided by the Government to the IPP's in the production of energy.
- It is believed that there will be competition and the price of electricity will reduced by 50% with the setting up of the coal power plant at Pointe aux Caves.
- But, according to him, there is no evidence that even then there will be a reduction in the price of electricity. In that regard he referred to the CentraleThermique de Belle Vue which has reduced its price of sale of energy to the CEB, but in fact there has not been any reduction in the CEB bill of customers.
- CT Power has said that the quantity of coal to be used would depend on technology and the quality of the coal. CEB should in fact buy the coal.
- Medical expenses of Government will go up as more people would be affected and would attend hospitals.
- Club Med would have to close down as no tourist would come there.
- CT Power will also impact on the whale population as sea water temperature will rise near the power plant and the sea and aquifer will also be polluted by the activities of the power plant.
- Mr Balisson supported the setting up of a 'Station Energetique' instead of a 'Centrale a production as advocated by Prof. Sharingaros.

Conclusions

- As a concluding note, he stressed that there is a need for a change in direction.
- The use of coal and other fossil fuel and carbon should be reduced considerably. The concept of Maurice Ile Durable and the use of RE sources of energy should be encouraged.
- Incentives should be given to Small IPP's to produce their own electricity to meet the increasing demand for energy requirements locally instead of investing in big power plant.
- Hotels should also be encouraged to be self-sufficient and make use of RE sources to produce their own electricity.
- NEC should not only have an advisory role but its role should be extended to a regulatory one.

Recommendations:

- The Chairman thanked Mr.Balisson for his presentation and informed him that the Utility Regulatory Authority which will regulate the utilities sector will soon be set up and will create the necessary environment to allow competition.
- He was informed that the gist of his presentation will be communicated to the main Committee.

Name : Mrs M. Troubat

Date : Wednesday 22 May, 2013

Subject Matter : CT Power Project

Presentation/Submission:

1.0 Mrs Troubat stated that she lives in Kensington Place, Pointe aux Caves and about 1.5 km from the Albion lighthouse. There are around 200 families living in that area, including old persons and children.

2.0 There have been high investments from these families and many are still paying their loans.

3.0 She inquired whether those families would need to be relocated. The fear is also that the amount of compensation would be low.

4.0 The K&M Report of 2002 dates back at the time when there were not many inhabitants as there are now.

5.0 She stated that, already, the bad smell from the wastewater treatment plant is a nuisance to the inhabitants. With the implementation of the coal power plant, people in the locality are now concerned about their health. She asked herself whether the 200 families would have to move/delocalised from Kensington Place and the implications thereof.

6.0 She suggested that Government should provide grants for RE projects in households, e.g., the installation of solar panel on houses to produce electricity and the Solar Water Heater Scheme, instead of setting up a coal power plant, which would be highly polluting.

Recommendations

7.0 The Chairperson thanked her for her submission and informed that the NEC would be apprised of the gist of the discussions.

Name : Mr AjayeJogoo

Date of Hearing : Tuesday 28 May, 2013

Subject Matter : Solar Thermal Energy project

Presentation/Submissions

1.0 Mr A. Jogoo stated that his company, Lake Eyre, deals with the energy issues since 1979. He added that the company has been working with CEB, UNDP and the Ministry of Finance & E.D to develop Tariff 312.

2.0 He stated that he is now working on an IRS project which would be carbon free and the estimated cost of the project is Rs 14 Billion. He pointed out that funds have been secured for a 4.6 MW clean electricity project. A MoU has been signed on 19 April, 2013 and an application for undertaker's license has been made and was still being awaited from the CEB.

3.0 He proceeded by a presentation of a new Solar Thermal Energy project for a 100MW energy generation (with storage facility) that they have submitted to the Chairman of the NEC on 10 March 2013. He added that the same technology has been tested in many countries, like, USA, Spain and Germany etc.

4.0 He stated that, though the price of coal is unbeatable at present but as coal is highly polluting, carbon credits could grow into a big sector in future. He even added that carbon credits would be the largest trade in the world in future.

5.0 He stated that with the implementation of the new project:

(i) there would be no pollution;

(ii) 4 to 6 hours of sun energy captured would be sufficient to produce for 24 hours of electricity;

(iii) the electricity would be stored in batteries;

(iv) the system used is hybrid (using solar and thermal sources);

(v) the pricing would be less than Rs 5 per kW per hour, during the first year (without carbon credits) and will decrease gradually; and

6.0 The land required for the project is one square mile in a sun rich area.

Recommendations

The Chairperson thanked him for his presentation and stated that the NEC would be apprised of the gist of the session.

Name	:	Mr PrakashSanjuDeenapanray
Date of Hearing	:	Tuesday 28 May, 2013
Subject Matter	:	Ecological living and sustainable development

Presentation/Submissions

1.0 Mr. P.S Deenapanray stated that he wanted to share his views for the consideration of the National Energy Commission. He submitted a copy of his presentation at Annex 1.

2.0 He highlighted the following issues for consideration:

(a) energy has a socioeconomic impact;

(b) energy in the context of Sustainable Development – a systems approach;

(c) integrating Energy in Development Planning using integrated assessment tools;

(d) the Energy-Climate nexus; and

(e) comments related to the ToR for the National Energy Commission.

3.0 He added that the three pillars of sustainable development are:

(a) society;

(b) economy; and

(c) environment.

4.0 He further stated that the three pillars of sustainable development are interconnected and complex. The same applies to climate change.

5.0 He informed the Committee that to understand the behaviour of a system, we need to:

(i) understand the structure of a system and all the decision making rules (formal and informal,explicit and implicit) within the system; and

(ii) establish the causal relationships between all variables within the system.

6.0 He said that if this is not done now, then there will be problems like:

(a) low-cost housing amplifying slum violence;

(b) building more roads for road decongestion leading to bigger problems in 20 years.

The question is how to integrate energy in development planning and how do we bring coherence between energy and land planning.

7.0 He added that the first recommendation of the mid-term review of the implementation of the Mauritius Strategy is to use integrated assessment tools to carry out sustainable development policy planning to enhance the resilience of SIDS.

8.0 The System Dynamics Modelling would:

- provide a transparent way to achieve evidence – based policy planning;
- check consistency and feasibility of major objectives and assumptions;
- inform decision makers of longer-term implications of policy choices;
- help achieve more coordinated and coherent decision making across sectors;
- provide scenarios; and
- allow for easy monitoring and evaluation (e.g. indicators/indices relevant to the country of application)

9.0 He stated that there is a methodology which can be used to develop policy instruments to support an evidence-based development of Nationally Appropriate Mitigation Actions (NAMAs) and to monitor their impacts on emission reduction, job creation, contribution to energy security, cost of investments etc.

10.0 He concluded by specifying that:-

(i) our energy policy cannot be decoupled from the wider climate change context, especially regarding mitigation under the UNFCCC;

(ii) for coherence, the climate changeconcept should form part of the ToR of Energy Commission;

(iii) the MID Fund should support capacity development in the policy-science interface;

(iv) MRC is funding Mr Deenapanray on a future energy project;

(v) It is also preparing a paper on how to stimulate statistical data, BAU and energy policy and the CEB case;

(vi) The Solar Water Heater, CFL and street lighting schemes should all be linked to climate financing.

Name/Organisation: Mr.KuganParapen.

Date of Hearing : Tuesday 28 May 2013.

Subject matter : The economic implication of a clean renewable energy.

Presentation/Submissions

Mr Parapen mainly focussed his exposé on energy production in Mauritius and elaborated on the following:

- The CT power project will cost about one billion rupees to the Mauritian economy. However, this cost includes only the accounting cost for the production of energy. The social costs and the cost of externalities should also be taken into consideration. For example the impact on tourism, health of the population and other environmental issues should be evaluated.

- According to him there is need to have a very independent report on the CT Power project which outlines the full cost/benefit analysis of the project. A full economic analysis for the current cost of production by coal v/s other renewable sources of energy, should be worked out.

- It is estimated that the importation of coal gasoline and fossil fuel for the production of energy accounts for 10% of our imports costs and 3% of our Gross Domestic product (GDP).

- It is believed that gradually there should be a shift from the current system to a system where we should not rely on import of fossil fuel and for the coal for the production of energy.

- According to him, Mauritius is a country where there are plenty of RE Sources such as wind, waves and solar and it is recommended that we should make maximum use of such sources which are not polluting and cheaper. Necessary steps should be taken to move towards such sources for the benefits of our economy. In that regard, he proposes the combined use of 50% of coal/ fossil fuel and the remaining 50% of RE Sources for the production of energy. This scenario will reduce the cost of import by 1.5% of the GDP of the country.

- This option has the following advantages for the country:-

    (i) a positive impact on the Balance of Payment that is a fall in imports will be noted and hence less foreign currency will be required;

(ii) ability and sustainability to move towards a greener energy that will cater for the future generation;

(iii) the economy of the country will prosper in the long run in term of energy production. Thailand was referred as one of the country which has made a first move towards production of energy from RE Sources and whose price is much lower today;

(iv) the shift to green energy will impact positively on the business and consumers at large. If the price of electricity bill is reduced at the end of month this means that the population will have more income to spend on other products. The shift from current mode of production to green energy will contribute towards a massive investment in the country. More and more investors and multi-nationals will be interested to invest in the country; and

(v) with the increasing competition, RE sources will cost less.

- As a concluding note, he recommends a new concept of partnership between the Government and private, corporate and household sectors to produce their own electricity. This model has been adopted by Norway and one of the main benefits for such a model is that the price of electricity will fall and everyone will get a return for his investment. It is believed that the 5 private IPP's, which are presently producing energy, are making huge profits and, hence, a new concept at a national level will benefit the whole economy.

Recommendations:

- The Chairperson thanked Mr.KuganParapen for his excellent presentation and informed him of the several projects that will be implemented in the field of RE. He was informed that the gist if his exposé will be transmitted to the NEC.

- Mr Parapen did not have any objection for his exposé to be posted on the website of the NEC.

Name/Organisation: Mr. K. Khittoo, SPR Ltée (Syndic du Syndicat des Co-propriétaires de "Kensington Place").

Date of Hearing : Wednesday 28 May 2013.

Subject matter : CT Power Project

Presentation/Submissions

Mr. K. Khittoo represents the Syndic of SPR Ltée, promoters of the housing units built at Kensington Place, Petit Verger and Pointe aux Sables.

- He expressed his concern on the implementation of the CT Power Project. He stated that Kensington Place, which started in 1997, falls well within the 1 km zone of the proposed CT Power Plant's buffer zone. The people in the locality (about 200 families) are very concerned that the implementation of the CT project represents a high risk for their health and safety. He circulated a paper from an inhabitant showing a list of sicknesses caused by coal.

- He expressed his concern to the fact that most of the families in the region are low income group and have contracted out loans to construct their houses. They are worried about their future in case they have to be relocated to another site. Being the promoter of the project and being given that there are still about 25 housing units to be sold, he fears that there will be a substantial fall of their prices.

- He said that all the risks associated with the implementation of the CT Power project should be communicated to the inhabitants.

- He added that there have been no contact between the promoter of the CT Power project or of any Government official with the representatives of the Syndic.

Recommendations:

- The Chairperson thanked Mr. K. Khittoo for his presentation and informed him that the apprehension of the residents will be communicated to the NEC.

Name/Organisation: **Mr Michel Chiffone and Mr KarimJauffeerally** for KolektifpuLenerziRenuvlab**(KLR)**

Date : 29 May 2013

Subject : CT Power and energy issues

Presentations/Submissions

1.0 Mr. Michel Chiffone stated that KLR was created with the merging of 6 groups *(ex comitésoutienlagrevlafin Jeff Lingaya)*. He thanked the sub-committee of the NEC on behalf of KLR for giving them the opportunity to share their views with regard to the energy requirements of Mauritius.

2.0 The salient features of their presentation are as follows:

- Mr KarimJauffeerally expressed that our country does not need the CT Power Project, but lacks a proper energy policy. The more coal is used, there is less chance that RE will be injected on the network.
- He added that he believes that the many figures given by CEB were erroneous, wrong and exaggerated. According to KLR, statistics show that the country does not need the CT Power Project as we have sufficient electricity production for the next 6-7 years. As such, we all have a responsibility to find other alternatives other than CT Power for electricity production. Hence, for KLR, it is vital to have a transition to renewable energy;
- He added that the IPPs have overtaken the CEB in the production of electricity although the latter has twice the capacity to produce electricity. This is a paradox, according to him;
- He further added that IPPs were precursors to CT Power. Without them, there would not be need for CT Power. He supported his arguments with a historical background;
- Moreover, our country has sufficient power stations to cater for any increase in demand of electricity up to 2018 and even beyond;
- Also, the figures show that there is no major risk of blackout in the country, but on the contrary, they show that the actual surplus in the production capacity covers our country up to 2020; and
- There is currently an effective capacity of 664 MW (CEB +IPPs) and the actual peak is 430 MW. Thus, there is a surplus. Mr Jauferally supported his arguments with detailed figures.

Proposals

3.0 Government should prepare a National Electricity Policy, which takes into consideration the social, economic and environmental aspects of the country concerning the use of fossil fuels and the control of the private sector on electricity production.

4.0 The fact that we have enough capacity up to 2020 provides a window of opportunities to do the following:

(a) a National energy policy; and

(b) a transition to RE.

KLR proposes a formula for an orderly transition to other alternatives to CT Power and coal plants as follows:

Liquefied Natural Gas + Renewable Power Generation + Electricity Power Storage (Large Scale) + Demand Side Management

Recommendations

5.0 The Chairman thanked KLR for their presentation and recommended that should the need arise, the KLR would be requested to make their presentation to the other Sub-Committee of the NEC chaired by Dr. A. Suddhoo, to consider the technical part thereof.

Name/Organization: MrP.Jeeha, representing Valo Re

Date of Hearing : Tuesday 29 May, 2013

Subject Matter : Project of a 4MW solar power plant equipped with energy storage system for Mauritius

Presentation/Submissions:

1.0 Mr.PradeepJeeha, made a presentation on behalf of Valo Re, an Italian company for a project of a 4 MW solar power plant, with storage capacity, stating that he has no stake therein. He is a consultant and the promoter is his client.

2.0 The project would require an extent of land of about 10 Ha, preferably in the west or north-west region. It will be fully financed to the estimated tune of EUR 7M and will be run by the promoter for 20 years. Finally, it will be handed over to the CEB in good running conditions.

3.0 The life span of the plant is estimated at 30 years.

4.0 The promoter expects to have state lands from government and in case state land is not provided, the promoter is ready to buy the land but this will be reflected on the selling price of electricity.

5.0 The project consists of an installation of 16640 panels and a storage of a capacity of 1000 kW/h. A yearly output of 6.7 million kW/h is expected.

Conclusions

6.0 Mr.Jeeha informed that:

- the project proposal has already been sent to the CEB on 29 April 2013, and the promoter would like the NEC to consider it as a valid proposal and act as facilitator for its implementation.
- once the PPA would be signed with the CEB, the project could be delivered within 5 months.
- the storage system will allow power to be released as and when required the most.

7.0 All the partners of this project are Italians except SAF, which French.

8.0 A premium is expected by the promoter for the storage system.

9.0 A complete technical dossier would be submitted to the CEB on 15 July 2013.

Recommendations

10.0 The Chairperson stated that the project is very interesting as it comes with its storage facility.

11.0 Mr.Jeeha agreed that a copy of his presentation be placed on the website of the NEC.

12.0 The Chairperson stated that the NEC would be informed of the gist of discussions.

Name/Organisation	:	Mr R. Awotar, Director of Council for Development of Environmental Studies and Conservation (MAUDESCO)
Date of Hearing	:	Wednesday 29 May 2013
Subject Matter	:	IPP's contract, the impact of coal burning and the role of the National Energy Commission (NEC)

Presentation/Submissions

Mr R. Awotar submitted a paper and also made an exposé which was focussed on the IPPs' contracts, the *bagasse* issue and on the impacts of coal burning.

The IPP's Contract

Mr R. Awotar congratulated the NGOs and the civil society for having been behind the making public of the Power Purchase Agreements of the IPPs. However, there contents are so complex that no one can understand and interprete them.

The Bagasse issue

- The IPPs were set up under the support of the World Bank. They are now burning about 13% of bagasse and 87% coal for the products of energy, whereas, initially, more than 60% of bagasse was being used. A few are even 100% coal based. According to him, no one is aware of what quantity of bagasse produced is presently used to generate electricity and how much is left and what is done with these.
- He also remarked that the small planters are paid only Rs 24.00 per ton of bagasse while in Reunion Island, the price of bagasse is Rs 1,300 per ton. This is unfair.

The impacts of coal burning

- He highlighted that since so long IPPs have been using coal to produce electricity, but there has never been any impact assessment made as to the effects on the surroundings. Many people are not aware how harmful the existing coal power stations are to them as compared to the CT Power, which is yet to start, but already has many environmental safeguards.
- According to him, members of the public have the impression that the NEC has been set up to look only at issues concerning the CT Power project and he thinks that this impression should be dispelled.

- 40 SIDS account for less than 2% of emissions as compared to big countries, like Germany alone, which has commissioned up to 17 coal power plants.

The urgent publication of two Reports

He mentioned about:

- the William & Hutton Report, which was commissioned by the authorities to undertake a detailed study of the IPPs Power Purchase Agreements and which has revealed that the IPPs have been benefitting from many advantages and have been making huge profits; and
- The K & M Report by the American consultants regarding the Pointe Aux Caves site should also be published in view of the various representations from the public and the press/media reporting about the Pointe Aux Caves site.

These reports have not been made public and many people do not know how harmful the IPPs are to them. An impact exercise on the IPPs will shed more light on the whole issue.

Proposals to the NEC

- NEC should organize meetings with the inhabitants of regions near the two IPPs (FUEL and St Aubin) to explain the impacts of coal burning on their health and environment;
- NEC should also have consultations with the small planters to discuss the issue of bagasse;
- NEC should also consider the publications of the two reports on the IPPs, namely the William & Hutton Report and the K & M Report, so as to restore equity (The 31 conditions applied on CT Power are unique but equity should apply to all);
- The IPP's PPAs contracts should also be reviewed;
- There should be a complete ban of disposal of ashes by the IPP's on the roads, open fields and rivers;
- NEC should commission a study on the impacts of coal burning on the health of the surrounding population and environment and on the impacts of coal ashes on underground water and should be carried out;
- The IPPs should be compelled to purchase pulverized coals with low mercury and CO_2 contents which are more effluent and less pollutants compared to raw coal;
- IPPs should replace their current obsolete equipment by the latest technology including EU standards emission filters;

- NEC, in collaboration with the MID Commission and other bodies, should carry out sensitization campaigns on energy issues particularly energy savings;
- NEC should produce an unbiased and balanced report that will guarantee transparency and will help to produce reliable, continuous and affordable energy to the country;
- Finally, NEC's mission should not end with the publication of its report but should continue and it might be requested to play a co-ordinating role on energy issues with all stakeholders, including women, youth, students and other NGOs;

Recommendations

The Chairman thanked Mr Awotar for his presentation and valuable suggestions and informed him that his views and comments will be brought before the NEC.

Name/Organisation: Mr.MukeshSeepaul and Mr B.Doobah of Algae Biodiesel Company Ltd.

Date of Hearing : Tuesday 04 June 2013.

Subject matter : Biodiesel Production from use vegetable oil and algae.

Presentation/Submissions

1. Mr. B. Doobah presented the project of Biodiesel Company Ltd on the production of Biodiesel from used vegetable oil and also from algae.

2. The points made were as follows:-

- The project consists buying and collecting the used oil from hospitals and hotels. This is treated and processed to be used as fuel in vehicles possessing diesel engine systems such as huge excavations, minibus, several 4x4 pick up trucks, trailers etc.
- Presently the pilot project is processing 700 litre of used oil per day, producing around 600 lts of biodiesel (around 3 barrels a day) through a biodiesel processor capable of producing 250 lts per batch. Around 3 batches can easily be processed per day which makes around 750 litres.
- 2.9 million litres of used oil is generated every year out of which 2 million litres can be effectively recovered.
- A by-product of crude glycerol is obtained during the process (120 litres daily).
- The use of the product on vehicles have proved to be successful up to now. Savings of around 10% daily on fuel consumption have been made(i.e biodiesel runs 10% distance more). It was also found that the smoke emission has reduced considerably and the product is acting as a lubricant in the engine as well. B2, B5, and B 10 can be envisaged. Even B100 is possible according to the company.
- Laboratory air emissions tests done at Rey &Lenferna concerning air pollution on several blends of the company's biodiesel have been successful. Opacity test, using smoke meter, was also successful.
- The selling price of the Biodiesel is estimated at Rs 39 per litre. The company is purchasing the used/waste vegetable oil from hospitals and hotels at the rate of Rs 5.00 per litre.

- Oil can be obtained from algae in huge quantities, by simple mechanical pressing, decantation and cleaning. Biodiesel is then obtained by the process of trans-esterification of the oil in a processor.
- The company also proposes to make biodiesel from used tyres in the near future.
- The company has approached the MIDF to fund the project.

Recommendations:

3. The Chairperson thanked Mr.Doobah for his presentation and informed him that his proposal is very interesting and will be referred to the main Committee of the NEC for consideration.

4. He advised the company to contact the Ministry of Commerce and the State Trading Corporation (STC) to commercialise its products. The STC is the only entity legally authorised to commercialise any type of fuel and the Ministry of Commerce is the only authority to allow blending.

Name : Mr. Patrick Tardieu and Mr. Stephan Law Kwong

Date : 04 June, 2013

Subject Matter : Mauritius as an importation platform for PV panels.

Presentation/Submission:

1.0 Mr. Patrick Tardieu informed the Committee that he lives in Reunion Island and is the Director General of a company called Idea Groupe, manufacturer of solar PV systems. His company is working with the Consultant Appavoo Corporate in Mauritius.

2.0 His project is to make Mauritius a platform for the importation and stockage of PV panels for energy production. Therefore, he wants to create a company in Mauritius which would sell photovoltaic panels to individuals, firms, etc and for export to countries in the region.

3.0 The company also makes use of innovative processes, such as laying of PV modules on the roof top of green houses thereby optimizing the upper surface for the production of energy and the green house for agricultural purposes, depending on the configuration of the land or according to the needs of its clients.

Recommendations

4.0 The Chairperson thanked Mr. P. Tardieu for his presentation and advised him to liaise with the Central Electricity Board with a view to find the way forward for implementation of the project. He also invited him to consult the following two documents before meeting CEB, namely, the:-

(i) Long Term Energy Strategy Plan on the website of the MEPU; and

(ii) Integrated Energy Plan on the CEB website.

Name/Organisation: Mr. Louis Appollon

Date: 05 June 2013

Subject: MID Commission and Renewable Energy

Presentation:

1.0 Mr. Louis Appollon, an inhabitant of Pointe aux Sables, thanked the Commission for having given to him the opportunity to express himself the on energy issues in Mauritius.

2.0 The salient features of his presentation are as follows:

- According to him, the MID Commission is not doing enough in the field of renewable energy.
- He informed that he has installed 2 series of photovoltaic panels at his residence since the past 3 years to produce electricity for his own consumption and this has helped him to make good savings.
- He believes that many people can encouraged to do the same by giving them incentives, like for the Solar Water Heaters Scheme and this will help decreasing the demand on the CEB grid.
- He also found it unacceptable that big industries were using electricity from the grid to boil water for dying, while they could have used other means and made savings and help the CEB too.

2.0 The Chairman intervened and explained to him that such grants/schemes exist to promote renewable energy. The Small Scale Distributed Generation (SSDG) for a generation capacity of up to 3MW was set up to encourage interested small power producers and more than 400 applications had been received. However, only 300 families and institutions benefited from this scheme at preferential feed-in tariffs. Still, ways and means are being looked into to accommodate the remaining interested parties. Mr.Appollon admitted that he was not aware of that. He added that people are unaware of those acitivities and he believed that there is a lack of communication in the field of renewable energy.

Conclusions and Recommendations

3.0 Mr. Louis Appollon suggested that;

(i) Government should invest more on renewable energy projects and should provide grants/loans and set up schemes to encourage people to make use of renewable energy.

(ii) there should be more communication on the activities of Government and the MID Commission in that field.

(iii) there should be more sensitization campaigns on energy efficiency and for people to use energy saving devices in their day to day life.

4.0 The Chairman thanked him for his presentation and informed him that the gist of his submissions will be communicated to the main Committee.

Name	:	Mr Laurent de Morelos and Mr Robin Virahsawmy of Equilibre Bioenergy Production Ltd
Date of Hearing	:	5 June, 2013
Subject Matter	:	Biomass as an alternative to Fossil Fuel

Presentation

1.0 Mr Laurent de Morelos made a presentation on biomass as an alternative to fossil fuel and on the project of his company, namely, Equilibre Bioenergy Production Ltd, to produce electricity from *arundodonax*.

2.0 He stated that the World Energy Outlook from the International Energy Agency predicts the demand for oil will rise from 85 Million barrels per day to nearly 120 barrels per day around 2030. It means that in year 2030, two-thirds of fossil fuel demand will have to be met from new forms of fuel, which is not available today.

3.0 He added that biomass has the ability to reduce the world's reliance on fossil fuels and spur the creation of new industries around the production of renewable energy because:-

(i) it is an effective way to capture vast amounts of carbon, and to provide an optimum energy feedstock for bio-energyproduction;

(ii) biomass from locally selected energetic plants can be harvested all year round in large quantities at a reasonably low cost;

(iii) energetic cane is not a food crop and offers very high yields, thus limiting the need for vast areas of agricultural land.

ArundoDonax - a Bio-Energy plant

3.0 *Arundodonax* is an energy crop cultivated by EQUILIBRE– Bioenergy Production Ltd from locally found species. It is a cane-reed like plant and can be harvested 2-3 times a year. The University of Mauritius and the Ministry of Agro Industry and Food Security have raised no objection to the project.

4.0 The advantages of cultivating that crop are as follows:

(a) sustainable and cost competitive alternative to fossil fuels;

(b) it grows in a wide range of climates and soil types in comparison to other food crops;

(c) its plantations mature quickly with the first harvest in seven months;

(d) planting and harvesting can be programmed to match feedstock requirements; and

(e) it requires much water at planting and germination stages and does not need irrigation afterwards.

5.0 The following issues were also highlighted by Mr Laurent de Morelos:

(i) the project would be financed from their own funds;

(ii) the country would reduce its importation on coal once the project would be implemented;

(iii) World Bank has been contacted for areas of assistance;

(iv) 3,000 hectares (with approx. 700 ha for each phase) of marginal/unutilised land would be required to cultivate the crop;

(v) allocation of 250 Ha of land has been guaranteed by the planters in Solitude, but the problem is that the portions are scattered; and

(vi) 5,000 hectares of cultivation of *arundodonax* would be required in the medium term. It would be used to produce diesel and electricity that would be equivalent to the importation of 4,000 tons of coal.

Proposals

6.0 Equilibre Bioenergy Ltd proposed that a 'Mauritius Energy Crops Scheme' be set up, which could provide loans/grants to small planters to assist them for the cultivation of approved energy crops with a view to entice the agricultural sector to support "Green" energy production.

6.1 Assistance could be as follows:

(i) the Development Bank of Mauritius could be requested to devise a scheme which could be a loan guaranteed by Government;

(ii) Ministry of Agro Industry and Food Security could be approached for the acquisition of state land/SIT Land to be used for the production of biomass for energy generation.

6.2 Financing could be provided through:

(i) 50% grant from the Government for actual costs (suppliers, materials, contractors costs ;or/and

(ii) 50% of on-Farm costs (use of own labour and machinery).

7.0 Two proposals were therefore made to be considered by the NEC as follows:

(a) to put in place a grant scheme for the production of electricity, e.g, Rs 50,000 per ha for the 3000 ha of land required. This would not apply for production from diesel. The Scheme would cover, in the first instance, the conversion of land so as to enable the production of 'arundodonax'; and

(b) Government to also make land available to the promoter.

Recommendations

7.0 The Chairperson stated that the National Energy Commission would be informed gist of the discussions.

Name/Organization: Mr Patrick Maurel, Chief Executive Officer, Ultimate Power Producers Ltd and Solid Waste Recycling Ltd

Date of Hearing : Wednesday 05 June, 2013

Subject Matter : Waste to Energy and Composting projects

Presentation/Submissions:

1. The presentation of Mr Patrick Maurel was based on his existing project of production of compost from waste at la Chaumiere and his proposed project to generate electricity from waste.

(i) Waste to Compost project (Solid Waste Recycling Ltd (SWRL))

- SWRL operates a successful composting plant at La Chaumière on a land leased from Government. SWRL receives about 300 tons of solid waste daily at La Chaumière for composting and the treated compost is sold as fertiliser.
- SWRL is actually receiving only half of the waste allocated by the Government. It is proposing to increase its daily input to some 550 tonnes of waste daily in the near future. With La Chaumière composting facility operational, a large quantity of waste is being diverted from the Mare Chicose Sanitary Landfill.
- Moreover, from the wastes that SWRL receives, some 30% to 40% cannot be composted and goes to the Mare Chicose landfill.

(ii) Waste to Energy project (Ultimate Power Producer Ltd (UPPL))

- The owners of SWRL have decided to set up a new company, Ultimate Power Producer Ltd (UPPL) to use the residual waste at the composting plant to generate electricity which would be sold to CEB. UPPL would build and operate a waste to energy plant on the land leased at La Chaumière.
- Any residual waste therefrom, which is estimated to be almost zero would continue to be transported to the landfill at Mare Chicose, but this time in very reduced quantities.
- Based on a preliminary assessment of prospective technologies, the plant would be running for 8000 hours annually to produce some 15 MW per hour of electricity **(based on the reject from processing of 550 metric**

ton of solid waste daily) while at the same time it would fully abide by the stringent EU standards on exhaust emission.

- UPPL has appointed WSP Future Energy based in London as Consultant to provide advisory services for the planning and development of its waste-to-energy project at La Chaumière. The consultant has already shortlisted four technologies which are environmental friendly to produce some 15 MW of electricity for 8000 hrs annually. All four technologies pertain to pyrolisis.

3. The representatives of UPPL informed that they have already presented their project to the Board of Investment (BOI) last year and that there is a Cabinet decision related to the project.

4. The Promoter has discussed the project with the CEB and the latter has asked certain technical details and its best offer/price of the electricity to be sold. The Promoter has also requested the NEC to facilitate communication with all stakeholders with a view to bring transparency, prior to the implementation stage.

5. According to SWRL, this project will lead to a savings of Rs 200M/year to Government.

6. SWRL added that, if approved, the project can start in 12 months.

Recommendations:

7. The Chairman thanked the company for the presentation and informed him that his proposal would be transmitted to the NEC.

Name/Organisation: Ms AdiTeelock, PlateformMorisLanvironnman (PML)NGO Network.

Date of Hearing : Tuesday 11 June 2013.

Subject matter : Use of coal for electricity generation and its impact.

Presentation/Submission

1. Ms.AdiTeelock circulated a copy of her presentation which is focused on the use of coal as a fuel input for electricity generation and its impact.

2. The salient issues raised in the presentation are highlighted below:-

(i) the importation of coal from South-Africa is not very expensive if measured in monetary terms, however, we should take into account the external costs involved, i.e, environmental, social and human costs. It can then be deduced that the cost of coal is very expensive compared to other sources. Moreover, up to now, no study has been done on the impact of coal on human health, rivers, marine resources etc;

(ii) Mauritius is in a contradictory situation, having, on one hand the MID vision and on the other the increasing use of coal for electricity production;

(iii) since 1990, over 1.5 billion tonnes of coal have been imported for the purpose of electricity generation and the successive stages in the increase in its use relate to the coming into operation of coal-bagasse power plants and one power plant using coal only;

(iv) Mauritius imports about 660,000 tonnes of coal annually and with the coming into operation of the 110 MW coal fired plants, imports of coal will increase by 66% yearly;

(v) the average wholesale price of coal in Mauritius has increased from Rs 2062 to Rs 4758 from 2004 to 2011 representing an increase of 130%;

(vi) electricity from coal represents 40.6% of total electricity production in 2011 and import of this fuel impacts heavily on the balance of trade;

(vii) calculations have shown that power plants using coal produce 30% of ash and have produced an average of 188,000 tonnes of coal ash per year between 2007 and 2011 inclusive. The total CO2 emissions in 2010 have been 3,666,500 tonnes of which 2,224,300 tonnes (60.6%) are from electricity production. The volume of CO_2 emissions (CT power included) will cost around **Rs 780 million yearly**.

The CT Power project

3. As regard the proposed CT power plant, it appears that this project will entail additional capital investment and operating cost due to the significant changes from the initial submission in 2007 which means that will impact on the proposed tariff for electricity. No change in PPA should be entertained. Furthermore, CT Power said that they were going to produce electricity at low costs.

4. It also appears that no detailed feasibility study in terms of the technical, social and environmental aspects have been carried out by the promoter for the installation of the coal power plant. These aspects should be taken into consideration to determine the capital and operating costs so that the feasibility of the project can be ascertained.

5. Furthermore, the coal to be supplied by the CEB to the CT power as per agreement between the two parties should have been precised. In the event CEB does furnish good quality of coal e.g pulverised coal then it would have to pay an additional costs to CT Power. This would have a direct impact on the electricity tariff.

Proposals of the PlateformMorisLanvironnman(PML)

PML is proposing the following options for the production of electricity within the framework of a sustainability assessment and a strategic environment assessment of an electricity generation policy:-

- concentrated and sustained efforts in demand-side management through energy conservation and energy efficiency;
- the conduct of a sustainability assessment/strategic environmental assessment, which includes a comprehensive comparative analyses of life cycle costs of all electricity generation technologies and practices, to guide the development of future energy policies;
- a phasing out of coal as a non renewable energy source for electricity production and phasing in of cleanly powered smart grids;
- the setting up of an independent commission to establish the feasibility of the CT Power Project;
- the promoter has to consider the various aspects, such as compulsory land acquisition and relocation of the land owners in the area, as per international standards and these

should be disclosed in the EIA report to reflect the social implications as well as economic costs to the project;

- the associated costs of the construction of the jetty to transport coal to the plant site as one of the conditions of the EIA Licence, should also be considered;
- specific measures and incentives to give a real impulse to renewable electricity production, including that by SIPPs;
- exploration of possibilities of collective electricity production;
- more efficient use of available bagasse and a national policy regarding bagasse use that is more proactive and beneficial to all bagasse producers. At the same time, the amount of bagasse as a renewable energy source for the existing bagasse/coal power plants must not be allowed to decrease;
- in case of the need to resort to fossil fuels, the use of natural gas (LNG) should be considered as natural gas has far less external costs that coal and fuel oil and carries the advantage of allowing flexibility of electricity production to meet peak demand;
- the immediate promulgation of stringent air emission limits for pollutants for all thermal plants (IPPs and CEB) and the development of a transparent and efficient regulatory framework for the monitoring of all wastes (solid, liquid and gaseous) at operation stage;
- the formulation of a national coal ash management policy for the existing power and industrial plants using coal as energy source; and
- the setting up of an independent (from production and distribution) regulatory body for the electricity sector. An independent committee should be set up to review the contract of all IPP's and the CT power project.
- In case CT Power wants a waiver for any condition, it should go to a tribunal and not to the Ministry of Environment & S.D.

Observations

CT Power has national implications as follows:

- It will take us further from our target of 35% of RE energy by 2025.
- It is an obstacle to the integration of renewable energy.
- We are going to be locked with an additional coal power plant.

Recommendations:

7. The Chairperson thanked the Ms.AdiTeelock for her exposé and informed her that the gist of the presentation would be referred to the National Energy Commission. Ms.AdiTeelock did not have any objection for the presentation to be posted on the website of the NEC

Name : Mr. KarimJauferally

Date of Hearing : Tuesday 11 June, 2013

Subject Matter :Impact of oil prices on the Mauritian economy

Presentation:

1. Mr.KarimJauferally made his exposé on the importation of oil on the GDP and economic growth rate.
2. He added that he has used readily available data from Statistics Mauritius, annual reports of the Bank of Mauritius and other reports on energy statistical review.
3. Various ratios have been computed from 1976 to 2011 and were displayed graphically. Accordingly, it was found that these ratios exhibit interesting trends over the years and they also correlated with each other to a high degree.
4. Using the above ratios, it was possible to map out the impact of oil prices on savings, consumption and economic growth in Mauritius, showing that the price of oil is a determinant factor in our growth rate. The main findings are that as the price of oil increases a larger proportion of our revenue on exports goes into paying for fossil fuels, whilst savings drops.
5. It was also shown that coal price depends on that of fuel oil.
6. A full power-point presentation was made and a copy was submitted to the committee.

Conclusions and recommendations

7. To conclude, he wanted to show, through statistics and figures, that, by all means, the importation of fuel oil should be made to decrease, in a sustainable Mauritius.
8. The Chairperson stated that the exposé was very sharp and technical and that the NEC would be informed of the gist of discussions. A copy of the presenation would be submitted to the Sub-committeee chaired by Dr.Suddhoo.

9. Mr Jauferally had no objection that his presentation be posted on the NEC website

Name : Mr. Mark Arendse, Director of Eaglefin Mauritius Ltd

Date : 12 June 2013

Subject Matter : Proposal for the setting up of a compressed Natural Gas Project in Mauritius.

Presentation/Submission:

1.0 Mr. M. Arendse stated that Eaglefin Structured Finance Mauritius Ltd (ESFML) is a private company located in Ebene and has a shared service office in South Africa. He stated that the company has thirty years of experience in the successful implementation of various projects in a variety of industrial sectors through Africa. He added that the company is submitting a project proposal incorporating a fully funded solution to the energy needs of Mauritius based upon the importation and storage of compressed natural gas (CNG).

2.0 The proposed project will cover the following:-

(d) a CNG import and bulk supply project.

(e) a 120 MW Floating Power Plant project.

(f) a CNG Vehicle Transportation Distribution Network (NGV) project.

3.0 He stated that natural gas is clean and sustainable source of energy and it has high energy conversion efficiencies for power generation.

Proposed 120 MW Floating Power Plant Project

4.0 ESFML is proposing to set up a new floating power plant consisting of 120 MW power generation capacity, specifically designed for Mauritian conditions. He stated that the project will consist of a power barge which will be set up in the South of Port Louis. He added that 120 MW of energy would be supplied to the grid of the CEB. The Chairperson queried as to how much would electricity thus produced would cost.

5.0 It was replied that the exact price cannot be ascertained. However, in Ghana, a country where there is no available gas, the price is USD 0.12 - USD 0.19/kW/h.

6.0 The power barge component of the project will be constructed in two stages namely:-

(i) the first stage will include the construction of the Floating Power Plant of 120 MW capacity, with two turbines, complete with all ancillary and auxiliary

equipment, inspection, testing, ABS certification, shop commissioning, handover and ready for transport to site; and

(ii) the second stage to be commenced simultaneously with the first stage is for the construction of all earthworks and civil works related to general site location including the graving dock, with all associated land based civil and structural facilities required, such as administration building infrastructure, tanks, workshops and stores.

CNG used by vehicles

7.0 He pointed out that CNG can be promoted as the ultimate fuelling alternative for the public transport sector in Mauritius. CNG is stored in cylinders designed and manufactured specifically to fit this purpose in any type of vehicle. He stated that modifications would have to be brought to the engine and tanks of the vehicle while using CNG.

8.0 He added that, there is one such project already in Venezuela and the company concerned is also involved here.

Funding of Project

9.0 ESFML, through its global funding capacity and partnerships is able to offer a funding solution for the projects described above under a funding structure which is 100% funded by their Funding Partners.

Duration of the implementation of the project

10.0 The project would be completed in 15 months' time.

Recommendations

11.0 The Chairperson stated that the NEC would be informed of the gist of the presentation. He also requested Mr.Arendse to liaise with the CEB and the State Trading Corporation with regard to his project.

Name/Organisation: Mr.KailashRamdhary and Mr. T. Ujoodah of Planters' Reform Association.

Date of Hearing : Wednesday 12 June 2013.

Subject matter: The price of bagasse to planters for use in the production of electricity.

Presentation/Submission

1. Mr.KailashRamdhary thanked the Commission for giving him the opportunity to present his proposal and to explain apprehension of the sugar planters' community regarding the price paid to them on bagasse used to generate electricity.

2. Presently, electricity production by IPP's represents between 40% to 45% of the total national consumption. More than half of this percentage is generated from bagasse. Bagasse has the great advantage of being carbon neutral and is readily available. Mauritius currently produces about 4 million tons of sugarcane every year and about 30% of this is bagasse (about 400,000 tons of sugar, 1,300,000 tons of bagasse and 120,000 tons of molasses).

3. Mr Ramdharry pointed out that electricity production from bagasse has increased but the Bagasse Transfer Price (BTPF) value has remained stagnant, that is Rs 100 per ton, since 1985. In Reunion Island, he added, the price is Rs 1, 300 per tonne.He also added that in the Government Programme 2012-2015, it is stated that there will be a review.

4. He further informed that about 9000 hectares of land which is lying waste and have a yield potential of some 750,000 tons of sugar cane, i.e, 78,000 tons of sugar, 250, 000 tons of bagasse and 22,000 tons of molasses. The use of the bagasse to produce electricity could help to save some 125,000 tons of coal.

Proposal of the Association

5. The Planters Reform Association have made the following proposals:-

(i) the price of surplus bagasse which has remained unchanged at Rs 100 per ton since 1985 must be urgently reviewed taking into consideration the present economic and environmental value of bagasse;

(ii) All legislation related to bagasse and all agreements between IPPs and sugar planters related to bagasse transfer to planters should be reviewed taking into consideration the planters' concerns;

(iii) the Control & Arbitration Department (formerly control Board) should work out a price mechanism for bagasse just like for molasses and sugar;

(iv) a study should be conducted on the ideal cane production mix taking into consideration energy production;

(v) planters should be encouraged to utilise their unused land to cultivate cane with high fibre contents of more than 40% which will considerably increase electricity output from biomass. This will enable the country to make consequent savings on the importation of coal.

(vi) A study should be carried out on how to use the abandoned/marginal land for production of electricity, like the production of biomass and installation of solar PV panels.

Recommendations:

6. The Chairman thanked the Mr.Ramdhary for his valuable contribution and informed him that his proposal would be transmitted to the main committee of the NEC for consideration. He might be called to make his proposals in front of the NEC.

Name	:	Mr P. Rungloll
Date of Hearing	:	Wednesday 12 June, 2013
Subject Matter	:	Disposal of coal ash

Presentation/Submissions

1.0 Mr. P. Rungloll stated that he requested for answers to his questions to the Sub-committee regarding the spreading of coal ash by IPPs, incl. CT Power. He wanted to know what provision has been made in the EIA report concerning the spreading of coal ash in sugar cane fields by the existing IPPs.

2.0 Mr R. Imrith explained to him that the terms of reference of the National Energy Commission (NEC) are to:

(i) review national energy requirements;

(ii) advise Government and other authorities concerned in the planning and execution of major projects in the energy sector to fully meet medium and long term needs; and

(iii) oversee the operation of the MID Fund.

3.0 He added that the Sub-Committee has been mandated to hear all the submissions related to the ToR and to submit its recommendations to the main committee of the NEC. He informed him that the relevant authority would conduct the appropriate tests with respect to the ash, and that CT Power would have to abide by the new conditions of the EIA prior to implementation.

4.0 Mr Y. Hookoomsing stated that the question raised by Mr Rungloll was very pertinent and same would be highlighted in the report of the Sub-Committee for submission to the main committee of the NEC.

Name/Organisation: TÜV SÜD South Africa – Mr. Leon Nel

Date: 14 August 2013

Subject: Environment services to support Mauritius in the reduction of emissions

Presentation/Submissions:

1.0 Mr. Leon Nel thanked the commission for giving him the opportunity to make a presentation to the National Energy Commission. He gave a brief overview of the company which was created in 1866 and is a multinational company present in various countries over the world. The company is considered as a ***one-stop shop technical solution provider***. It is involved in providing services such as testing, certification, inspection, auditing and system certification, Knowledge and training**.**

2.0 The salient features of his presentation are as follows:

- TÜV SÜD provides high quality technical services in the field of Energy efficiency, Renewable energy, mainly wind and PV technologies;
- TÜV SÜD can provide its services in major renewable projects starting from the technical consultancy, pre-feasibility, feasibility, design, procurement and construction to commissioning, operation and repowering phases;
- The company is interested to provide its services in Mauritius; and
- The company has the vision of being a global player, with the objective of using our country as a platform to provide its services for major projects in the region and on the African continent.

3.0 The Chairman thanked Mr Leon Nel for his presentation and pointed out that the main challenges facing Mauritius in renewable energy are:

Cost of renewable energy;

- Grid parity; and
- How to resolve the intermittency issue.

4.0 The Chairman suggested that TÜV SÜD considers to come up with solutions regarding the above issues and submits for consideration by Mauritius.

Recommendations

5.0 Mr. Leon Nel thanked the Commission for allowing him to make his presentation thereto and stated that his company came to Mauritius following the invitation of Enterprise Mauritius.

6.0 The Chairman informed MrNel that the NEC will be made aware of the gist of his presentation.

Name : Solarprod Ltd

Date : Wednesday 14 August, 2013

Subject Matter : Gasification of Waste for the production of energy.

Presentation/Submissions:

1.0 Mr Hoarau, the representative of Solarprod Ltd stated that with urbanisation, industrialisation and economic development, there has been a rapid and constant increase in the production of waste. This causes a bad effect on the health of the human beings and on their quality of life as well as on the environment.

2.0 He further stated that between 2007 and 2011, the generation of waste by the world population has increased by 37.3 % which represent about 8% yearly. The world demand in energy keeps on increasing due to industrialisation and growing population. Therefore, there is an urgent need to find alternative solutions to the problem of waste.

3.0 Solarprod is member of a French group, which operates on all French departments. It is engaged in 3 businesses, namely, RE operation, the manufacture of equipment of solar, wind and small hydro power plants and in the plant of gasification of waste to produce energy.

The process of gasification

4.0 Mr Hoarau briefly explained the process. Partial oxidization of organic matter at low temperature (400 degrees) converts the organic matter, treated in syngas and inert ash, which is commonly known as “dissociation moléculaire”.

5.0 Therefore, a plant has to be installed which will extract up to 95% thermal energy contained in any type of organic matter having a rate of humidity up to 60%. One such plant will treat 60,000 tonnes of waste and generate 1 MW of electricity.

6.0 The gasification technology is a clean, performing and economical system which converts the biomass and wastes into thermal and electrical energy.

Recommendations

7.0 The Chairperson stated that the representatives of Solarprod should liaise with the Ministry and Local Government and Outer Islands which is responsible for the disposal of wastes.

8.0 The Chairperson stated that the NEC would be apprised of the gist of the discussion.

Name/Organisation: Island Power Ltd Mauritius-Mr. Ahmed Bundhoo and his consultant Dr. Kevin Ramdhun

Date: 14 August 2013

Subject: Biodiesel from algae

Presentation/Submissions:

1.0 Mr. Ahmed Bundhoo thanked the commission for giving him the opportunity to make a presentation to the National Energy Commission. He informed the members of the NEC, that Dr. Kevin Ramdhun, his consultant, will make the presentation which is on the cultivation of algae for the production of biodiesel.

2.0 The salient features of the presentation are as follows:

- Algae can be cultivated on any type of soil and its cultivation does not affect other agricultural crops;
- Algae cultivation is very much dependent on the sun, and with Mauritius being a tropical island, it is easy to cultivate algae at a larger scale. With good climatic conditions, algae can be harvested after 48 hours;
- 5000 litres of oil may be produced daily from algae cultivated on 10 acres of land. Mr. Ahmed Bundhoo pointed out that he has already applied for land for algae cultivation in February 2013 and is still waiting for a reply;
- Glycerine is also a by-product of algae and can be used in the production of beauty products and shampoo;
- The production of biodiesel from algae is 99.9% pure biodiesel and can be mixed with the one we currently buy on the market.
- Car importers are willing to add only 5% of biodiesel with diesel used presently.

Conclusions and Recommendations

3.0 The Chairman thanked the members for their presentation and made the following suggestions:

- To meet the Ministry of Commerce and the State Trading Corporation
- to meet the Ministry of Housing & Lands to discuss the issue of land allocation;

- to consider talking with companies that has already been granted land from Government for wind energy projects. The space in-between the turbines can be used for the cultivation of algae;

- to discuss with car importers about the possibility of mixing biodiesel with the current diesel being used on the market.

4.0 The Chairperson also wanted to know whether biodiesel has reached commercial stage in any country. Dr. Kevin Ramdhun confirmed that one company, Culturing Solutions Inc., is already selling biodiesel in the United States of America.

5.0 The Chairman concluded by saying that the NEC would be informed of the gist of the presentation and about the different issues raised. He also suggested that he may facilitate a meeting with the STC for further discussions regarding the possible commercialization of biodiesel.

Name/Organization: Dr Kevin Ramdhun, Kievnov International

Date of Hearing : Wednesday 14 August, 2013

Subject Matter : Domestic Biogas Plant

Presentation/Submissions:

1.0 Dr K. Ramdhun circulated a paper on his project regarding the KievnovSyrod Environmental Technology Domestic Biogas Plant. He informed that, at Kievnov Science and Environmental Technologies Co. Ltd, they are engaged in the implementation, promotion, popularization and research in Bio-waste Management, non-conventional energy and energy conservation programmes.

2.0 He added that biogas plant is an airtight container that facilitates fermentation of material by a micro-organism, under anaerobic condition. Recycling and treatment of organic wastes (biodegradable material) through anaerobic digestion (fermentation) technology not only provides biogas as a clean and convenient fuel but also an excellent and enriched bio-manure.

3.0 Anaerobic digestion of organic matter produces a mixture of methane and carbon dioxide gas that can be used as a fuel for cooking, lighting, mechanical power and generation of electricity or a replacement for other fuels.

4.0 He highlighted that waste from the kitchen, human and animal waste, indigenous plants or residues from agriculture crops can be used for the production of biogas. The plant produces 1 kg of gas daily with 5 kg waste mixed with water.

5.0 Biogas provides safe and environmentally sound way to dispose of a variety of organic wastes, thus improving local health and sanitation.

6.0 One unit of the biogas plant could cost around Rs 30,000 and can come to Rs 20,000 with mass production.

Recommendations:

7.0 The Chairperson stated that the project is a very interesting one and in line with the MID concept. He requested Mr K. Ramdhun to submit a comprehensive project brief to the Maurice Ile Durable Fund for consideration. He added that the project could be implemented on a pilot basis in schools.

8.0 Mr K. Ramdhun agreed that his presentation be placed on the website of the NEC.

9.0 The Chairperson stated that the NEC would be apprised of the gist of the discussion.